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ABSTRACT

The purpose of this thesis is to evaluate whether the Territorial Use-Rights in Fishing (TURFs) of Lake Titicaca, Peru, are effective in overcoming the common property problem of typical fisheries and therefore whether TURFs may prove valuable as part of a more formal management system. It has recently been argued that TURFs should be incorporated into small-scale fisheries management schemes since they should be effective in controlling fishing effort, in promoting a more equitable distribution of the benefits from fishing and in reducing administrative inefficiencies.

To determine whether TURFs are in fact effective in controlling fishing effort, I examine Lake Titicaca fisheries in Peru. First, I demonstrate the widespread existence of Lake Titicaca's TURFs and their control over the entire shoreline, most of the littoral area and even part of the pelagic area. Second, I document how, in spite of TURFs' illegality, Lake Titicaca shore dwellers are able to combine legal and illegal means to enforce their traditional rights over their fishing areas. Third, by showing that the relative difference between the returns to labour from fishing with those from alternative activities ranges from 50 to more than 100%, I demonstrate that local fishermen capture substantial fishing rents. If one takes into account that most fishing activities are carried out when there is little else to do, this range increases to 90-180%. I thus conclude that Lake Titicaca fisheries have not reached their bioeconomic equilibrium yet and that the predictions of the common property theory do not apply to them. And fourth, I demonstrate that the origins of these rents can be traced to fishermen's membership in TURF-holding communities, their ability to restrict physical access to the shoreline, and the obligations associated with this membership. Among these obligations are the participation in communal projects and celebrations, the
fulfillment of administrative or ceremonial responsibilities, and the
undertaking of agricultural activities, all of which constrain the amount of
household labour available for fishing. In the concluding section, I consider
the potential role of TURFs in a formal management context. I show that, in
the long term, even formally recognized TURFs would not be sufficient in
themselves to prevent overfishing. I therefore propose that Lake Titicaca
TURFs be incorporated into a broader, decentralized management strategy which
would capitalize on their strengths and promote cooperation between members of
shore communities, fisheries scientists and administrators.
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This dissertation study sprung from my initial involvement with Lake Titicaca fisheries while working in Peru, between 1979 and 1981, for the Food and Agriculture Organization of the United Nations. I wish to acknowledge the financial support of the University of British Columbia through its Summer Fellowship and Graduate Student Fellowship programs, of the World University Services of Canada through its Franco-Canadian Fellowship program and of the Donner Foundation. I also wish to acknowledge the support of Project FAO-PER/76/022, the National Science Foundation, the CIDA/UBC/UNTA project and the Canadian Association for Latin American and Caribbean Studies for the undertaking of my fieldwork during the summer of 1984.

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Although primarily an academic exercise, this project resulted in a continuous challenge for personal growth. I wish to acknowledge here the tremendous help received during trying times from my friends. May they all find here the expression of my sincere appreciation and profound gratitude for sharing both the enjoyable and the less enjoyable times with me.

I dedicate this thesis to my parents who by their trust and affection have demonstrated to me their continuous support and their conviction that I would eventually complete a meaningful and worthwhile project.
CHAPTER 1

INTRODUCTION

1.1 OBJECTIVES AND RATIONALE

The overall objective of this study is to determine whether Territorial Use-Rights in Fishing (TURFs), which I define as exclusive and limited rights held by locally or culturally defined communities of shore dwellers over fishing resources found in specific parts of their aquatic environment, are effective in overcoming the common property problem of typical fisheries. Taking the TURFs system of Lake Titicaca fisheries in Peru as a case study, I consider whether TURFs could be integrated into a formal management regime.

According to common property theory, fishing effort within an unregulated fishery tends to increase until the corresponding resource rents are dissipated (Gordon 1954). To prevent the dissipation of these rents, fisheries management in the form of control of fishing effort is needed. TURFs have recently attracted a growing amount of attention because of their potential for mitigating the problems resulting from the common property status of most fisheries resources (Christy 1982; Panayotou 1984). While there remain serious doubts as to whether this theoretical potential is translated into practice (Lawson 1984), the effectiveness of TURFs can be evaluated in terms of their ability to control fishing effort and to prevent the dissipation of the rents from a fishery. In the case of Lake Titicaca, Peru, such an evaluation entails:

1. Documenting the existence and dimensions of Lake Titicaca TURFs;
2. Demonstrating their active enforcement all along the shoreline;
3. Determining whether fishing rents are captured by local fishermen;
4. Evaluating the contribution of TURFs to the generation of these rents.

The research addresses the general need for appropriate forms of fisheries management by documenting the potential of TURFs for the management of small-scale fisheries. The selection of Lake Titicaca TURFs for study is specially useful because of their potential contribution to the economy of the Peruvian Altiplano surrounding Lake Titicaca.

1.2. NEED FOR APPROPRIATE FORMS OF FISHERIES MANAGEMENT

1.2.1. Need for fisheries management

Fisheries resources have to be managed because, although renewable, they are vulnerable. They can be destroyed by pollution particularly in shallow coastal areas and inland waters where most small-scale fishing takes place (Scudder and Conelly 1985). And, because of their common property status, they can be overexploited and eventually decimated by the very people whose welfare depends upon them (Gordon 1954), a phenomenon popularly known as the tragedy of the commons (Hardin 1968).

According to common property theory, fishing effort within an unregulated fishery tends to increase until average fishing revenue becomes equal to average fishing cost (Gordon 1954). As long as the expected revenues from participating in this fishery (AR) are greater than the costs faced by an average fishing unit (AC), new fishing units have an economic incentive to enter this fishery, unless physically or legally prevented from doing so (Figure 1). Once average revenue equals average cost, this incentive dissappears, the resource rents represented by the difference between average revenue and average cost are said to have been dissipated, and the fishery is said to have reached its bionomic equilibrium (Ibid.).
FIGURE I: BASIC ECONOMIC MODEL OF A SINGLE SPECIES FISHERY (from Gordon 1954).
An unregulated fishery which has reached its bionomic equilibrium is said to be exploited beyond its social optimum (i.e. overfished) because some of the resources allocated to fishing could have generated higher returns in other sectors of the economy (Gordon 1954). Within such a fishery regulation is needed to control fishing effort in order to prevent the dissipation of fishing rents and therefore to promote a more efficient allocation of society's resources (Ibid.).

The regulation of fishing effort is only one form of fisheries management, because fisheries management includes all activities designed to increase the utility that accrues to society from its fisheries resources (Carlander 1969; Rothschild and Forney 1979). However, I use the terms regulation and management interchangeably, following a practice common in the literature of fishery economics which is more specifically concerned with legislative or regulatory techniques of fisheries management (Anderson 1977; Panayotou 1982).

Given the predictions of common property theory, the only way to determine whether a regulation or management technique is effective in controlling fishing effort within a particular fishery is to demonstrate that this technique is responsible for the capture of fishing rents within this fishery. Fisheries management techniques could also be evaluated in terms of other criteria such as their ability to promote an equitable distribution of the benefits from a fishery (Christy 1982). However, I have not considered these additional criteria here, because they may be promoted independently of effort control and without an increase of the economic yield from the fishery considered. Furthermore, trade-offs may have to be made between them and economic efficiency, as in the case of social equity (Ibid.).

Following Gordon's (1954) seminal analysis, the occurrence of overfishing
has been documented in many large-scale commercial and industrial fisheries in the developed world (Crutchfield and Zellner 1962; Crutchfield and Pontecorvo 1969; Scott and Neher 1981). More recently, the occurrence of overfishing has been demonstrated in many small-scale fisheries of the Less Developed Countries (LDCs) as well (Smith 1981; McCay 1981; Bailey 1982; Neal 1982). Furthermore, the fisheries regulations used so far have proved ineffective in controlling fishing effort and particularly inappropriate for the limited technical and administrative abilities of most LDCs (Scudder and Conelly 1985; Pollnac 1986) such as Peru.

1.2.2. Shortcomings of past fisheries management practices

A wide array of regulations has been proposed and implemented for the purpose of controlling fishing effort. These regulations have often proved ineffective, because fishermen repeatedly find new ways to circumvent them and to increase their fishing effort (Pearse 1979; Wilen 1979). Moreover their implementation has proved expensive because, to counteract fishermen's evasive tactics, fisheries regulations have to become more complex, which makes their administrative efficiency dwindle (Scott and Neher 1981; Panayotou 1984). The administrative costs of small-scale fisheries management have outgrown the financial abilities of many LDCs, and local fisheries agencies are hardly able to keep their activities at even a minimum level (Scudder and Conelly 1985; Pollnac 1986). In addition to administrative inefficiencies, the implementation of fisheries regulations often leads to higher fishing costs by inducing an increase in redundant fishing capacity (Munro 1982; Munro and Scott 1984). The shortcomings of the management techniques presently used have spurred a continuous search for alternatives which would be both more appropriate for LDCs' administrative abilities (Pollnac 1986) and more effective. Ideally, such alternatives should eliminate the common property
problem without leading to an increase in redundant fishing capital and to the administrative inefficiency resulting from fishermen's evasive tactics.

1.2.3. Alternative forms of fisheries management

The search for more appropriate forms of fisheries management has led to the identification of two major sets of alternatives involving either the imposition of taxes or the conferring of property rights (Clark 1979). Taxes are payments of part of the fishing revenues to the state. They correspond to an artificial increase in fishing costs, which can be incurred either before fishing takes place in the case of licence fees, or after it has taken place in the case of taxes on landings.

Property rights correspond to fishing rights granted to individual or groups of fishermen, either over portions of the aquatic space, or over portions of the fishing resources regardless of their location, or over portions of the fishing resources in specific locations. The creation of limited property rights has been proposed as a solution to the common property problem (Demsetz 1967; Eckert 1977; Pearse 1981). Such rights may be translated into individual catch quotas which are granted to each fisherman. Alternatively, these rights may be constrained by such criteria as time or fishing method. Individual fishermen may thus hold temporary access rights to specific fishing grounds, providing they use specific fishing methods. The specification of property rights is referred to as stinting (Ciriacy-Wantrup 1975; Pearse 1980). It may indirectly result in a quantitative allocation of fisheries resources between users.

Theoretical comparisons between property rights and taxes indicate that they are roughly equivalent in terms of controlling fishing effort and promoting economic efficiency within a fishery (Clark 1979; Crutchfield 1979).
However, property rights are likely to involve lower administrative costs than taxes (Maloney and Pearse 1979; Scott 1979). One should thus try to determine which of the various systems of property rights would be most effective.

In his theoretical comparison of various forms of property rights, Pearse (1980) shows that the more exclusive fishing rights such as sole property are likely to be more effective in controlling fishing effort, but that the less exclusive ones such as group property would minimize administrative costs. A regime of property rights of intermediate exclusivity between the extremes of no property and sole property would therefore be optimal, because it would give the best trade-off between economic efficiency and administrative costs (Pearse 1980; Runge 1986). Existing systems of water tenure and customary fishing rules, including Territorial Use-Rights in Fishing (TURFs) are among the forms that such a regime could take.

1.3. TERRITORIAL USE-RIGHTS IN FISHING (TURFS)

1.3.1. Definition of TURFs

In the last decade, a large number of studies have documented the existence of territorial fishing rights. These rights have alternately been referred to as native possessory rights (Goldschmidt and Haas 1946), traditional or customary fishing rights (Lawson 1984), territorial fishing rights (Acheson 1975; 1979; Panayotou 1982), sea tenure (Alexander 1977), sea ownership (Petit-Skinner 1983) or sea territoriality (Pallson 1982; Levine 1984), and traditional fisheries conservation or management practices (Kapetsky 1981), until the term of Territorial Use-Rights in Fishing (TURFs) was coined by Christy (1982), and gained some currency (Panayotou 1982; 1984; McGoodwin 1984).

For the purpose of this study, I define Territorial Use-Rights in Fishing
(TURFs) as systems of aquatic tenure which involve the holding of exclusive and limited rights by spatially or culturally defined communities of shore dwellers over fishing resources found in specific parts of their aquatic environment. This definition disqualifies both nationally held Exclusive Economic Zones and privately owned fishing areas (Panayotou 1983). It expands on previous definitions (Christy 1982; Panayotou 1984) because it does not restrict the types of rights involved to exclusive use rights. Finally, it underscores the need for caution in a survey of the literature in which the existence of TURFs is documented.

Studies in which the existence of TURFs is documented have often focussed upon particular fishing resources, for example lobster (Acheson 1975; 1979), crayfish (Levine 1984) or cod (Andersen and Stiles 1973). However, TURFs are generally more site-specific than resource-specific (Christy 1982). They can involve any type or combination of aquatic resources including fish, algae (Arzel 1984), shellfishes and crustaceans (Asada et al. 1983), irrespective of whether they are used for food, medicinal or decorative purposes (Petit-Skinner 1983). Contrary to resource rights which cover the whole range of a particular resource, they may cover only part of the range or habitat of the resources they involve, as in the case of highly mobile or migratory species.

Such studies have also often focused upon particular fishing methods, such as fixed fishing traps (Martin 1979) or beach seines (Alexander 1977), although TURFs are not method-specific. They often concern a range of fishing methods used by local fishermen (Johannes 1977; 1978), even if they do not affect all of them to the same extent. For instance less effective fishing methods, such as the small gear used by foot fishermen (Andersen 1979; Labby 1976: 86) or hand collection by women and children may not be subject to the restrictions of TURFs (Allan et al. 1948: 118).
Finally, many of these studies have dealt with specific ecological or fishing zones, such as brackish coastal lagoons (Cattarinussi 1973; Demestre et al. 1977) or river estuaries (Cordell 1974; 1978), although TURFs can affect any part of the aquatic environment surrounding a fishing community (Berkes 1977; Davis 1984). Many fishing communities actually hold a series of fishing rights over various parts of their aquatic environment defined by such criteria as water depth, distance from shore (Andersen 1979; Petit-Skinner 1983) or distance from the community (Johannes 1977; 1978).

1.3.2. Dimensions of TURFs

Because some authors have focussed on the spatial dimension of TURFs, we tend to think of TURF as a unidimensional concept. However, as a system of water tenure, TURF is a multidimensional social concept which, like a land tenure system, can be characterized in terms of four major dimensions: spatial, temporal, demographic and cultural.

The spatial dimension refers to the physical boundaries of the territory to which a TURF system applies. The temporal dimension refers to the period during which it is in force. Implicit in the spatial and temporal dimensions is a resource dimension, which corresponds to the proportion of the resource involved. The presence of resources within a TURF area may be temporary, as with migratory resources, or permanent but only a small proportion of the resources concerned is found within any given TURF area.

The demographic dimension classes individuals and groups according to their inclusion or exclusion from a particular set of rights and obligations. It indicates how exclusive the rights involved are by describing the referent group. Finally, the cultural dimension refers to the legal (formal) or customary (informal) conditions under which the distribution, transfer and exercise of rights apply, thus to the kind of rights TURF holders can exercise.
over local resources and to the duties these rights entail. As for land tenure systems, these different rights are grouped into six broad categories: direct use-rights, rights of indirect economic gains, control rights, transfer rights, residual rights and symbolic rights (Crocombe 1974).

Direct use-rights include the rights to harvest or to husband the resources within a TURF area. Rights of indirect economic gain involve TURF holders' ability as individuals or as a group to get an economic compensation from outsiders whom they allow to use their resources temporarily. Control rights refer to the types of controls and regulations that can be implemented by TURF holders. Transfer rights stipulate the conditions under which TURF holders can transfer their rights permanently, or those under which outsiders can gain membership into a TURF holding community. Residual rights specify what happen to rights which cannot be transferred by their holders for lack of an acceptable recipient, or because these rights have been withdrawn from their holders. Finally, symbolic rights represent the political, cultural, or spiritual significance of the resources and areas of a TURF for their holders.

Not only are TURFs multidimensional, but they may also be reinforced by other forms of ownership, for example, the ownership of such intangibles as fishing techniques, fishing songs and fishing rituals (Johannes 1977; 1978; Petit-Skinner 1983). They can also be reinforced by exclusive navigational, landing, berthing or mooring rights (McCay 1980; Fernando et al. 1985; Ruddle and Johannes 1985: passim) and by exclusive rights over portions of the shore used for fish processing, particularly fish drying (Petit-Skinner 1983) or fish smoking (Suttles 1960). Finally, TURFs can be found in combination with other informal or self regulatory mechanisms (McGoodwin 1984), sometimes referred to as customary rules (Alexander 1980) or as social practices (Berkes 1977), which various authors have tried to classify (Pollnac and Littlefield
1.3.4. Potential benefits of TURFs

For decades, fishing traditions, including TURFs, have been considered as impediments to fisheries development and to the improvement of fishermen's welfare because fisheries development was assimilated with an unconstrained increase in fishing effort (Kirby and Sczepanik 1957; Sabri 1977; FAO/RAS/77/P10 1979). Although government regulations have frequently superseded traditional TURFs, the latter are still customarily enforced in many regions of the world (Pollnac and Littlefield 1983; MacGoodwin 1984; Scudder and Conelly 1985; Ruddle and Akamichi 1985; Ruddle and Johannes 1985; Berkes 1986). Most recently, their potential contribution to fisheries management has warranted them a growing amount of interest.

The potential contribution of TURFs to fisheries management actually involves five major elements. First, it has been claimed that TURFs could reduce if not eliminate the common property condition of fisheries resources and eliminate the problems associated with it (Pollnac and Littlefield 1983: 235). These problems, or externalities, result from the negative effects of each fisherman's actions on the catches and returns of other fishermen. Fishermen do not perceive these impacts, nor do they have any economic incentive to take them into account. Because TURFs incorporate self-serving individuals into small and autonomous communities whose members know each other, they create social or moral incentives for these individuals to take externalities into account, thus imposing on them "the larger rationality of community survival" (Emmerson 1980: 32). However, both the exclusion of outsiders (Ciriacy-Wantrup 1975) and the control of the use of labour and capital within TURF holding communities must be combined to achieve the
desired result (Panayotou 1982: 155). The implementation of fishing rules within these communities may also be necessary to reduce interferences and conflicts between fishermen.

Second, TURFs could promote administrative efficiency in at least three different ways. They would allow for adjustments to social or economic change by introducing flexibility into the control of fishing effort since TURF holders could adapt their management objectives to new social or economic circumstances almost instantaneously (Panayotou 1982). They would also allow for the introduction of necessary on-line revisions of management objectives to adapt to environmental variability (Scott and Neher 1981). Finally, they would transfer a large share of organizational costs to TURF holders themselves (Pearse 1980). In particular, they would reduce implementation costs wherever TURFs already exist (Kapetsky 1981), simply because formalized management regimes based on them would be more readily acceptable than alternative forms of fisheries management. And since TURFs are so common in small-scale fisheries as to be almost ubiquitous, such strategies could be used in many parts of the world.

Third, TURFs could promote an increase in the physical productivity of exploited fish resources, because they would give their holders the incentive to invest in their resources for increased future returns. They would also allow for the collection of more appropriate and more reliable technical information, since under a TURF-based management regime fishermen are both the principal producers and beneficiaries of such information. This could in turn allow for a reduction in the security margins of catch limitations, which would permit the utilization of fisheries resources at a level closer to their actual potential. This could be further reinforced by the possibility of engaging in an active process of adaptive management (Walters and Hilborn
1975; 1978) since harvesting experiments could be undertaken in the discrete management units corresponding to different TURF areas.

Fourth, TURFs could promote social equity because traditional sea tenure and customary fishing practices often lead to an equitable distribution of fish catches (Alexander 1980). The corresponding joint rights of access could also promote a more equitable distribution of aquatic resources among users than a system of private rights (Runge 1986). And a TURF-based management strategy would also reduce the bureaucratic complexities associated with centralized fisheries management (Neal 1982) which tend to discriminate against the disadvantaged, the least educated or the poorest (Ward 1982). Finally, it would instill greater accountability into the present system of fisheries management which has already lent itself to accusations of despotism (Scott and Neher 1981) and insensitivity to fishermen's needs (Davis 1984).

Because of these benefits some authors do not hesitate to advocate the granting of a formal status to traditional sea tenure and customary fishing rules (Johannes 1982), or their incorporation into fisheries management practices (Pollnac and Littlefield 1983; Davis 1984). Most contributors, however, are more cautious in their recommendations. They acknowledge the potential benefits of TURFs, but they also recognize the paucity of relevant information, and suggest careful examination of traditional TURFs and of their appropriateness for fisheries management purposes (Acheson 1981; Pearse 1980; ICLARM 1981; Kapetsky 1981; Christy 1982; Panayotou 1982; 1983; Lamson and Cohen 1984; Lawson 1984).

All this confirms that it is indeed critical to determine whether the "many kinds of norms and institutions fishermen (have) invented to control access and fishing procedures could be used as a basis for successful resource management" (Acheson 1981: 307-308). Such an investigation would lead to the
elaboration of new institutions which would capitalize upon the advantages of traditional fisheries management practices (Alexander 1980). It would thus contribute to the emergence of a new model of resource management similar to those proposed by various contributors: resource self-management (Berkes 1985), community-based resource management (Lamson and Cohen 1984) and fishery co-management (Pinkerton 1986).

1.4. EFFECTIVENESS OF EXISTING TURFS

1.4.1. Limitations on the effectiveness of TURFs

It has been argued that the theoretical effectiveness of TURFs in controlling fishing effort is not translated into practice. For example, these systems result in an allocation of space, rather than of resources (Andersen and Stiles 1973; McCay 1980; 1981), and they provide rules for the conduct of fishing, rather than for the conservation of fisheries resources (Acheson 1981; Pallsson 1982). Although these objections do not necessarily invalidate TURFs for fisheries management purposes, they raise the issue of whether existing TURFs actually lead to a control of fishing effort.

The effectiveness of TURFs in controlling fishing effort depends in part on the ability of their holders to coordinate their fishing practices, both within and between TURF holding communities. Coordination within TURF holding communities is necessary, because the creation of incentives for individual fishermen to take the external effects of their fishing activities into account is not an automatic consequence of the existence of TURFs. Internal mechanisms controlling TURF holders' fishing activities have to be devised to induce them to incorporate these externalities into their decision-making processes. As Gordon himself stated: "In cases of group tenure where the numbers of the group are large, there is still the necessity of coordinating
the practices of exploitation" (Gordon 1954: 134). Coordination between TURF holding communities is also necessary, because highly mobile or migratory fish resources do not remain within a TURF area for their entire life cycle. Moreover, neighbouring TURFs often share the same transboundary stocks, since individual TURFs are rarely large enough to encompass the whole range of a stock. In either case, TURF areas rarely correspond to the ranges of fisheries resources. In short, one cannot argue that existing TURFs should be used for fisheries management purposes simply because they already exist or because of their theoretical effectiveness. Their actual effectiveness has to be tested in each case.

1.4.2. Evaluation of the control of TURFs on access to fishing

A review of the relevant literature demonstrates that few scholars who have documented TURFs evaluate their effectiveness on the basis of empirical data. Some by-pass the difficulty of this assessment by claiming that the assumptions of the common property model do not apply (Pollnac and Littlefield 1983: 235). Others do claim that existing TURFs prevent outsiders from gaining access to local fisheries, thus resulting in a control of fishing effort through a control of the number of participants (Acheson 1975; Berkes 1977; 1985; 1986; Davis 1984). Berkes (1977) observes that the lack of incentive to create a surplus in a subsistence economy may result in a high yield per unit of effort while controlling total effort and therefore impact on stocks.

The evidence presented by these authors is insufficient to prove the effectiveness of TURFs for three reasons. First, the claim by insiders that they exclude outsiders does not prove that the latter would want to enter the
fishery anyway. For instance, insiders' control of access to a fishery may be of little relevance to outsiders if the bionomic equilibrium of this fishery has already been reached.

Secondly, the exclusion of outsiders is a form of limited entry which allows for the control of only one dimension of fishing effort. It does not imply a willingness or an ability on the part of the licensed-in or insiders to limit their own fishing activities (Rettig and Ginter 1978). TURF holders may still increase their respective fishing efforts till the bionomic equilibrium of the fishery is reached.

And thirdly, contrary to Berkes's (1977) conclusion, a high biological yield does not prove that either TURFs, or the social practices associated with them control total fishing effort. The fishery studied may have a high biological yield, even at its bionomic equilibrium, simply because the cost of fishing happens to be high relative to the value of the fish caught, as could occur with any lightly exploited fishery (Troadec 1983: 10). If average fishing cost was twice as high as depicted in Figure 1, a much higher biological yield would be obtained for the fishery considered, with a much lower level of fishing effort, but still at bionomic equilibrium. TURFs and associated social practices would not have to intervene in the explanation of this high yield.

1.4.3. Evaluations of the control of TURFs on fishing effort

Only a handful of scholars have actually considered the role of TURFs in the promotion of economic efficiency to demonstrate their effectiveness in controlling fishing effort. Gordon (1954: 134) does claim that in a few places along the Canadian Atlantic coast, lobster fishermen manage to capture fisheries rents, but he does not provide empirical evidence to support his claim. Acheson and Wilson confirm Gordon's earlier claim by demonstrating
that both biological and economic productivity are higher in the controlled areas of the Maine lobster fishery (Acheson 1975; Wilson 1977). However, they end up demonstrating that privately-held fishing rights are more effective than communally-held TURFs.

Fernando, Munasinghe, Panayotou and their collaborators demonstrate that small-scale fishermen in Sri Lanka are able to capture substantial economic rents, and argue that local TURFs are responsible for this (Fernando 1984a; 1984b; Fernando et al. 1984; Munasinghe 1984; Panayotou 1984). Unfortunately, they provide no information on the dimensions, distribution or enforcement of these TURFs about which, with one exception (Alexander 1975; 1977), little is known. Finally, Smith and Panayotou (1984) demonstrate that the system of municipal concessions in the milkfish fry gathering fisheries of the Philippines allow the TURF-holding municipalities to capture the corresponding rents through competitive bidding over annual concessions.

Only those studies which determine whether a fishery is operated at an economically efficient level, and also assess the role of TURFs in preventing this fishery from reaching its bionomic equilibrium, actually assess the effectiveness of TURFs in controlling total fishing effort. Therefore, to be complete, an empirical evaluation of the effectiveness of TURFs should include four successive steps. First, it should document the existence of local TURFs; second, it should demonstrate that TURF holders are actually able to enforce their TURFs, in spite of any official opposition resulting from the informal and eventually illegal character of TURFs; third, it should show that substantial rents are being captured by TURF holders (i.e. that local fisheries have not reached their bionomic equilibrium yet); and fourth, it should provide evidence that these rents result from the active enforcement of local TURFs rather than from some technological or economic limitations on
total fishing effort.

1.4.4. Evaluation of the effectiveness of Lake Titicaca TURFs

There were several advantages to selecting the communal fishing rights traditionally enforced by Lake Titicaca shore dwellers as a case study. First, there was preliminary evidence that the territorial fishing rights of Lake Titicaca fit the definition of TURFs (Levieil 1986). Second, it was clear that one could calculate the economic value of Lake Titicaca fishermen’s catch, since they exchange about 83% of it through barter and trade (Orlove 1986), which is not always possible with subsistence-oriented fisheries. Third, a large amount of information on the social and economic structures of local populations was already available, which is not usually the case for small-scale fishing populations of the Third World. All this information was necessary for the completion of the tasks involved in the assessment of local the effectiveness of TURFs.

Finally, there is ample evidence that Lake Titicaca fisheries did contribute to the economy of the Peruvian Altiplano surrounding Lake Titicaca, and that their effective management might preserve and eventually increase this contribution over the long term. Lake Titicaca fisheries represent a major source of income and protein for more than 3,000 shore-dwelling families (Bustamante and Trevino 1976; Alfaro et al. 1981) and a supplementary source of protein for the population of the rest of the Altiplano (Ferroni 1980). Appropriate management of these fisheries is thus highly necessary given the poverty of the Altiplano relative to the rest of Peru (Amaty Leon 1981), the failure of numerous local development projects (Sanchez 1983), the dramatic depletion of some of the local fish resources (Appendix B), and the inability of the local fisheries administration to assume its management responsibilities (Laba 1979).
CHAPTER 2

CONTEXT, MATERIAL AND METHODS OF THE STUDY

2.1 NATURAL AND HUMAN ENVIRONMENT OF LAKE TITICACA

2.1.1. Natural environment

Lake Titicaca (Figure 2) is a large (8,559 km²), high altitude (3,808m), tropical (15 degrees south) lake which lies on the border between Peru and Bolivia. According to the official map of the Peruano-Bolivian hydrographic commission, its maximum length is approximately 250km, its maximum width 60km and its perimeter 1,850 km. It includes three connected basins: the Large Lake or Lago Grande (6,542 km², 284 m deep), the Puno Bay or Bahía de Puno (589 km², 25 m deep), and the Small Lake or Lago Pequeno (1,367 km², 40 m deep) (Boulange and Aquize 1981). Two smaller lakes, Arapa (195 km²) and Umayo (46 km²) are intermittently connected with Lake Titicaca through the floodplains of the Ramis and Illapa Rivers respectively (Figure 2). The Peruvian portion of Lake Titicaca represents about 60% of its total area. It includes about 65% of the total shoreline, five of the seven main tributaries to the lake, and half of its only outlet, the Rio Desaguadero, which marks the boundary between Peru and Bolivia (Figure 2).

Most of the 57,340km² (Ibid.) of Lake Titicaca's watershed corresponds to a high altitude plateau, the Altiplano, which lies between the western and the eastern Andean ranges. The Altiplano is covered with rolling hills of alluvial and lacustrine origin. Low average temperatures (6 to 12 degrees Celsius) with frequent night frosts, and low annual precipitation (500 to 1,000 mm in the circumlacustrine area, 200 to 500 mm further inland) are responsible for its semi-arid mountain climate (Ibid.). Precipitation is
highly seasonal on the Altiplano where the rainy months (December to March) account for 72% of the total rainfall, the transition months (April, September to November) for 22% and the dry months (May to August) for 6% (Ibid.).

Variations in precipitation are largely responsible for the seasonal fluctuations of the lake level which average 1 m per year (Collot 1980). Long term changes in precipitation also generate year to year fluctuations of the lake level, with a difference of 5.2 m between the recorded extremes of 1940 and 1980 (Ibid.), which has been superseded since the rainy season of 1986, when the lake reached a level higher than its recorded maximum. Because much of Lake Titicaca is surrounded by flat shore areas where a change of the water level of 1 or 2 meters means a displacement of the shoreline of a few kilometers, fluctuations of the lake level often entail drastic changes in the local supply of cultivable land with dramatic impacts on the local economy (Claverias and Manrique 1983).

2.1.2. Administrative organization

Peru includes 24 Departments. The Department of Puno represents 5.6% of the country's total area, and 4.6% of its total population. The Peruvian Altiplano accounts for 30% of the area of the Department, and more than 90% of its population of 871,000 (INE 1981). The population comprises two linguistic groups, the Quechuas and the Aymaras, and is concentrated around Lake Titicaca (Figure 2) with a density 37 inhabitants/km2 close to the lake, compared to a density of only 5 inhabitants/km2 further inland (INE 1981). This concentration may be explained as the result of the favourable conditions for agricultural production in the circumlacustre area and of the history of the Altiplano (Appendix B).

The Department of Puno includes 9 Provinces, three of which encompass the whole lake shore area: Puno, Chucuito and Huancane. These Provinces are
divided into Districts, 21 of which are adjacent to the lake (Figure 2). Finally, these Districts comprise a number of human settlements with various administrative statutes: agrarian cooperatives, municipalities, communities and parcialities. Only a minor part of the shoreline belongs to collectively owned agrarian cooperatives, or to municipalities such as the City of Puno. The majority belong to peasant communities (Comunidades Campesinas) and to parcialities (parcialidades).

Peasant communities and parcialities are territorial groups of families exploiting both privately owned or usufructed lands for continuous production, and collectively owned lands for fallow cultivation. They are not only characterized by the sharing of a common residence and territory, but also by their social, political and religious organization, all of which result in their solidarity and maintenance (Casaverde 1978; Fioravanti-Molinie 1978). The major difference between them is that land is by law collectively owned in communities and privately in parcialities. In practice, however, the distinction is blurred.

In peasant communities, individuals actually own the land customarily inheriting, exchanging or selling it, even though the latter is illegal. In parcialities, the group of residents retains traditional rights of control over its members' agricultural activities (Mayer 1985). Since parcialities and peasant communities operate in the same way as social, political and administrative institutions, I treat them as equivalents for the purpose of this study. Unless specific reference to official status is required, I will refer to them both as communities, and I will indicate the district to which each belongs because they are often difficult to locate.
2.2. LAKE TITICACA FISHERIES

2.2.1. Aquatic resources

a) Fish resources

Lake Titicaca fish resources include native species and exotic species. The former are endemic to the lake and include the cyprinodont genus *Orestias*, which represented 67% of the fish harvested from Lake Titicaca in 1980 (Alfaro et al. 1982), and the catfish genus *Trichomycterus* which represented 6.7% of this harvest (Ibid.). Exotic species include the rainbow trout (*Salmo gairdneri*) introduced to the lake in the early 1940s, which contributed 14.2% of the total catch in 1980 (Ibid.), and the silverside or pejerrey (*Basilichthys bonariensis*) introduced in the mid 1950s and which contributed 15.2% of the total 1980 catch (Ibid.).

According to the latest taxonomic revision (Parenti 1984), the genus *Orestias* consists of 43 species grouped in four complexes, 29 of which can be found in Lake Titicaca itself, and 33 in its watershed (Appendix A). Local fishermen commonly identify four major types of *Orestias*, the umanto, the boga, the ispis and the carachis. They also distinguish five types of carachis, according to their size, shape and coloration (Appendix A), but often give the same names to various species, or different names to the same species. For example, they refer indifferently to all small *Orestias* as ispis, and to all yellowish carachis as carachis amarillos. Conversely, they refer to *O. agassii* as fish (*Ch'aulla*), white, grey or black carachi (*carachi blanco, gris, negro*). The remaining two types of carachis, the dwarf (*carchi enano*) and the greenish one (*carachi gringo*), are only of marginal economic importance. As for the genus *Trichomycterus*, it is represented by only one species on the Altiplano (Tchernavin 1944b), although fishermen commonly
distinguish the *mauri*, a small littoral form, from a larger one usually found in deeper waters, the *suche*.

b) Other lacustrine resources

Apart from the fish resources, shore-dwellers extract two other types of aquatic resources from Lake Titicaca: waterfowl and lake-plants (or aquatic macrophytes). About 14 species of migratory waterfowl are harvested when they come to the lake for nesting (CENFOR-Puno 1979). Aquatic macrophytes are represented by a variety of plants found in associations, depending upon depth and other limnological parameters (Collot 1981). Two associations are of particular economic importance, the totora (*Scirpus* or *Schoenoplectus* sp) and the llachu, an association of three genera of aquatic plants (*Myriophyllum*, *Elodea* and *Potamogeton*). Finally, aquatic toads from the *Telmatobius* genus are sometimes accidentally caught in gill nets and may be used in the elaboration of traditional remedies.

2.2.2. Fishing operations

Fishing on Lake Titicaca involves small-scale operations, with simple technology and small fishing crafts, often single-handed. Fishing operations are short range, rarely lasting for more than an overnight trip, although some fishing involves daylight operations. Gillnets are set late in the afternoon and checked or retrieved early the following morning. Individuals, usually from the male gender, go fishing with their close relatives, sometimes with those of their wives (i.e. their affines) and share the catch. Fishing infrastructures are minimal, although a few tiny harbours have been built on exposed parts of the shoreline. About half of the fishermen operate from a balsa reed boat (48%), and the other half from a wooden boat propelled with oars (48.5%). A few use a motorized wooden boat (3%) with a greater range of
operation, or a small flat-bottom boat (7%) which would be unsafe to operate offshore (Bustamante and Trevino 1976).

The 1976 census demonstrates that Lake Titicaca fisheries are not spatially concentrated. Fishing is practiced by individuals from each shore community (Bustamante and Trevino 1976), and because fishermen leave their craft at a landing spot within easy reach of their home compound, and because houses are scattered among the fields rather than gathered in villages, there is little clustering of fishing craft into fleets operating from the same harbour. Only in the case of the ispi trawl fishery do fishermen tend to congregate on the ispi schools.

Lake Titicaca fisheries are also characterized by a lack of occupational specialization. Fishing is usually carried out by men, although there is no prohibition against the participation of women in fishing activities. Most engage in fishing as an activity secondary to agriculture, and often in combination with a host of additional activities such as handicrafts, cattle raising, and migration for wage labor. They rarely undertake more than a few fishing trips per week, once agricultural activities have been completed. Shore dwellers often distinguish between occasional, seasonal and permanent fishermen. Occasional fishermen fish sporadically with a pushnet in shallow waters, with a small balsa and a couple of gillnets near shore, or as crew members for a relative. Seasonal fishermen operate a few months per year, usually during the rainy season when temperatures do not go below freezing at night. And permanent fishermen fish year round, although they may do so only a few days a week.

Finally, Lake Titicaca fisheries are characterized by low capitalization. Local fishermen use a variety of simple and relatively inexpensive fishing methods. They carry out most of their fishing with gillnets made of purchased...
mesh panels (Ibid.) but also rely upon pushnets, small harpoons, or beach seines along the shoreline, and various kinds of gillnets and trawls further from shore. To reduce fishing costs they use local materials as much as possible and undertake, with the help of the members of their household, as many fishing-related operations as possible, including the construction and maintenance of their fishing craft and gear, and the retailing of their catch.

2.2.3. Fisheries stratification

The combination of fishing craft and gear, and of the crew to operate them represents a Fishing Economic Unit, or FEU (Bazigos 1974a). The terms "fisherman" and "FEU" are thus not strictly equivalent except when a fisherman operates alone or with a junior helper. For the purpose of this study I have identified 10 types of FEUs according to fishing craft, fishing gear and the mesh sizes (measured along the stretched diagonal) of the gillnets used, according to distinctions made by local fishermen themselves (Table 1).

However, because fisheries are defined as including all FEUs which target their fishing operations on the same group of species in the same aquatic areas, and because different types of FEUs may be used in the same fishery, I have identified only five different fisheries on Lake Titicaca.

<table>
<thead>
<tr>
<th>Gear</th>
<th>Gillnets: Mesh sizes (stretched diagonal)</th>
<th>Huayunaccana</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;63mm</td>
<td>&gt;=63mm</td>
</tr>
<tr>
<td>Balsa reed boats</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Rowing boat</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Motorized boat</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

26
a) Demersal gillnet fishery for native species

The demersal gillnet fishery for native species targets on the black

*carachi* (*O. agassii*), although yellow carachis (*O. luteus*) and a few mauris

(*Trichomycterus*) may also be caught. Fishermen set multifilament nylon
gillnets with mesh sizes between 38 and 63 mm along the lake bottom, not
deeper than 30 meters (littoral zone) in the late afternoon, and check them at
dawn the following morning. Those who use balsa reed-boats for this fishery
(FEU type 1) own an average of 6.9 nets, thus somewhat less than the 9.7 nets
owned by those who use wooden boats (FEU type 4).

b) Trawl (*huayunaccana*) fishery for native species

The trawl (*huayunaccana*) fishery for native species previously targeted
the boga (*O. pentlandii*), but nowadays yields mostly black carachis (*O.
*agassii*). It is practiced in the littoral zone of the Small Lake where the
conditions required for safe and efficient operations are met, i.e. a flat
bottom with little or no macrophytes and protected waters. It involves two
craft, ideally two light rowing boats with one or two rowers each, though a
relatively heavy sail boat may be operated in conjunction with a small row
boat, or even a balsa. The corresponding FEU (type 10) thus includes one
trawl, two fishing vessels, and two to four fishermen. Trawling usually takes
place from dawn to midday, for an average of twenty tows, each lasting fifteen
to twenty minutes (Trevino et al. 1980; Franc et al. 1986).

c) Pelagic gillnet fishery for introduced species

Fishermen from the northern and southern ends of the Lago Grande practice
a pelagic gillnet fishery for introduced species using nylon gillnets of
mesh sizes between 63 and 152 mm. Those from type 5 FEUs use rowing boats,
while those from type 8 FEUs use boats powered by outboard engines. All set
their nets overnight in the pelagic zone of the lake, and most spend the night in their boats drifting with their nets. During the rainy season, they set their gillnets closer to, or directly into the mouth of the major tributaries of the lake, to catch the adult trout migrating upstream for spawning.

d) Mixed species gillnet fishery

A number of fishermen participate simultaneously in the demersal fishery for native species and in the pelagic fishery for introduced species, because they use a combination of gillnets of meshsizes both smaller and larger than 63 mm. Although they could use a balsa (FEU type 3), almost all of them use a wooden boat (FEU type 6).

e) Ispi fishery

Fishermen involved in the ispi fishery, harvest ispis at night with beach seines or with small trawls (Bustamante and Trevino 1976) when the fish come close to shore to spawn or to the surface to feed (Nunez 1982). Few ispi fishermen fish for other species, and most come from only four shore communities: Jacantaya (Moho) in the Lago Norte, Llachon (Capachica) in the Bahia de Puno, Cachi Pucara (Pilcuyo) in the Lago Sur and Vilurcuni (Yunguyo) in the Lago Pequeno.

f) Exploitation of other lacustrine resources

Lake Titicaca shore dwellers frequently hunt waterfowl, collect their eggs, and harvest aquatic macrophytes. These activities are most important in the economy of shore communities with access to large areas of totora beds (i.e. totorales) and llachu beds (i.e. llachales). Sometimes they catch waterfowl accidentally in their fishing nets, but they usually hunt them and collect their eggs on the way back from fishing trips. They harvest aquatic macrophytes when still green as cattle fodder, and as material for roofing,
balsa making, or for handicrafts when dry and yellow (Levieil et al. 1985).

2.2.4. Status of Lake Titicaca fisheries

Since World War II some major changes have affected Lake Titicaca fisheries which historically had been quite simple until then (Appendix B). Exotic fish species were introduced into the lake: the trout in the early 1940s and the silverside in the late 1950s. Subsequently, a successful rainbow trout fishery developed in the 1960's. This fishery supported up to five artisanal canneries and reached a peak production of 400 mt in 1965. Overfishing apparently brought about its collapse and forced the canneries to close down in 1969 (Everett 1971a), however, recent evidence indicates that this fishery has recovered (Alfaro et al. 1982). In the early 1970s, the silverside became the object of a limited fishery (Wurtsbaugh 1974) which has increased ever since (Alfaro et al. 1982; Avila et al. 1985).

In the same period Lake Titicaca fishermen have adopted a number of technical innovations. They have abandoned cotton gillnets and fish traps made of totora reeds in favor of nylon gillnets. Many have replaced their balsa reed boats with wooden boats, and some have even adopted outboard engines to propel their boats (Appendix B). Finally, fish marketing has changed considerably during this period. Urbanization, transportation improvements and the multiplication of markets on the Altiplano have opened new opportunities for fish traders, with a consequent increase in their number, and in the amount of fish they trade (Ibid.).

Data collected for this study indicate a total catch in the Peruvian portion of Lake Titicaca of 8,160 mt in 1980 (95% confidence interval: 6,490 to 9,830 mt), which is much higher than official catch figures of about 1,000 mt for Peru (MIPE 1980), and of 500 mt for the Bolivian portion (Vergara...
1980). But even after doubling to take Bolivian fishing into account, this figure is still much lower than the lake's annual productivity estimated to be between 20,000 and 160,000 mt (Richerson et al. 1977). This observation is further reinforced by the estimation of the lake's standing biomass at 120,000 mt (Johannesson et al. 1981) which suggests that an annual yield of more than 10,000 mt could theoretically be sustained. This has lead to the hypothesis that local fish resources were underfished or utilized below their maximum biological potential (Orlove 1979). An analysis of the restrictions on fishing resulting from the enforcement of communal TURFs by Lake Titicaca shore dwellers should indicate whether and to what extent this underfishing does occur.

2.3. MATERIAL AND METHODS

2.3.1. Existence and structures of TURFs

Demonstrating the existence of TURFs requires documenting insiders' control of access to their TURF area, which involves a number of difficulties, because few TURF holders are willing to acknowledge their informal and often illegal enforcement activities (Acheson 1975). Interviewed fishermen who claim that outsiders are tolerated in their area often conveniently forget to mention that they require the latter to meet certain preliminary conditions. Fishermen are thus more willing to report on TURFs when the latter are already vanishing (Johannes 1978) or gone (Andersen 1984), and when they do not have to fear reprisals for their illegal enforcement activities. To these difficulties one must add the logistical problems of research in geographically isolated regions where fishing communities are widely dispersed and difficult to locate (Pollnac 1984). These problems are further compounded by informants' suspiciousness of enquiries in view of the ubiquity of
smuggling and of drug production activities, and of the rise of political radicalism on the Peruvian Altiplano.

To demonstrate the existence of TURFs and their widespread distribution around Lake Titicaca, I have used three types of sources described and analyzed in a methodological appendix (Appendix C): a series of bibliographical references, interviews conducted during fieldwork in 1980-81 and in 1984, and a survey of the fishing activities of 251 fishermen in 1976. The latter relied upon a questionnaire which avoided self-incrimination since informants were requested to report the problems they had encountered when trying to operate in other fishing areas rather than their own illegal enforcement activities.

2.3.2. Enforcement of TURFs

Since both exclusive use and defense characterize territoriality (Dyson-Hudson and Smith 1978), a complete demonstration of the existence of TURFs should demonstrate both the control of TURF holders over access to fishing and the repulsion of outsiders. Enforcement or defense must be documented to distinguish TURFs from cases where exclusive use results from the wide dispersion of available resources or their availability in quantities far beyond the catching or consumption abilities of local populations (Ibid.).

To document the legal arguments used by TURF holders to protect their resources, I have relied upon official texts, and to document TURFs enforcement I have used field interviews in which I have asked informants about the difficulties they had encountered when operating outside their own fishing areas (Appendix C). However, I have systematically cross-checked trespassers' accounts with those of the victims of their trespassing activities. This approach proved successful because trespassors were prompt
to accuse TURF holders of stealing nets, and because the latter were equally willing to complain of the former's misbehaviour when they did not have to mention their own illegal enforcement activities.

2.3.3. Rent Capture

To demonstrate that rents were captured within Lake Titicaca fisheries, I had to demonstrate that fishing revenues per FEU were greater than fishing costs, which include material costs and the opportunity cost of fishermen's labor (see inequality below). The latter cost is defined as the income that fishermen could have earned in the best employment alternative available to them. For this purpose I had to select an appropriate time period. Because employment alternatives cover periods of a day to a few months, I had to base my comparison on a shorter time period. I have thus evaluated economic returns to fishing labour on an hourly basis, and compared the latter with the income per hour that fishermen could have earned in the most financially rewarding occupation available to them (irrespective of the legality of this occupation). An additional advantage of this method is that it allows me to account for the labour invested by fishermen and their households in the construction and maintenance of their craft and gear, or in fish retailing (which I generically refer to as fishing-related activities) without assuming, a priori, an opportunity cost for this labor. The inequality I therefore demonstrated for an average FEU on an annual basis is:

$$FR > MC + (L \times OC) \text{ or its equivalent:}$$

$$\frac{(FR - MC)}{L} > OC$$

where:

- **FR** = Fishing revenue
- **MC** = Material costs of fishing craft and gear per year
- **L** = Total labour involved in fishing and related activities
- **OC** = Hourly opportunity cost of fishing labour
- $$\frac{(FR - MC)}{L}$$ = Hourly return to fishing
Because most available statistics were either unreliable or invalid, to evaluate fishing cost and revenues I had to collect data on fishing yields and on the time and resources invested in fishing and fishing-related activities. For this purpose I used three different surveys, all described in the methodological appendix (Appendix C): a Catch Assessment Survey, a Coverage Check Survey, and a socio-economic survey.

To estimate fishing revenues I needed fish price figures and catch estimates. For the former, I have used the official fish price list of the Ministry of Fisheries (hereafter MIPE) because it provides a conservative estimate of fish prices (Appendix C). For the latter I have used a Catch Assessment Survey (CAS) for which 50 collaborating fishermen reported their respective catches and daily fishing activities from August 1979 to July 1980 for a small fee (Ibid.). In addition to this CAS, I have used a Coverage Check Survey (CCS) which was conducted twice during this same year, approximately at six month intervals to test for misreporting and for biases (Ibid.). To estimate fishing costs such as investments in fishing craft and gear, I have used a socio-economic survey (Ibid.). For variable fishing costs, I have used data from the CAS survey which, in addition to information on catch levels, provided information on fishing effort levels (e.g.: duration of fishing trips, number of nets used, number of crew members involved).

2.3.4. Contribution of TURFs to rent capture

To demonstrate the contribution of TURFs to rent capture, I had to show that their control over fishing and landing space is transformed into a control over fishing effort. This required demonstrating that TURF holders are not only able to exclude outsiders, but also to control their own fishing effort. I have done the former by demonstrating that shore dwellers were successful in preventing inland dwellers from fishing on the lake, and the
latter by demonstrating that the obligations entailed by community membership constrained the amount of household labour that shore dwellers could dedicate to fishing. For this latter purpose I have evaluated how much labour was required by communal obligations including agricultural production, using information available from the above-mentioned questionnaires, from a number of monographs on shore communities (Hickman 1963; Lewellen 1977; Brown 1978; Verliat 1978; Collins 1982; Painter 1982) and from studies of the economy of agriculture in various communities (Ccama 1981; Lescano et al. 1982; Figueroa 1984; Gonzales 1984).
In this chapter I demonstrate the existence of Lake Titicaca TURFs and their widespread distribution. I describe which areas of the aquatic space they encompass, the aquatic resources they include, who is likely to benefit from them and in what ways, thus analyzing their spatial, temporal, demographic and cultural dimensions (Crocombe 1974). The area dimension applies to the physical boundaries of the territory to which the TURF system considered applies. The time dimension refers to the period during which it has force. Implicit in these two dimensions is that of a resource dimension, which corresponds to the proportion of the resource involved. As for the population dimension, it refers to the specificity of the ownership. It classes individuals and groups according to their inclusion or exclusion from a particular set of rights and obligations. Finally, the cultural dimension refers to the legal (formal), or customary (informal) conditions under which the distribution, transfer and exercise of rights apply, thus to the kind of rights that can be exercised by TURF holders over the resources found within their area.

3.1. EXISTENCE AND DISTRIBUTION OF TURFS ALONG THE SHORES OF LAKE TITICACA

3.1.1. Existence of TURFs

a) Historical evidence

During the Inca times and the early colonial period which followed it, collective property rights, not only over beaches and landing spots, but also
over fishing zones, were common in Peru (Antunez 1981; Buse 1981; Flores-Galindo 1981; Ramirez-Horton 1981; Rostworowski 1977; 1981). According to Buse, the Inca administrators had even combined this allocation of fishing space with an adequate control of fishermen’s density, using such drastic measures as the forced transfer of fishing populations to new fishing zones along the Pacific Coast and eventually, on inland water bodies (Buse 1981).

In the case of Lake Titicaca, the Inca emperor Huayna Capac granted exclusive rights over aquatic resources to the Uros ethnic group, now extinguished, at the beginning of the 16th century:

"[He] determined how the Uros had to live on that lake, and divided its shores where they had to fish" (determino la manera en la que los Urus debían vivir en ese lago, y dividió los bordes donde ellos tenían que pescar), (Cabeza Balboa [1568], quoted in Manelis 1973:147, Footnote 2).

Evidence that the Inca empire, or Tahuantinsuyo, was a centralized organization (Pease 1985), and early chroniclers’ claim that the same organizational structures were replicated everywhere (Ramirez 1985: 420-30) confirm this testimony.

Within the Tahuantinsuyo, localized kinship groups, or ayllus, were granted formal recognition, and exclusive rights over the resources within their territories (Murua in Ramirez 1985: 430). There are strong reasons to believe, in particular, that the collective fishing rights found all along the Pacific shores of the Tahuantinsuyo (Rostworowski 1977) were paralleled on those of inland water bodies. Antúnez provides the example of the division of the Rimac River in two fishing zones: two different fishing groups had exclusive fishing rights, each in only one of these two zones respectively (Antúnez 1981: 33).

In addition, forced transfers (mitimaes) of fishing populations from the Pacific coast, to the shores of inland water bodies, such as the transfer of a
Moche group of fishermen from Northern Peru to the shores of Lake Titicaca and to the Marañon River (Buse 1981) are likely to have resulted in the establishment of fishing zones, either through the granting of fishing rights by the Inca administrators, or through the transfer of the ensuing custom by the transferred populations themselves. Alternatively, the existence of Altiplano colonies on the Southern Pacific Coast of Peru, since the Tiahuanuco period preceding the Tahuantinsuyo, and the extensive contacts between these colonies and the Altiplano (Hyslop 1976; Mujica 1985) lead to the hypothesis that centrifugal influences for the organization of fishing may have come from the Altiplano to the coastal area, instead of the reverse.

During the colonial period, the Spanish administration reorganized the territories of the ayllus. It stripped many of them of their most distant sections. It also forced them to regroup in single settlements, or reducciones. However, the number of human settlements along the shores of Lake Titicaca was not modified then, as the correspondence between traditional ayllus and modern administrative units demonstrates (Martinez 1981). This suggests that the boundaries of local aquatic territories were not drastically modified.

The Spanish rulers also tried to open fishing to all, irrespective of ethnic or geographical origins, and to promote the development of commercial fisheries. Apparently they met with little success at first. In 1566, the Spanish administrator Gregorio Gonzales de Cuenca, for example, had to revoke his initial decision to open ocean fisheries access to all, when confronted with the strong opposition of indigenous fishermen of the northern coast of Peru (Rostworowski 1981).

It was not until the early 1770's, that repeated conflicts between neighboring fishing communities eventually leading to judicial actions
provided the Spanish colonial government with a justification to open access
to landing spots (caletas) to all, and to allow everyone to fish (Flores-
Galindo 1981:160-1; Rostworowski 1981:85-86). Customary access rights to
landing spots and fishing zones must have persisted for decades after that,
since in 1786 the Gobierno Superior del Peru had to reaffirm the "libertad de
pescar" decreed by the Visitador Escobedo (Flores-Galindo 1981:160-161), and
since lawsuits opposed various fishing communities at least until the late
1790s (Rostworowski 1981: 85).

All this suggests that territorial fishing rights were formally
recognized on Lake Titicaca's shores for more than 250 years (1500's to
1770's). Evidence that Uros people were the only one required to pay their
tribute to the Spanish crown in dried fish suggests that informal respect of
these rights may have persisted until the beginning of this century, as it did
on the Pacific coast (Fiedler 1944). To determine whether they have persisted
until the present requires additional information.

b) Bibliographical evidence.

The existence of TURFs over exclusive fishing areas along Lake Titicaca
shores has been mentioned by various contemporaneous authors. Most of them
have claimed that fishing on Lake Titicaca and its tributaries was an activity
undertaken by shore dwellers exclusively (Romero 1925: 438; Martinez 1962: 55;
Some of them have referred to the ownership of landing spots (Pacori 1976: 15)
and of fishing weirs by individuals (Tschopik 1946: 525; Solc 1969: 51) or by
extended families (Vellard 1949: 180). Others have indicated that fishing
places (Wegener 1934, quoted in La Barre 1948: 184-185), or fishing zones
(Tschopik 1946: 521; Galdo 1962a: 92; Solc 1969: 53) were owned by the
immediately adjacent fishing communities.
However, little information is available regarding the extension, distribution and characteristics of the corresponding TURFs. After indicating the existence of fishing territories within one particular community, such as Chucuito in Peru (Tschopik 1946: 521) or Suriqui in Bolivia (Solc 1969), or within a group of communities unevenly distributed around the Lake (Galdo 1962a), most contributors have claimed that TURFs were enforced all along Lake Titicaca's shores (Tschopik 1946, Solc 1969) and those of its major tributaries (Galdo 1962a). Even if cumulatively the number of communities surveyed gives some credibility to such a statement, these authors fail to provide sufficient evidence to support their claim. Fortunately, information from a survey of fishing settlements carried out in 1976 along more than 90% of Lake Titicaca's Peruvian shores confirms the TURFs' ubiquity.

c) Empirical evidence.

In 1976, the scientists from the Peruvian Marine Institute (IMARPE) carried a comprehensive survey of Lake Titicaca fishing settlements. They enumerated 3,040 fishermen and personally registered more than 60% of them, all residents of onshore communities (E. Bustamante and H. Trevino 1984: pers. com.). During this survey, they used a structured questionnaire to interview 8.2% of the fishermen censused. They asked each informant whether he had encountered difficulties when operating in other areas, and recorded the type of problems reported if any. I have summarized informants' answers in Table 2 and 3 (IMARPE-Puno 1976: Unpublished data).

In Table 2, I have classified the 251 interviewed fishermen according to whether they claim to encounter difficulties when operating in other areas or not. The 40.6% informants (Group I) who claim to have problems both confirm TURFs existence and their active enforcement.
### TABLE 2: DISTRIBUTION OF ANSWERS TO QUESTION "DO YOU ENCOUNTER DIFFICULTIES WHEN OPERATING IN OTHER FISHING AREAS?"  
(Data Source: IMARPE-PUNO 1976)

<table>
<thead>
<tr>
<th>Yes</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Interference and theft of nets</td>
<td>32.3%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not specified</td>
<td>8.3%</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Do not operate in other areas</td>
<td>36.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequent 1 fishing site</td>
<td>8.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequent 2 fishing sites</td>
<td>5.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequent 3 sites or more</td>
<td>6.7%</td>
<td></td>
</tr>
<tr>
<td>No answer</td>
<td></td>
<td></td>
<td>2.4%</td>
</tr>
</tbody>
</table>

TURF INDEX  
Confirm that TURFs exist    | 90.9%  
Do not confirm nor deny it  | 9.1%  

### TABLE 3: DISTRIBUTION OF RELATIVE FREQUENCIES FOR THE NUMBER OF FISHING SITES BY GROUP OF FISHERMEN  
(Data Source: IMARPE-PUNO 1976)

<table>
<thead>
<tr>
<th>Number of sites</th>
<th>Group I</th>
<th>Group II</th>
<th>Group IIA</th>
<th>Group IIB</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.6</td>
<td>42</td>
<td>43.5</td>
<td>39.2</td>
</tr>
<tr>
<td>2</td>
<td>25.5</td>
<td>23.8</td>
<td>21.7</td>
<td>27.5</td>
</tr>
<tr>
<td>3</td>
<td>28.4</td>
<td>19.6</td>
<td>15.2</td>
<td>27.5</td>
</tr>
<tr>
<td>4</td>
<td>17.6</td>
<td>7.0</td>
<td>7.6</td>
<td>5.9</td>
</tr>
<tr>
<td>5 to 7</td>
<td>10.8</td>
<td>7.7</td>
<td>11.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Group I = trespass but encounter difficulties  
Group II = do not encounter difficulties  
Group IIA = do not encounter difficulties because do not trespass  
Group IIB = do not indicate why do not encounter difficulties
Their answers imply that they trespass into other TURF areas and have to endure the brunt of TURF holders' retaliation. The 57.0% fishermen who claim not to have such problems can be divided into two groups (group IIa and IIb). Those in the first group (IIa) indicate that they do not experience any problems, because they do not operate in other areas, that is because they do not trespass. Those in the second group (IIb) do not indicate whether they operate outside their own area or not. This second group (IIb) can be subdivided according to the number of fishing sites indicated by each fisherman (Table 3) since all informants were asked about the fishing areas they frequented in different fishing seasons.

Most of the names of fishing sites are easily identifiable and can be related to those of the fishing settlements and of the various parts of their territories. An analysis of these names reveals that the fishermen who indicate only one fishing site (39.2% of group IIb, or 8% of the informants) and those who indicate two fishing sites (27.5 of group IIb, or 5.6% of the informants) operate within the fishing areas of their respective communities. As for the fishermen who indicate three or more fishing sites, although some of them do remain within the fishing areas of their communities, it is not clear how many actually do so (Table 3).

Summing up the percentages of fishermen corresponding to the groups and subgroups which do confirm TURFs existence yields an estimate of the proportion of interviewed fishermen who actually confirm TURFs existence, which I have called a TURF index (Table 2). This index sums up to 91% approximately. The analysis and interpretation of informants' answers thus leads to the conclusion that at least 91% of the fishermen interviewed in 1976 confirmed the existence of TURFs, and that at least 40.6% of them confirmed TURFs active enforcement, while the remainder (9%) simply did not provide
evidence either way. Not a single one of the 251 informants denied the existence of local TURFs, irrespective of his own attitude towards them.

An analysis of the same data in terms of fishing communities rather than fishermen, also demonstrates that for all but two communities (94%), at least one fisherman confirms TURFs existence. As for the remaining two, other sources indicate that for the first one, Jasincoya (Huancane), local fishermen do restrict fishing to their own bay (Bustamante and Trevino 1976: fieldnotes), and that for the second one, Isani (Huancane), TURFs were actually enforced in previous years (Galdo 1962a).

3.1.2. Distribution of TURFs along the shoreline

A sample of 80% of the shore communities shows that virtually all of them hold TURFs over the portion of the lake immediately adjacent to their shoreline (Table 4). Furthermore, by locating these communities along the shoreline (Figure 3), I was able to verify that there is no gap in their distribution. Each shore section corresponds to a TURF area, and no gap is left open for inland dwellers to get access to aquatic resources (even if in some areas TURF holders rarely fish).

<table>
<thead>
<tr>
<th>Lake area</th>
<th>Number of shore communities</th>
<th>Communities sampled</th>
<th>Number</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahia de Puno</td>
<td>50</td>
<td>44</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Lago Norte</td>
<td>43</td>
<td>35</td>
<td>81.4</td>
<td></td>
</tr>
<tr>
<td>Lago Sur</td>
<td>43</td>
<td>28</td>
<td>65.1</td>
<td></td>
</tr>
<tr>
<td>Lago Pequeno</td>
<td>29</td>
<td>25</td>
<td>86.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>165</td>
<td>132</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
FIGURE 3: SOURCES OF EVIDENCE OF THE EXISTENCE OF TURFS ON LAKE TITICACA.

- Bibliographical sources
- IMARPE: 1976 fieldwork
- 1980-81 & 1984 fieldwork
3.2. SPATIAL DIMENSIONS

So far the evidence provided suggests that most of Lake Titicaca shore dwellers are members of territorial communities who hold TURFs over part of the aquatic space adjacent to their land territory. These communities have well defined terrestrial boundaries formally recognized by the administration. Their terrestrial boundaries extend into the lake, either perpendicularly to the shore, or following some irregular but clearly defined trajectory, with the same types of visual markers often being used to delineate both aquatic and terrestrial boundaries. The physical extension of the aquatic territory delineated by these aquatic boundaries corresponds to TURFs spatial dimension.

To describe the spatial dimensions of Lake Titicaca TURFs, I use evidence gathered during field work in 1979-81 and 1984, data collected in the field by scientists from the IMARPE, documents from the Ministry of Agriculture in Puno such as maps drawn by shore dwellers of the territory of their communities, and a few bibliographical references (Bustamante and Trevino 1976; Nunez 1982). I consider first the lateral or intercommunal boundaries which separate the TURF areas of neighbouring communities and determine the width of the shoreline corresponding to each shore community. Later, I consider the position of the offshore boundaries which determine the distance from shore to which TURFs apply (which I call the length of the TURF areas) and the few cases where offshore boundaries turn into intercommunal boundaries. Finally, I turn to the visual markers used to delineate aquatic boundaries, because of their influence on the amount of overlap between neighbouring TURF areas.

3.2.1. Lateral boundaries.

Members of Lake Titicaca shore communities consider the aquatic space immediately adjacent to their land as their collective aquatic property. The
lateral boundaries of these communal territories are extended in direct prolongation of the terrestrial boundaries which separate neighbouring communities, as illustrated by community members in graphical depictions of their community such as those of Ramis (Figure 4) and of Requena in the Lago Norte (Figure 5). In some cases, the lateral boundaries may change direction relatively to the terrestrial ones, as those between Sajo and the neighbouring community of Villa Santiago de Ccama in the Lago Sur (Figure 6).

The origin of the intercommunal boundaries along the shores of Lake Titicaca can be interpreted in terms of the historical attempt by Andean communities to control a maximum number of ecological levels distributed along a vertical gradient (Murra 1985a; 1985b). At least since Tiwanaku times (1500 BC to 1000 AD), Andean communities have striven for self-sufficiency, rather than relied upon the exchange of goods between specialized and independant producers (Brownman 1981; Masuda et al. 1985).

An important characteristic of the verticality principle is its compatibility with a physically discontinuous territory, often described as a vertical archipelago whose islands are characterized by strikingly different ecological conditions. To use the land and resources of these islands, Andean people have thus had to migrate periodically from one to the other, taking advantage of the lags between asynchronous production cycles in different ecological levels. The system of forced migration and colonization widely practiced by the Incas is thought to have contributed to or reinforced the principle of verticality common to Andean communities, while the Spanish colonization and administration is considered to have weakened it considerably (Saignes 1978; Masuda et al 1985).

The application of the verticality principle to Lake Titicaca shore communities implies that the latter should stretch their territories across as

* No scale given on original.
Redrawn by the author.
FIGURE 5: FACSIMILE OF THE MAP OF THE COMMUNITY OF REQUENA, TARACO (Direccion de Comunidades Campesinas, MINA-PUNO). *No scale on original.

- house
- boundary marker
- boundary

* Norte Jasana
* Rio Salate
* Laguna Temporal
* Comacatta
* Salitrera
* Sur Lago Titicaca

Scale: 0 50km

47
FIGURE 6: FACSIMILE OF THE MAP OF THE COMMUNITY OF SAJO, POMATA (Direccion de Comunidades Campesinas, MINA-Puno). * No scale given on original Redrawn by the author
many ecological levels as possible, from the lakeshore to the top of a nearby mountain range, a physical impossibility for the communities of the vast plains of Ilave, Pilcuyo, Ramis or Taraco. This allows community members to combine a variety of agricultural zones and practices, thus spreading the risks of poor environmental conditions. Agriculturalists with widely dispersed plots of land are less likely to suffer a catastrophic crop failure, than those whose plots are concentrated in one ecological area (Brush 1977). In a region where frost is a serious risk (Morion 1978; Figueroa 1984) this is an important consideration for agricultural practice.

The territories of a sample of 32 communities distributed along the shores of the Lago Sur and Lago Pequeno actually verify this prediction. They look like elongated triangles whose bases correspond to the shoreline, and apices to the summit of the Cerro Ccapia (Figure 7). Computing the ratio of the length of their shoreline to that of their boundary perimeter (Table 5) shows that for a majority (78%) of them, it is smaller than 30%, and for half of them smaller than 15%.

TABLE 5: FREQUENCY DISTRIBUTION OF PROPORTION OF SHORE LENGTH TO PERIMETER FOR LAKE TITICACA SHORE COMMUNITIES. (SOURCE: PLANO CADASTRAL, MINA-PUNO, 1973)

<table>
<thead>
<tr>
<th>Range of values</th>
<th>Absolute frequency</th>
<th>Relative frequency</th>
<th>Cumulative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5</td>
<td>3</td>
<td>9.4</td>
<td>9.4</td>
</tr>
<tr>
<td>5 to 10</td>
<td>7</td>
<td>21.9</td>
<td>31.2</td>
</tr>
<tr>
<td>10 to 15</td>
<td>6</td>
<td>18.8</td>
<td>49.6</td>
</tr>
<tr>
<td>15 to 20</td>
<td>3</td>
<td>9.4</td>
<td>59.0</td>
</tr>
<tr>
<td>20 to 25</td>
<td>3</td>
<td>9.4</td>
<td>67.2</td>
</tr>
<tr>
<td>25 to 30</td>
<td>3</td>
<td>9.4</td>
<td>76.6</td>
</tr>
<tr>
<td>over 30</td>
<td>7</td>
<td>21.9</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>
This confirms that the shores of Lake Titicaca are divided into relatively narrow strips between neighbouring communities whose territory often stretches far inland over a variety of ecological levels. How far offshore the aquatic portion of this territory stretches is the topic of the following section.

3.2.2. Offshore Boundaries

According to the evidence available, physical and ecological factors determine to a large extent the distance from shore to which aquatic boundaries extend (Levieil and Orlove 1987). As a general rule, communal fishing zones include a shallow water area, often demarcated by the presence of aquatic macrophytes, and an area of open water, both of variable width. Since it is the slope of the bottom which determines the distance to which TURFs apply, I have distinguished between three different types of TURFs which grade continuously into one another, for the purpose of this analysis.

a) Type I TURFs

TURFs of the first type are found where the shallow water area extends to a great distance from the shoreline, because of a gentle bottom slope. In Puno Bay and the Ramis delta area for example, this area is greater than 5 km. These areas are characterized by the presence of aquatic macrophytes, more particularly by that of dense beds of totora reeds. Communities with type I TURFs extend their boundaries far into these totorales, and usually claim some open water space, not more than a couple of hundred meters wide, on their outer edge. It is difficult to associate the outside boundary of type I TURFs with any particular depth contour, though it rarely goes beyond 3 meters and almost never beyond 5 (Figure 8).
FIGURE 8: TURF TYPES: I, II & III

A

B

C

NOTE: Diagrams not to scale.
FIGURE 9: DISTRIBUTION OF THE THREE TYPES OF TURFS AROUND LAKE TITICACA, PERU.
Type I TURFs are common in the southeast part of Laguna Arapa, in the northwest of the Lago Grande between the Ramis delta and Capachica peninsula, in the northern half of Puno Bay, and all along the western shores of the Lago Grande between Socca island and Juli (Figure 9). In the latter case, however, the outer edge of the totora reed beds is demarcated by a littoral dune or shicata which is cultivated during the rainy season. Local community members still claim the open water space on the outer edge of the dune as part of their exclusive fishing zone, even if they rarely exploit it, since they would need two craft for that purpose: one to cross the lagoon between the main land and the dune, and the other one to go fishing on the lake.

Alternative solutions could be used too, such as carrying the fishing craft over the dune, as done by the fishermen from Balsapata in the Lago Norte (Bustamante and Trevino, field notes 1976) or a small ferry service for fishermen to cross the lagoon. But this requires some organization and cooperation on the part of the fishermen (between at least six of them in the case of Balsapata). Another solution tried in 1983 by some fishermen from the community of Santa Rosa de Yanaque (Acora), is to move into a temporary dwelling on the dune. However, this experiment came to a rapid end, because it required too much specialization on the part of the fishermen involved who, lacking flexibility, could not continue their normal agricultural practices on the mainland.

b) Type II TURFs

For the second type of TURFs, a steeper bottom slope brings the outer edge of the totora reed beds within a few hundred meters from shore. In such cases, local community members claim the totora beds in the shallow waters and an area of open and deeper water at least a few hundred meters wide, as theirs. Given that totora reeds rarely grow in water deeper than 4 meters
(Tutin 1940; Collot 1981), the outer limit of type II TURFs is often close to the 10 meters depth contour (Figure 8). However, when this depth occurs fairly close to shore, the outer edge of type II TURFs can be pushed out as far as the 20 meter depth contour.

Type II TURFs are found along the northwest and southeast shores of Laguna Arapa, in the bays of Mililaya, Moho and Vilquechico on the Northeast shores of the Lago Grande, on the western sides of the Capachica and Chucuito peninsulas in Puno Bay, and of the Lago Pequeno (Figure 9).

c) Type III TURFs

For the third type of TURFs, the shallow water area and the totora reed beds are only a few meters wide, because of a very steep bottom slope. The latter may even disappear altogether, because of a rocky substrate or exposure to wave action. In these areas, alternative criteria of demarcation are used, and the width of the corresponding area is highly variable, depending on the fish resource and harvesting methodology involved. In the case of gillnet fishing for demersal (bottom) native species, the 50 meters depth contour provides a reasonably good approximation of outer edge of type III TURFs, even if gillnets for demersal fish are rarely anchored deeper than 25 meters (Figure 8). This can be observed along the shores of the Lago Norte between Tilali (Huancane) and Jacantaya (Moho), around the Jonsani peninsula, on the eastern sides of Capachica and Chucuito peninsulas, of Socca and Iscata islands, and along the shores of the Lago Sur from Juli to Yunguyo (Figure 9).

Alternatively, in the case of the trawl fishery for ispi, no depth contour seems to correspond to the outer edge of type III TURFs. Distance from shore and competition with fishermen from other communities appear to be the major determinants for the width of type III TURFs in this case, as can be
observed in the strait separating the communities on Amantani and Taquili islands and that of Llachon at the southern tip of Capachica peninsula. In the few cases where ispis are fished with beach seines, communal ownership of the beaches is determined by the position of intercommunal terrestrial boundaries, as in the case of Jacantaya (Moho) and its neighbours, in the Lago Norte. Beach seining is therefore of little relevance for the determination of the outer edge of TURFs.

Whenever communities are sitting on opposite sides of narrow bodies of water, they have to divide the corresponding water space between themselves. The general practice then is for an imaginary line to be drawn, approximately equidistant from both sides. This can occur in relatively small bays whose shores are divided between a number of neighbouring communities, such as the bay of Moho whose shores are divided between Lacasani and Muelle Cariquita in the Lago Norte, in straits between islands such as in the one between Taquili and Amantani islands, or in straits between islands and peninsulas such the one between Isla Iscaya and Vilurcuni (Yunguyo). This can also occur along river mouths, such as that of the Ramis River which is divided between the communities of Balsapata and Ramis, or that of the Ilave River which is divided between the communities of Huayllata, and Santa Rosa de Huayllata (Bustamante and Trevino 1976: 53-54). Natural features when they occur are also taken advantage of, irrespective of their equidistance from the shores of both communities, as for the Rio Tujsa-Jahuira in the part of the Puno bay called Huayllata Ccota, which divides the totoral of Sillamuri between the communities of Ccarana, Cuchiraya and Isla Quipata to the northeast, and those of Chucuito-Sillamuri-Attoja and Chincheras to the southwest. That natural features may determine TURFs boundaries underscores the importance of visual markers in their delineation, which is the topic of the next section.
3.2.3. Visual markers

According to shore dwellers, the lateral boundaries of Lake Titicaca TURFs are extended in direct prolongation of the terrestrial boundaries which separate neighbouring communities and, if necessary, visual markers or hitos are used to delineate them. The latter are relatively simple natural or man-made features of the landscape, which are used to delineate TURFs lateral boundaries rather than their outer edges. The only type of visual markers used to delineate TURFs outer edge are the totora beds and the natural channels dividing them, which can be found in type I and type II TURFs. Environmental conditions determine to a large degree what type of visual markers can be used in specific circumstances, either because it is best suited for a given area or TURF type, or because appropriate material is locally available.

For type I TURFs, the presence of totora reeds in shallow waters greatly simplify the problem of boundary marking. The natural channels crisscrossing the totora beds can be used and, if necessary artificially enlarged, both for lateral and offshore boundaries. In the case of Huerta and Millojachi Huaraya in the Bahia de Puno, for example, the Rio Huile, a large natural channel, delineates TURFs outer edge, while the smaller channels of the Ranja Mayo and Sanja Mayo separate the areas of this community from those of the neighbouring communities of Jirata Huaraya and Chincheros respectively. A few islets like that of Lampa K'ara are also used as boundary markers along these channels (Figure 10).

Closer to shore, in very shallow waters, man-made markers persisting from the times in which the lake level was lower, such as lanes, ridges, trenches and wide furrows or sanjas are used. Stones are rarely used in those areas, simply because they are not locally available in sufficient quantities.
FIGURE 10: FACSIMILE OF THE MAP OF THE TOTORA REED BEDS OF THE COMMUNITIES OF HUERTA AND MILLOJACHI HUARAYA*(CENFOR-Puno)

* No scale given on original
Redrawn by the author

~ Boundary
As for natural markers, they are rarely visible on a low shore line hidden behind tall reeds. When they are high enough to be visible, whether in the form of hills, islands, as in Huerta and Millojachi Huaraya, or in the form of sand dunes as in Ramis and Requena in the Lago Norte, people incorporate them into their system of boundary marking (Figure 10, 4 and 5).

In the case of type II TURFs, a steeper shoreline and relief make land marks much more readily available for boundary identification. Natural features such as prominent rocks, hills or promontories on shore, and small islands offshore are often used for that purpose. In various communities of the southeastern shores of the Peninsula of Chucuito, such as Perca, Sihuicaní and Huincalla for example, local fishermen consider that their respective fishing areas correspond to the open bays facing their communities which are limited by small peninsulas on both sides.

Although it may occur much more frequently in TURFs of type II than in those of type I, simply because of shore relief, onshore promontories may also play a role in the delineation of type I TURFs. In Huerta and Millojachi Huaraya, for example, TURFs lateral boundaries follow natural channels within the totora beds, but they also correspond to the onshore promontories of Cerro Ch'uri and Jallo Pata (Figure 10).

When natural features are missing, TURFs holders rely upon material available locally to delineate their boundaries. Rocks and stones for example are found in such abundance in areas corresponding to type II TURFs that it is often a problem for local farmers to get rid of those they pull out of their fields. Rocks are piled up on the side of agricultural plots, or used to build terraces and small walls to delineate private plots and communal boundaries. Submerged walls reminiscent of times of lower lake levels can be seen in many areas of type II TURFs. Most corrspond to private rather than
communal boundaries. In a few instances, however, stone constructions built on shore and later submerged provide a clear delimitation of aquatic territories, as can be observed in between the various communities between Chimu and Cusipata on the Western shores of the Puno Bay, or in the Northeastern part of Laguna Arapa.

When rocks and stones are less abundant, trenches up to a couple of meters wide and a half meter deep, called sanjas or rayas, are often dug through near shore totora beds and in the mud of the littoral. These trenches extend terrestrial boundaries to the aquatic space, as in between Pucani and Tacasaya, or between Anu Callejon and Pallalla on Chucuito Peninsula, and all along the shores of the Lago Sur from Isla Socca to Santiago Mucho.

Finally, in the case of type III TURFs, alternative criteria of demarcation have to be used, because totora beds are almost non-existent and water depth prevents the construction of walls further than a few meters from shores. Physical features such as small valleys, outstanding rock formations, or irregularities of the shoreline are convenient, because they are easily noticed from offshore. In the community of Llachon, at the southern tip of Capachica peninsula, for example, fishermen refer the canyon of the K'ollpa Mayo (an intermittent stream) as their boundary with the community of Yapura. Onshore man-made markers, such as lanes, walls or houses are also commonly used since a rapid shore elevation makes these markers visible from quite a distance. In Llachon, people also refer to the dock of Chucarilla, which lies at the mouth of the K'ollpa Mayo, as their boundary with Yapura (Figure 11).

In conclusion, it may be said that the outer edge boundary of type I TURFs is in most cases better defined than that of type II, and always better defined than that of type III TURFs. The reason for this is that visual markers in the form of totora beds are nearly always available for outer edge
FIGURE II: FACSIMILE OF THE MAP OF THE COMMUNITY OF LLACHON, CAPACHICA (NUÑEZ 1982)

* no scale given on original
delineation in TURFs of type I and II, while they are almost always absent in those of type III. Lateral boundaries are also often better defined in TURFs of the first two types than in those of the third type, for the same reason. Because of this, variations may be expected in the degree of overlap between neighbouring TURFs according to their type. Finally, despite their crucial role as boundary markers, totora beds are more properly considered as resources. As informal questioning during fieldwork revealed, outsiders are well aware that they have to stay at least a couple of hundred meters away from them, not to become suspect of any wrongdoing. This leads me to consider the aquatic resources included within TURFs areas, thus TURFs resource dimension.

3.3. RESOURCES DIMENSION

Lake Titicaca shore dwellers believe that aquatic boundaries apply to the aquatic space and all the resources therein, just as terrestrial boundaries do to land space and resources. Aquatic resources are of two types: biological and physical. Biological resources of economic interest include fish, aquatic macrophytes, and both waterfowl and their eggs. Physical resources include the land and shallow waters of the shoreline, both of which are used by shore dwellers for craft storage, navigation, fishing, macrophyte harvesting, live fish storage, waterfowl hunting and egg collection.

The objective of this section is to determine which aquatic resources are likely to be affected by TURFs' existence. Since these resources are heterogenously distributed along and across the littoral zone, and since the outer edge of most TURF area coincides roughly with the 50 m isobath or with a distance of 1 km from shore (whichever comes first), the question is what proportion of each type of aquatic resources is found within the corresponding
littoral zone. This raises the question of fish horizontal migrations whether perpendicular to shore from the TURF-controlled littoral fringe to the "no man's land" beyond it, or parallel to it from the fishing zone of one community to that of another one.

3.3.1. Fish Resources.

For this section, I have had to rely upon fishermen's accounts whenever published information was unavailable, or when the latter was of doubtful scientific value. The relevant information is summarized in graphical form in Figure 12. For this figure I have used the ecological zonation of Loubens, Osorio and Sarmiento (1984) because it uses the same criteria as those upon which my distinction between TURF types is based: depth, topography and the presence of aquatic macrophytes.

The six zones considered are: the deep zone (zone 1: 50 to 284 m deep), the medium depth zone (zone 2: 10 to 50 m deep) with no bottom vegetation, the Chara zone which bottom is blanketed by Chara and and other lake plants collectively referred to as 1lachu by the shore dwellers (zone 3: about 2 to 10 m deep), the totora zone characterized by the presence of beds of Scirpus called totora by the shoe dwellers (zone 4), the littoral zone characterized by its shallowness, muddy bottom and the presence of 1lachu (zone 5), and the rocky zone which corresponds to steep rocky shores with little or no macrophytic vegetation (zone 6) (Loubens, et al. 1984: 155). A simple comparison of the characteristics of these zones and those of the three types of TURFs demonstrates a close correspondance. Areas of type III TURFs coincide with zone 6, while those of type II encompass zone 2 to 5, and those of type I encompass zone 5 and either part of zone 4, or the whole of zone 4 and part of zone 3 (Figure 8 and 12).
FIGURE 12: RESOURCE DIMENSION OF LAKE TITICACA TURFS

Fig. 13a: Orestias agassii

Fig. 13b: O. luteus, olivaceus, mulleri

Fig. 13c: Orestias pentlandii

Fig. 13d: O. ispi, O. forgeti

Fig. 13e: Basilichthys bonariensis

Fig. 13f: S. gairdneri, Trichomyct.
a) Carachis.

The carachi blanco or negro (*O. agassii*) is the species for which most information is available. It is a very polymorphic species, capable of colonizing the most diverse habitat in the lake (Lauzanne 1982). Loubens and his collaborators (1984; 1985) indicate that adults are found either in a benthic or in a pelagic form in zone 2 and 3, juveniles in a littoral form in zone 4 (Figure 12a), and that spawning occurs year round in zone 3 to 5 with a slight maximum during the dry season. They also indicate that *O. agassii* is definitely a perimacrophytic species (Loubens et al. 1984; Loubens and Sarmiento 1985). This shows that the majority of *O. agassii*'s habitat is included within exclusive fishing areas where type I TURFs exist, and that it is totally included in them where type II TURFs exist. It also suggests that the majority of *O. agassii* populations remain within TURF-controlled shore area during their entire life cycle (Figure 12a).

Most carachis are caught at night and it has been shown that they follow a diurnal pattern of migration, staying in deeper waters by daylight and coming closer to shore at night to feed or to spawn (Trevino et al. 1984: 14). Fishermen claim that carachis also follow a seasonal pattern of migration which brings them closer to shore during the rainy season, and sends them back to greater depths during the dry season. However, it is thought that carachis migrate only through short distances, whether perpendicular or parallel to the shoreline (Bustamante and Trevino 1984: pers. com.).

Three types of evidence suggest that carachis have a limited range of migration. First, because of their body shape carachis can only swim slowly (T. Northcote 1987: pers. com.) and presumably not very far. Second, because they stay close to the bottom or within protected macrophyte beds, they are unlikely to be transported alongshore by lateral currents (Peter Richerson
1986: pers. comm.). And third, distinct populations of *O. agassii* have been identified in the Lago Grande and in the Lago Pequeno, thus indicating that only limited exchange takes place between populations separated by distance or deep water areas (Loubens and Sarmiento 1985). This suggests that lateral diffusion between neighbouring TURFs is bound to be slow and limited, at least for the adult carachi.

Although far less information is available on the biology of the two other carachi species of commercial interest, the carachi amarillo (*O. luteus*) and the carachi gringo (*O. olivaceus*), the same major conclusions seem to apply. While infrequent and only of small sizes in zone 2, their distribution overlaps with that of *O. agassii* in other zones (Figure 12b), and their ecology seems to be quite similar (Bustamante and Trevino 1976; Loubens et al. 1984; Loubens and Sarmiento 1985).

*O. mulleri* is mostly found in the benthic part of zone 1 and 2 (Figure 12b), (Loubens et al. 1984), but experimental fishing suggests that it is not entirely benthic (Vaux et al. 1986: 15). It seems to remain within these two zones for most of its life cycle, with the possible exception of spawning migrations to zone 3 and 4 where local fisheremen capture it occasionally. Lauzanne (1982) never found the species at depth less than 15 m. It is thus unlikely to be much affected if at all, by existing TURFs, and in any case, is only of marginal commercial interest.

b) Boga.

Most of the information available on the boga (*O. pentlandii*) relates to Laguna Arapa, a small lake at the northwest tip of Lake Titicaca, where it was relatively abundant until late 1983 (Levieil and Paz 1984). It is a planktivorous fish which is found in the pelagic part of zone 2 to 6, and on the shallower fringe of zone 1, between 10 and 20 m of depth (DIREPE 1981).
This suggests that the boga spends most of its life cycle outside of the TURF-controlled littoral area (Figure 12c), except for spawning migrations which bring adult bogas to the macrophytes of zone 3 and 4 (Ibid.).

c) Suche and Mauri

The mauri and the suche are two forms of the same benthic species (Trichomycterus dispar) whose ecology is as poorly understood as that of the carachis. Mauris and carachis are often captured in the same nets, in zone 3 to 5 and in the lake's tributaries, while suches are caught at greater depths, in zone 1 and 2, and in the lake's largest tributaries (Figure 12f). Suches and mauris are caught at night and thought to spawn at the end of the dry season in zone 3 (Bustamante and Trevino 1976; DIREPE 1981), but there is no indication that spawning migrations occur. It has been claimed that the mauri is very sedentary, and that the suche roams much larger areas (DIREPE 1981) though little is actually known of the movements of either type of catfish. Given that suches are found further than the outer edge of the TURF-controlled littoral area, it may be suggested that they are unlikely to be much affected by the existence of TURFs, while mauris are as likely to be as the carachis.

d) Ispi.

The commercially exploited ispis are small pelagic fish (O. ispi and O. forgeti), which live in relatively large schools in zone 1 or 2, and come to spawn on the macrophytes of zone 3 to 5 (Figure 12d) throughout the year, but mostly during the dry season (Bustamante and Trevino 1976; Loubens et al. 1984; Trevino et al. 1984). Echo-traces indicate large concentrations of fish thought to be ispi, at 30m depth (Johannesson et al. 1981), and as deep as 50m (Vaux et al. 1986: 8). Most ispi captures in zone 1 and 2 occur at night when, according to fishermen, ispis come closer to the surface (Nunez 1982).
This has led to the suggestion that ispis follow a diurnal pattern of vertical migration which has not yet been confirmed by experimental fishing or echo-sounding (Vaux et al. 1986). Large quantities of ispis are also harvested at night with beach seines and *collanchas* in zone 4 and 5, when they come closer to shore (Bustamante and Trevino 1976; Levieil 1981: fieldnotes; Trevino et al. 1984).

Ispi fishermen often underscore the unpredictability of ispi availability. In August 1984, for example, fishermen from Llachon were complaining that for the past two years, the ispis had stayed out of their reach around the islands of Taquili and Amantani. Similarly, those from Vilurcuni in the Lago Pequeno were complaining that in the previous six years, the ispis had come only twice to their area. The common belief among them is that ispis represent a large but elusive and unpredictable resource which should be taken advantage of whenever available, lest they disappear, or worse, lest they move into someone else's fishing area.

Because ispis spend most of their life cycle outside of the TURF-controlled littoral area, one could think that they are unlikely to be much affected by existing TURFs. However, the opposite is actually more likely to occur because the ispi fishing locations known so far, whether spawning beaches (in zone 4 or 5) or open water areas (in zone 1, 2 or 6), are few and because most of them are actually found within TURF-controlled areas. Only in those locations do ispis appear often enough for local fishermen to invest in gear appropriate for ispi fishing.

e) Silverside

The silverside or *pejerrey* (*B. bonariensis*) is found at less than 5 m from the surface of all six identified zones (Figure 12e). The adults are
found predominantly in zone 6, 1 and 2, and may come to zone 3 to spawn, the juvenile forms are found in zone 2 to 4, and the smallest juveniles in zone 5 (Wurtsbaugh 1974; Loubens et al. 1984; Trevino et al. 1984). Fishermen catch adult silversides offshore with surface gillnets less than two meters deep, and juveniles inshore with surface gillnets, beach seines or hooks.

The silverside is known to migrate both horizontally and vertically on daily and seasonal time scales. The pattern of these migrations is not yet well understood, although it has been shown that the silverside moves inshore in the afternoons (Wurtsbaugh 1974; Trevino et al. 1984). Considering the speed and distance of the silverside's migrations, the latter is unlikely to remain within the TURF-controlled littoral area during much of its life cycle. Moreover, and contrary to the ispi, the silverside can be caught almost anywhere in the lake, including some highly polluted areas (Trevino et al. 1984). It is thus very unlikely that any group of fishermen could reserve for itself any right of access to the silverside.

f) Rainbow trout

The rainbow trout (Salmo gairdneri) is found in most parts of the lake, but more particularly in zone 1 to 3, and in waters shallower than 25 m of zone 6 (Figure 12f), (Everett 1973: 439). The large adults are harvested year round in these 4 zones (Alfaro et al. 1982), and in the mouths of Lake Titicaca's major tributaries, when they migrate upstream for spawning at the end of the rainy season (Everett 1971; 1973). Because the trout spends most of its adult life roaming in relatively deep offshore waters, it is most vulnerable at the time of its upstream spawning migration when it passes through narrow river mouths. Access to the corresponding TURF areas is thus very valuable and severely restricted by their holders (Bustamante and Trevino 1976).
In conclusion, TURFs affect local fish resources according to the latter's distribution and migrations. Widely roaming species like the rainbow trout and elusive species like the ispis, which become available to local fishermen only periodically and in a limited number of locations, are unlikely to be affected in the same way as more sedentary species. Yet access to these resources can be restricted, either because access to all fishing locations in the case of the ispis, or because the best fishing locations in the case of the trout, is the privilege of a few fishing communities. Sedentary species like the carachis and the mauris which remain within the TURF-controlled littoral area during most of their life cycles, are likely to be most affected by the existence of TURFs.

3.3.2. Aquatic macrophytes: Totora and llachu

The aquatic macrophytes category includes two sub groups: submerged aquatic plants, or llachu, and emergent aquatic reeds, or totora. Totora and llachu harvesting is an important economic activity for most shore dwellers (Levieil et al. 1986). In their mind TURFs and totora ownership are related, not only because the carachis live and hide in the totora beds (Galdo 1962a: 92), but also because they are part of the same organic whole (Bustamante and Trevino 1976), a notion of great importance in Andean cosmology and sense of territoriality (Bastien 1978; 1985). The same can be said of the relationship between carachis, mauris and llachu.

The llachu is exploited both in the shallow waters of zone 5 where cattle graze it, or further from shore in zone 3 and 4 where people collect it themselves as fodder (Levieil et al. 1986). However, llachu weeds are not subject to the same type of private ownership as the totora reeds, because they are never planted whereas the latter usually are, and because planting confers special rights to the individual who undertakes it independent of his
rights to the land.

3.3.3. Waterfowl: eggs and birds

Waterfowl are exploited for human consumption, both as eggs and as fully grown birds. Juvenile birds are sometimes captured alive and raised much like domestic fowl. Ecologically, waterfowl are closely associated with the totora beds of zone 4, because the reeds provide them with a sheltered nesting area close to the muddy shallows of zone 5 where they feed. Virtually all their nesting and feeding area is included in zone 4 and 5 thus within the TURF-controlled littoral area. Most of this area is divided between shore communities, although the Reserva Nacional del Titicaca in the Bahia de Puno is theoretically controlled by a state agency.

The conclusion from this analysis is that the type of TURF encountered in a particular littoral area is bound to affect aquatic resources in very different ways according to their ecology. The proportion of the habitat of these resources included within the TURF-controlled area provides an indication of the likely impact of TURFs existence on access to these resources. Type I TURFs can encompass a large proportion of the habitat of the demersal and benthic species such as the carachis and the mauris (not to mention a large part of existing totora and llachu beds). Type II TURFs, however, can encompass the whole habitat of these same species. Both types allow for the control of access to the spawning areas of most fish resources, and to the nesting areas of waterfowl. Conversely, type III TURFs may only allow for the restriction of access to a very limited part of the habitat of pelagic fish resources. The latter, however, may be the only one where the resource is vulnerable to fishing, thus the most important for the exploitation of this resource as in the case of the ispis.
3.4. DEMOGRAPHIC DIMENSION

In this section, based on fieldwork carried out in 1980, 1981 and 1984, I determine who belongs to the TURF holding category. Since only members of a TURF holding community have access to aquatic resources, I consider the criteria for community membership, according to which I distinguish between three categories of TURF holders: those who have acquired membership in a TURF holding community by birth, those who have acquired it by assimilation, and those who have established ritual or fictive kinship ties with members of a TURF holding community.

3.4.1. TURF holding communities

In the previous sections, I have demonstrated that all the shore communities of Lake Titicaca hold TURF over the area of the lake immediately adjacent to their portion of the shoreline. I have also shown that these communities are well defined, locally based socio-political institutions, many of which have the special administrative status of peasant communities. However, the question arises as to whether inland communities could not also hold some TURFs. In this section I demonstrate that Lake Titicaca TURFs are held exclusively by shore communities.

The application of the verticality principle to the communities of the Altiplano entails that shore communities could have retained access over distant lands and resources, and conversely, that inland communities could have done so over Lake Titicaca shore areas. I could find various onshore communities with access to distant inland resources. The members of the community of Maquercota and of Santa Rosa de Yanaque in the Lago Sur, for example, have retained their traditional access rights to small lakes about 100 kilometers further inland (Velasco 1978; Chirapo 1982; Flores 1983).
Those of various communities of the Moho and Conima districts still maintain their traditional connections with the Amazonian slopes of the Andes, often combining agricultural practices in both areas (Collins 1982; Painter 1982).

However, contrary to the predictions of the verticality model, I could not find a single example of an inland community whose members had any rights, even temporary ones, to Lake Titicaca's resources, nor could I find any reference of inland dwellers establishing temporary fishing settlements on the lake's shores or on those of a neighbouring lagoon. Apparently, inland dwellers never came to the lake shore to fish but to exchange their products with those of shore dwellers, including dried fish from the lake. Members of distant communities, such as the llama and alpaca herders of Paratia and Vila for example, still come once a year to the shores of the Lago Norte for this purpose (Flores 1977), as confirmed in 1984 by the fishermen of Pusi (Taraco).

This result can probably be explained by the predominance of the Altiplano mode of economic integration over the archipelago one, around Lake Titicaca, during most of the Tiahuanaku era, from 200 B.C. to 1000 A.D. approximately (Browman 1981). In the altiplano model, access to goods from other ecological zones is achieved through trade networks between specialized communities rather than direct exploitation by members of a single, unspecialized community. Thus members of communities specialized in cameloid herding obtained fish from the lake through trading with shore communities, rather than through fishing. Having demonstrated that membership in shore communities determines access to aquatic resources, I can now consider the criteria which govern the latter: birth, marriage, and fictive kinship.

3.4.2. Access by birth

Community membership is granted to the children of community members, who reside within the community territory, although only periodic residence may be
Membership in officially recognized peasant communities is theoretically granted to the heirs of former members of either sex, who have reached legal age or who have established a family, who live within the community, but who do not own agricultural premises within or outside the community, nor earn significant income from outside sources, nor belong to another peasant community (Decreto Supremo 37-70A: Articulo 23a to 23g). Membership can also be acquired by assimilation, or common law marriage with a community member, providing approval is granted by a majority of the community members present at a General Assembly meeting (Articulo 24a to 24c). However, in practice, the kinship and residency requirements appear to be the only decisive ones.

On the other hand community membership may not always be sufficient for an individual to get access to communal TURFs, as when the community is divided into sectors, and the individual considered happens to be from the inland sector. This is illustrated by a conflict in the Bolivian community of Compi on the northern shores of the Lago Pequeno, in which the residents of the coastal sector tried to deny traditional rights of access to the shoreline to those from the inland one (Buechler and Buechler 1971: 52-53). However, examples of such conflicts are rare. Instead, informants recurrently confirmed the rights of access to the shoreline of the inhabitants of the inland sectors, on the grounds that the latter owned land within the onshore sectors, and that they had kinship ties with members of these sectors. Fishermen from Escallani (Capachica), for example, acknowledge that those from the landlocked community of Isanura, a former sector of Escallani, could and did operate within Escallani's area.

Male community members who no longer live within their community may still fish in the TURF area of their original community. This is true if they
reside in the community of their wife (i.e. uxorilocally), as for a fisherman of Santiago Mucho who could still fish in the area of Juli where he was from, or as for a fisherman who has settled on the outskirts of Puno city who could still fish in the area of Ch'ulluni where he was from. It is also true if they reside neither in their original community, nor in that of their wife, (i.e. neolocally), as for various fishermen living in Barco (Chucuito), or along the shores of the urbanized part of Inner Puno Bay, who could still operate in the areas of their original community.

Access rights can also be inherited by the children and grandchildren of community members who do not live within the community themselves, providing their kindred within the community confirm their family ties. One informant, for example, indicated that he could go fishing in the Uros area of Kapi in the middle of Puno Bay where his father and grandfather were from, although he was himself living in Barco.

3.4.3. Access by marriage

Access to the aquatic resources of a shore community may be granted to a young man who has married a woman from this community after she settles in his own community i.e. virilocally. Virilocal residence is by far the most common pattern of residence in the Andes, though it is not exceptional for the groom to settle in the bride's community i.e. uxorilocally (Bolton and Mayer 1977). Because of the bilaterality of Peruvian laws of inheritance, women are legally entitled to the same share of their parents' inheritance as their brothers. Although numerous exceptions to this rule have been reported, it is nowadays common practice in the Andes and around Lake Titicaca in particular (Lambert 1977: 12-14). Submerged plots of land on which totora is planted, for example, are commonly inherited by women, and a woman's household is
entitled to harvest her totora, whether she resides uxorilocally or virilocally. For fishing, however, the situation varies according to the choice of residence of the couple considered, as detailed below.

a) Uxorilocal residence

A young man who settles uxorilocally is entitled to operate within the fishing area of his wife's community, in addition of that of his original community. According to the Official Statute of the Peasant Community, he can become a legitimate community member (Decreto Supremo No 37-70A). In practice though, men in his situation rarely acquire the same status as members by birth (Casaverde 1978: 32; Hickman and Stuart 1977: 32). For example, they may not be able to allow their consanguinal relatives to operate within the fishing zone of their wife's community, unless some kind of a deal is struck with other local fishermen as well. They may also become the target of envy and mockery, as one fisherman of Juli who had settled uxorilocally in Santiago Mucho, and who repeatedly complained of harassment by other fishermen from the community. The latter was, however, allowed to fish and did so constantly. Conversely, a young man who had recently settled in Laccone (Acora), the community of his wife, could fish there without any problem, and various informants used similar cases as arguments to deny that TURFs were enforced in their respective communities.

b) Virilocal residence

A young man who marries a woman from a shore community and keeps living in his own community, i.e. virilocally, never acquires the legal status of member in his wife's original community. Nevertheless, he is usually entitled to go fishing in the TURF area of the latter, but according to informants consulted during fieldwork, two different situations may arise, depending on
whether the groom himself belongs to a shore or an inland community.

A young man from a shore community who marries a woman from another shore community is generally entitled to operate in the TURF area of his wife's original community. Other fishermen are unlikely to deny him access, although they may resent his competition. One of the collaborating fishermen from Ichu Raya (Puno), for example, reported that he could go fishing in the area of Pallalla (Acora), his wife's original community, but that he felt more comfortable when she would come fishing with him.

This right of access is not simply transmitted by a woman to her husband, but also to her household, thus children and grand children. Many fishermen have access to the TURF zone of a neighbouring community, because it was the original community of their mother or grand mother, as demonstrated by fishermen's common indication that "they can fish in the area of [another community], because their mother was from there" ("puede pescar en la zona de [otra comunidad], porque su mama es de alla"), or "because they have relatives there" ("porque tiene sus parientes -o su parentesco- alla"). Another common expression, though not as self explanatory, to confirm this, is that "they can operate in the fishing area of [another community], because they have guarantees" ("puede ir a pescar en la zona de [otra comunidad] porque hay garantias"), or "because they are (well) known" ("porque es conocido").

Fishermen do not usually have to travel very far from their community's fishing zone to that of the community from which their mother or grandmother came. They are frequently close together if not almost contiguous. Some fishermen, however, are required to travel over fairly long distances. A fisherman from Barco-Chucuito, for example, had to travel out of the Puno Bay and around the Chucuito Peninsula to reach the island of Socca where he had relatives, and where he could fish.
A young man from an inland community who marries a woman from a shore community, is also entitled to go fishing in the TURF area of his wife's original community. Similarly, this access right is transmitted to this woman's heirs, even if they live in a landlocked community. Individuals from inland communities, whose mother or grand mother originally came from a shore community, also have access to the latter's fishing zone. If they do not own a craft themselves, they may go fishing with their wife's father or one of her brothers, as crew members, and receive a share of the total catch, or the catch of their own nets if they bring any.

Since it may be time consuming for them to commute on foot from their own community to the shore every time they want to go fishing, they may move temporarily with some of their shore dwelling relatives. One fisherman from Barco (Chucuito), for example, reported that three of his relatives from the inland community of Laykoma used to come and live in Barco to go fishing almost daily, for up to three months at a time. He also indicated that they would have to purchase a small fishing balsa which would last approximately that long, since they would not be allowed to harvest totora reeds from the communal beds of Sillamuri.

3.4.4. Access by fictive kinship

The ties of fictive kinship between a fisherman and a family from another shore community when the fisherman becomes co-parent of one of this family's children may allow this fisherman to operate within the TURF area of this family's community. By sponsoring one of this family's children for some of the rituals which the child has to undergo as part of his or her growing up, the co-parent (i.e. compadre) creates a privileged relationship with this family (Michaud 1973; Lambert 1977).

Fictive kinship entails a number of reciprocal obligations, just as true
kinship does. For example, people are expected to offer the goods they have to exchange or to sell, to their co-parents first, or to reserve some of these goods to meet the latter's needs, and eventually to give them a preferential rate of exchange or a better price. Mutual help for tasks requiring a large amount of labour can also be requested from co-parents in critical periods of the agricultural cycle, and so can loans of small amounts of money (Brush 1977; Brown 1978; Hickman and Stuart 1977).

Although co-parenthood does not necessarily guarantee access to the TURF area of the co-parents' community, it does so in some of the communities with type III TURFs. Various fishermen from the community of Llachon (Capachica), for example, could operate in the fishing zones of Amantani island and of some communities of the Chucuito peninsula because of their fictive kinship ties with members of those communities. In addition co-parenthood had the advantage of insuring them of a place to stay, should the weather preclude them from sailing back home. Having identified the criteria for community membership and access to TURF area, I can now consider the short to long term deals which can be worked out between individuals and the members of the communities in whose TURF areas they want to operate.

3.4.5. Strategies to gain access to TURFs

a) "Making friends"

Short term agreements are easier to enter, because they do not imply a commitment to repeat similar reciprocal exchanges in the future. They can be reached simply, when outsiders offer some coca leaves, alcohol or food, for immediate or later consumption, to the fishermen of the areas where they want to operate for a while (a few nights to a few weeks). Fish or agricultural products such as cereals and tubers can also be given to local shore dwellers.
Fishermen often refer to this as "making friends" (hacer amistades). Such practices have been reported in most parts of the lake, though it may have been more systematic in some areas, such as the Lago Pequeno. The fishermen of Vilurcuni (Yunguyo), for example, used to compensate the shore dwellers of various communities such as Pajano, Tapoje, Calampune, systematically, with coca, alcohol or fish (Bustamante and Trevino 1976). Similarly, those from the southern shores of the Puno Bay and of the Chucuito Peninsula exchanged agricultural products for the right to fish in the area of K'api controlled by the residents of the Uros islands, who lacked these products.

b) "Making Co-parents"

Another common type of arrangement is that by which fictive kinship ties are established between fishermen and inland dwellers. This is commonly referred to as "making godparents" (hacer compadres). The creation of co-parenthood ties (compadrazgo), as strategy to gain access to scarce resources, is well documented for the Peruvian Altiplano (Michaud 1973; Bolton 1977; Brown 1978) and in the Andes in general (Lambert 1977: 22-24). The use of this strategy by Llachon (Capachica) fishermen to gain access to aquatic resources is mentioned above. Another common example of such ties is given by shore dwellers of the Capachica and Chucuito peninsulas, who gain a more secure access to the aquatic resources of the totora beds of K'api by becoming co-parents with residents of the Uros islands (Mario Nunez 1984: pers. comm.).

c) Getting married

Establishing true kinship ties by arranging marriages between offsprings of different communities is also a strategy to gain access to aquatic resources over the long term. Its use has been documented for various parts of the Andes (Brush 1977: 137; Sherbondy 1982: 24) and for the Peruvian
Altiplano (Bolton 1977; Hickman and Stuart 1977). As mentioned earlier, marriage is commonly used along the shores of Lake Titicaca to get access to all the aquatic resources of another community, not just its fish resources.

d) Crewing for an in-law

Because of a tradition for Andean people to collaborate more frequently with their sisters' husbands or wives' brothers than with their own cousins (Lambert 1977: 20), a would-be fisherman from a landlocked community whose sister has moved in with her shore dwelling husband, may engage in a fishing partnership with his brother-in-law. A man from the landlocked community of Camacani (Chucuito), for example, could travel to the relatively distant community of Pallalla (Acora) to fish with his sister's husband. A similar arrangement with a fisherman from the closer-by community of Ccota would not only have shortened his trip considerably, but would also have given him access to a larger and apparently richer fishing ground. However, he did not have any relative with whom to go fishing in the latter community.

e) Exchanging fishing rights

The last type of arrangement by which fishermen from neighbouring shore communities would trade fishing rights for different species in their respective TURF areas, is the least commonly encountered. The fishermen of Llachon (Capachica), for example, claim that they can fish for ispi in the TURF areas of the neighbouring communities of Capano, Yapura and Siale, because they allow the fishermen from the latter communities to fish for carachi in their own area.

3.4.6. Synthesis

A fisherman may be granted access to the exclusive fishing areas of a
FIGURE 13: ACCESS TO LAKE TITICACA TURF AREAS BY BIRTH AND BY MARRIAGE.

FIG. 13A: THEORETICAL ACCESS

C1 = Ego's community
C2 = Ego's mother's c.
C3 = Ego's wife's c.
C4 = Ego's father's mother's commun.
C5 = Ego's mother's mother's commun.

FIG. 13B: EXAMPLE OF INFORMANT FROM BARCO

C1 = Barco
C2 = K'api
C3 = Karina
C4 = Laykoma

△ Ego
○ Female relative
△ Male relative

△ Informant
○ Female relative
series of nearby communities in addition to his own, as a consequence of his true kinship ties (Figure 13) and eventually of his fictive kinship ties too. He may be allowed to operate within the TURF areas of the communities from which his mother and eventually those from which the mother of his mother and the mother of his father originally came from (C2, C4 and C5 respectively on Figure 13). Finally, he may be allowed to operate within the area of the community from which his wife came from (C3 on Figure 13). It is unlikely though not impossible that a fisherman could be lucky enough to get access to five TURF zones. One informant from Barco (Chucuito), for example, had access to Karina on the Chucuito Peninsula where his paternal grandmother was from, to the Uros islands of K'api where his paternal grandfather and his father were from, and of course to Barco where his mother and maternal grandfather were from. Because his maternal grandmother was from the landlocked community of Laykoma, he did not have access to a fourth TURF area, but instead had to facilitate access to the lake for some relatives on his mother's side.

Although one could think that the patterns of access to TURF areas are regulated by a well established, and homogeneous set of norms common to all shore communities, a number of exceptions demonstrate the limits of these norms. Access to the TURF area of a woman's community may not be granted to the consanguinal relatives of a fisherman who resides uxorilocally, for example. Yet an informant from Escallani (Capachica) could fish in the waters of Taquili island where his brother had settled with his wife. Similarly, by settling in her husband's shore community a woman from an inland community does not normally confer access to the latter's TURF area to her blood relatives. As mentioned earlier, the informant from Camacani whose sister had settled in the shore community of Pallalla would not have been able to fish there on his own, but by crewing for his sister's husband he got access to the
aquatic resources of the latter's community.

I did identify during fieldwork a number of exceptions to general practices, where individuals who normally would not have been entitled to it, had been granted access to TURF areas because of some special circumstances. The reverse also occurs, and individuals may be denied access to which their consanguinal or affinal ties entitles them. But identification of the latter would have required a different approach such as a survey of inland communities. Documenting these exceptions would show how much variability there may be in the way shore dwellers enforce their TURFs.

It would be very difficult to estimate the exact proportion of fishermen with access to more than one TURF area because of true or of fictice kinship ties. The number of fishing sites indicated by the fishermen interviewed in 1976 (Table 6) provides some indication of this proportion.

<table>
<thead>
<tr>
<th>Number of sites</th>
<th>Absolute</th>
<th>Relative</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>78</td>
<td>31.8</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>24.5</td>
</tr>
<tr>
<td>3</td>
<td>57</td>
<td>23.3</td>
</tr>
<tr>
<td>4</td>
<td>28</td>
<td>11.4</td>
</tr>
<tr>
<td>5 to 7</td>
<td>22</td>
<td>9.0</td>
</tr>
<tr>
<td>Total</td>
<td>245</td>
<td>100</td>
</tr>
</tbody>
</table>

As underscored earlier (cf. section 3.1.1.), the names of these fishing sites indicate whether fishermen operate within the TURF areas of more than one shore community. An analysis of these names, for all interviewed
fishermen, reveals that at least 56.3% of them operate within the TURF area of their own community. It may be assumed that the other 43.6%, who operate regularly within more than one of these TURF areas, do so because of their special ties to local TURF holders.

The size of the TURF areas, the proportion of the aquatic resources these areas include, and the identity of the people who have access to these resources determine TURFs' concrete dimensions. The kind of rights TURFs entail determine their abstract dimensions.

3.5. CULTURAL DIMENSION

Nowadays, fishing in Peruvian waters is legally open to all Peruvian citizens duly registered as fishermen. The only restrictions that can apply to their fishing activities are those emanating from national laws and official regulations. Yet, as demonstrated above, Lake Titicaca shore dwellers are able to maintain their traditional rights over the fishing areas immediately adjacent to the shores of their communal territories. These informal or customary rights correspond to the cultural dimension of local TURFs. Customary rights refers not only to the kinds of rights collectively held by shore dwellers, but also to the conditions under which the distribution, transfer and exercise of these rights apply (Crocombe 1974; Christy 1982). I have used Crocombe's (1974) classification of customary land rights in six broad categories to organize the following section: direct use, indirect economic gain, control, transfer, residual and symbolic rights. Since none of these rights is presently recognized or protected by Peruvian laws, what I summarize in this section are shore dwellers' concepts of customary rights over aquatic resources.
3.5.1. Rights of direct use

Lake Titicaca shore dwellers consider that they hold a number of direct use rights over the resources encountered within their TURF areas. They believe that their membership in shore communities give them the right to harvest and to husband aquatic resources, whether fish, macrophytes or birds.

a) Fish resources

Lake Titicaca shore dwellers consider that all community members hold the right to fish within the TURF area of their community, without restriction on the species caught. There are some restrictions on the location of capture, as one may not set his nets within privately owned patches of totora. One collaborating fisherman from Ichu Raya (Chucuito), for example, indicated that some of the nets he had lost, had probably been stolen because he had set them in the patch of a local land owner (calados en el totora de un vecino). However, the rationale behind this restriction appears to be the protection of reeds rather than that of fish.

Fish captured alive can sometimes be kept in small pens submerged in secret locations, in private patches of totora, or occasionally in small fish holding tanks built onshore. It is then considered the private property of the owner of the container. This also applies to rainbow trout raised in floating pens for experimental or commercial ventures (Levieil and Paz 1984).

b) Totora reeds

Depending upon the community considered and the corresponding type of TURF, the right to husband and harvest totora may be shared equally between community members or not. In TURF areas of type II and in most of those of type I, the totora beds are usually completely divided into individually owned patches (Galdo 1962b: 138; Vellard 1963: 191; Solc 1969: 29; Hyslop 1976: 61;
Chirapo 1982: 11). The same pattern of individual ownership also occurs in the rare parts of type III TURF areas where totora can be found (e.g., small bays). However, in some TURFs areas of type I, the totora beds are divided into two sections, the closest to shore being comprised of individually owned patches, and the farthest one being accessible to all community members (Martinez 1962: 22; Hickman 1963:3).

The explanation commonly provided for the privatization of part of the totora beds, is that the individually owned patches correspond to the private plots of land on which owners have planted totora reeds when these plots were submerged by the rising lake level (Hickman 1963: 3; Gonzales 1979: 87; Chirapo 1982: 11)

c) Llachu weeds

Any member of the TURF holding community can harvest llachu weeds without restriction on the location of the harvest, even on submerged plots of land which are individually owned. Informants justify this by indicating that contrary to the totora reeds, the llachu weeds cannot be planted. Still, llachu weeds do contribute to reinforce shore dwellers' sense of territoriality over nearshore waters, as illustrated by some conflicts between neighbouring communities. During the drought of 1983, for example, when competition for cattle fodder was acute, members of the community of Sajo appealed to the Ministry of Agriculture in Puno, to repel trespassers from the neighbouring communities of Chatuma and Villa Santiago de Ccama (Letter of the community of Sajo to the Regional Director of the MINA, July 11, 1983).

d) Waterfowl and their eggs

Waterfowl hunting and egg collecting are accessible to all community members without any restriction of species. Some restriction on where eggs
can be collected may occur, because waterfowl nest in the thickest of the totora beds, and eggs seekers avoid the privately owned patches. Juvenile waterfowl captured alive may be raised with domestic fowl, thus becoming the property of the family who raises them.

e) Aquatic space

Shore dwellers consider both the water column and its bottom as resources. Direct use rights over the bottom are held by the community as a whole or individually by its members, depending on depth and distance from shore. Outsiders would not be allowed to plant totora reeds on any part of the bottom of a TURF area. The same holds true for the water column even if transit by outsiders across TURF-controlled areas is tolerated in the open water parts of these areas where totora reeds cannot be damaged or stolen. Outsiders are cannot use it for trout aquaculture without compensating the community in whose TURF area the floating pens are located. Failure to do so explains some of the problems which have plagued trout aquaculture on Lake Titicaca. Because such activities were often imposed on local communities, they were deeply resented by TURF holders except for the few who benefitted directly from them, and sabotage occurred more than once (Levieil and Paz 1984).

In conclusion, members of shore communities hold direct use rights over the aquatic resources encountered within TURF areas. These include the rights to harvest and to husband aquatic resources in any location within a TURF area, except for the privately owned patches of totora reeds where these rights belong to the patch owner. I found no situation, theoretically possible (Crocombe 1974), in which rights of direct use over different aquatic resources within the same portion of aquatic space were held by different actors. And the only example of subsidiary rights of direct use I could
identify was that of transit through the open waters of TURF areas.

3.5.2. Rights of indirect economic gain

Shore dwellers hold a right to indirect economic gain for the exploitation of some of the aquatic resources encountered in their collective TURF area. There is a lot of variety depending of the resources and of the communities considered.

a) Fish resources

The right of indirect economic gain from the fish resources of a TURF holding is held by the community as a whole. However, it is considered acceptable practice for community members to receive a compensation for allowing outsiders to fish in the TURF area of their community. As indicated earlier, a common expression used by outsiders to refer to this practice is "to make friends" with TURF holders (hacen amistades) by giving them something, either a ritual gift of coca leaves and alcohol, or a more pragmatic gift of fish or agricultural products.

TURF holders may also request compensation in the form of a preferential treatment when purchasing or bartering fish from known trespassors. Fishermen from Socca island, for example, indicated that customers from Santa Rosa de Yanaque always demanded a preferential price, or a more generous overweight, or yapa, for the fish which they claimes had been caught in their TURF area. Similarly, an elderly lady from the outskirts of Puno indicated that she required the fishermen from Chimu to give her a better price for the fish which had been caught in the fishing zone of her community. As she said "we tell the fishermen from these communities (who trespass) to lower their prices, because the fish they sell comes from our (area of the) lake" (a esos pescadores [quienes incursian] le decimos de bajar el precio, porque el...
Shore dwellers can also get fish from the fishermen of their own community for a lower price, or for "goodwill" (de voluntad). In most cases, they receive this preferential treatment because they are relatives of the fishermen (familiares) who can expect some unspecified favor in return. But there is also a moral obligation for fishermen to sell or to barter their fish with other community members (particularly the poorest ones) at a preferential rate for the latter.

The TURF holding communities have generally been unable to collect the indirect economic gains to which they are customarily entitled, because of TURFs illegal status. This could explain why individual members may collect access fees from outsiders in the name of the community. Some officially recognized communities, however, have required outside fishermen to pay a lump sum in cash to their treasurer, for the right to fish in their area. One community from the Southern part of the Bahia de Puno, in particular, has required outsiders to pay a lump sum (equivalent to 25 kilos of silverside) as a contribution to its school (cuota para el colegio), for the right to fish in its area during a whole year. Some communities from the Mantaro Valley, a few hundred kilometers north of the Altiplano, also charge outsiders a fee everytime they want to fish for trout in their river (Mayer 1985: 75).

b) Totora reeds

TURF holders do not usually allow outsiders to harvest totora reeds from their communal totora beds, as confirmed by a majority (72%) of the collaborating fishermen (18.6% of whom did not provide a definite answer). The reason invoked is that few communities have enough totora for the needs of their own members. Only in the very large totora beds of Moro and K'api in
the Bahia de Puno, are outsiders allowed to harvest the reeds themselves for the payment of a small rental fee or arriendo. Members of the community of Uros-Ch'ulluni, for example, have traditionally obtained agricultural products and cash nowadays, from this practice (Calancho 1984; Levieil et al. 1986).

In conclusion, shore dwellers are entitled to indirect economic gains from the exploitation of the fish resources within the TURF area of their community. Residents of the Uros islands of K'api in the Puno Bay may also hold a similar right for totora resources. But I encountered no evidence of such a right for llachu weeds or waterfowl. There is probably some limit to these gains, as demonstrated by the criticisms levied against some of the collaborating fishermen who, being paid a modest sum for their collaboration, were accused of selling the lake of their fellow fishermen to the foreigners (venden nuestro lago a los gringos!).

3.5.3. Rights of control

Legally, the local administration holds the right of control over activities related to the exploitation of aquatic resources and decides how these resources may be used. In practice, however, community members are normally involved in decisions related to matters of communal interest and their membership entitles them to a share of communal resources and to the right to participate in the control of these resources. Numerous examples of communal control over agricultural practices and water rationing have been documented all over the Andes (Mayer 1985). They demonstrate Andean agriculturalists' ability to organize productive activities at the community level by coordinating practices among member households. Around Lake Titicaca, this ability is translated in practice by the rules which various communities have implemented for the protection of their aquatic resources or for their orderly exploitation.
a) Fish resources.

Fishermen from some communities have promulgated rules for the orderly conduct of fishing. In the early 1970s, for example, fishermen from the Asociacion de Pescadores Menores de Consumo Humano de Escallani set fishing schedules and turns to avoid net theft and interferences in the area of Sejnachi (Bustamante and Trevino 1976: 78). Similarly, those from the "Comite de Pescadores Jose Olaya de Arapa" organized fishing activities for the boga in the western half of Laguna Arapa. They prohibited nocturnal fishing activities, to avoid fishing accidents and net theft under the cover of darkness. They also agreed on restricting to two the number of nets per fisherman and prohibiting meshesizes under 41 mm (A. Gonzales 1984: pers. com.). Finally, those from Ccota (Acora) in the Puno Bay stipulated a minimum size of capture for the carachi, and those from Socca (Acora) implemented a closed season (veda) without much success in either case.

Traditionally, some rights of control over the practices of fishing were held by local master fishermen. In Laguna Arapa, for example, an experienced fisherman, the 11icalloc, was responsible for the direction of collective fishing operations, often because he was the owner of the large trap net, or 1lica, used. The 11icalloc could decide when to use his net and who could participate in an operation which required two dozen fishermen and half as many balsas. However, the 1licas are not used anymore, and the 11icalloc have lost their limited powers.

b) Totora reeds

Many more communities have implemented regulations for the harvesting of totora reeds than for fishing. The major objective of these regulations is to minimize the theft of reeds. Because of the minute size of most totora patches, and because one is hidden among the reeds when harvesting them off a
low lying shore, it is tempting to harvest the totora of one's neighbour, when few people are around. To mitigate this problem and the ensuing brawls, most communities holding type I TURFs (eg Huayllata, Cachi Pucara), and some holding type II TURFs (eg Barco, Socca) have implemented a cutting season, and a schedule of cutting days, which apply to all totora within the community's TURF area, whether individually owned or not.

Some of these regulations also promote greater reed production. The cutting season, for example, has the advantage of allowing the reeds to grow during the rainy season when alternative cattle fodder is plentiful. In addition, many communities have prohibited pulling out the edible root, or chullo, without which the totora reeds cannot regenerate. They have also prohibited cutting the reeds too far from the surface of the water, or too close from the bottom, which would hamper their regeneration.

In conclusion, the right of control over TURF resources is held by community as a whole. The peer pressure exerted by community members upon individuals who appear to take more than their share of the communal resources may be assimilated to a form of communal control. This form of control results from a shared understanding among community members, of what constitutes an acceptable level of exploitation of communal resources, for barter or sale. Alternatively, the community may delegate the responsibility of its control rights to individuals appointed on an annual shift basis. In the case of the totora reeds, the rescatistas or vigilantes de totora are responsible for the respect of the corresponding regulations, and their failure to do so may lead to them being fined. This underscores the potential for the appointment by the shore communities of an individual in charge of the control of fishing. The communities of the Mantaro Valley mentionned earlier, for example, created a special charge, or cargo, for the specific purpose of
controlling trout fishing in their creeks and of collecting outsiders' fishing fee (Mayer 1985:75).

3.5.4. Rights of transfer and residual rights

As demonstrated earlier, TURF holders transfer their fishing, macrophyte harvesting and bird hunting rights to their heirs, with their community membership. They can also transfer their rights over individually owned patches of totora by sale to other community members, but this is less common. Among a sample of 53 totora patches owned by 38 shore dwellers, only 11% had been acquired through purchase by 10.5% of these shore dwellers.

The shares of the collective rights of a community member who dies without children are reverted with the community, when his/her rights to individually owned patches of totora reeds are returned to his/her closest consanguinal kins, rather than to a surviving spouse (Bolton 1977: 223), a pattern commonly observed in the Andes (Lambert 1977: 12). TURFs residual rights thus belong to the community as a whole, except for individually owned patches of totora beds which belong to the consanguinal kins of the deceased.

3.5.5. Symbolic rights

Perhaps more important to shore dwellers than all the material resources included within the territory of their community and all the corresponding rights, is the deep religious significance of this very territory. The latter's most salient features are usually associated with spirits and deities (Bolton and Mayer 1977: passim; Sherbondy 1982) of great significance in the Andean cosmology. In every mountain peak lives a Wamani, or Apu, to whom ritual offerings, or "payments" (pagos) have to performed periodically, usually where natural features known as huaca exist, or where small shrines, or capillas, have been erected (Isbell 1977). Similarly, fishermen have to
"pay" the lake goddess and owner of the fish, Mamacocha, at least once a year (Tscheschik 1946; La Barre 1948; Nunez 1982).

The deities of the Andean communities are integrated into a whole cosmological order, with hierarchies and functional relationships (Cordero 1966; Vallee 1972). Lake Titicaca itself used to be the highest lake in the Inca cosmological hierarchy, because it was the one from which the founder of the Inca dynasty, Viracocha (or "Lake of fat"), had originally come from. And the Wamani are ranked according to the size of their mountain peaks. They are connected to the earth, Pacha Mama, by the Amaru who represents the force and fecundation power of water, and who is often symbolized by the rain, a river, an irrigation channel or a large snake. Every major section of a community's territory including the shrines of one or more spirits, is thus part of the residents' cosmological vision of their own world. In many cases, this vision is integrated into an organic analogy.

The intimate correspondence between the physical territory and the cosmology of Andean people indicates how intimately political concepts and religious symbols are connected (Gow 1981: 221-255; Sherbondy 1982). The loss of part of the community's territory is deeply felt because it implies the impossibility to perform the corresponding rituals. In cases where the corresponding cosmological vision assimilates this territory to the body of a human being, or that of an animal (Gow 1981: 235; Bastien 1985), such losses have been compared to a loss of limbs. Reciprocally, the features of the physical landscape are often portrayed as living characters in the myths which serve to record traditional claims to land (Bastien 1985) or to water (Sherbondy 1982).

I recorded a few myths associated with Lake Titicaca aquatic resources during fieldwork. Most of them dealt with a giant catfish, or Catari, who
would drawn imprudent or greedy fishermen by dragging them and their nets into water holes. Fishermen from Laguna Umayo and Laguna Arapa reported the existence of local shrines, or **huacas**, associated with fishing. It was indicated that the **huaca** of Isla Arapa, had been blown up with dynamite by a métis land owner (**misti**) who wanted to prevent fishermen from paying their dues to the **Cocha Mama**, and who paid dearly for his sacrilege when he died paralyzed a few years later.

The ritual celebrations and "payments" to the mountain, earth and water spirits are performed on specific dates, usually associated with the Catholic calendar of saints (La Barre 1948: 184; Galdo 1962; 1967; Nunez 1982). Because they determine the agricultural calendar, they can be considered as agricultural (Sherbondy 1982: 111-2) and fishing technologies (Tschopik 1951: 200; Cordero 1966:63). But most importantly for the implementation of TURF areas, rituals contribute to reassert traditional rights (Sherbondy 1982: 25), and to reinforce the sense of territoriality shared by community members (Labarre 1948: 184; Tschopik 1951: 280). In many Andean communities, for example, the rituals of the 1st of January or of carnival "celebrate the inviolability of boundaries and prescribe the right means to cross them" (Gow 1981: 242). In Luquina Grande (Acora) for example, on San Sebastian day (January 20th), a band of musicians leads the whole community as it dances along the boundaries of its territory, thus teaching the younger generation to recognize them (Lescano et al. 1982: 146). It is in this way that the contribution of symbols to the delineation of aquatic territories is made most obvious nowadays.

3.5.6. Obligations of community members

Within a tenure system "each right is associated with reciprocal duties,
and with a total network of relationships" (Crocombe 1974: 7). This network can be "a rank system (which) includes institutionalized differences between rights and their related obligations" (Ibid.). In the case of Lake Titicaca shore communities, no such institutionalized differences exist between members with respect to TURFs. Each and every member is entitled to the same share of the communal aquatic resources, excluding private patches of totora. Consequently, all members are expected to fulfill in the same way the obligations entailed by their membership. These obligations include "the giving of labour, and participation in the rule-making, rule-breaking and rule-enforcing mechanisms" (Mayer 1985: 64).

The giving of labour, or faena, is required for the construction and maintenance of the infrastructural features necessary for the community (roads, irrigation channels and ditches, school or communal buildings). A contribution of 100 mud bricks, or adobes, is a standard contribution to the construction of a school for a community member and his household. In some shore communities, the faenas may also include the construction and maintenance of docks to protect small harbours. In addition to the performance of the necessary rituals, the repairing and cleaning of irrigation channels, for example, is necessary, for the annual reassertion of communal rights to the channels and their water (Sherbondy 1982: 23). Similarly, individual rights are gained by participation in the construction of communal infrastructures, and maintained by regular faena participation (Mayer 1985: 61). Some fishermen from Llachon, for example, were allowed to fish in the area of a community on Chucuito peninsula because they had participated in the construction of the local school.

Participation in the implementation of rules for the control of the community over individual practices, entails filling the various positions, or
cargos, necessary for the political administration of the community, and the organization of its major celebrations, or fiestas, including the performance of the associated rituals (Carter and Mamani 1982).

Finally, a financial contribution may be required from community members, for the use of communal resources, such as pasture lands and fallows. I recorded only two such examples during field work, one in Chaulla Camani, where fishermen were required to pay "a small annual contribution to help the community" (una quotita al ano, como ayuda para la comunidad), the other in Arapa, where they were required to contribute to the purchase of a typewriter for the municipality.

Because all the rights identified are held by well-defined and relatively autonomous communities (except for the resources within private patches of totora) one may speak of shore communities' collective property over aquatic resources. However, these rights are only informal, since TURFs are illegal in Peru, as in most countries. One may thus wonder how Lake Titicaca shore dwellers manage to enforce their TURFs and how effective this enforcement is. Documenting this enforcement in the next section demonstrates that TURFs do not result from an absence of competition for resources within fishermen's reach, from a lack of interest on the part of potential competitors, or from some form of social prejudice against fishing.
CHAPTER 4

ENFORCEMENT OF TURFS

Despite the opposition of the administration, shore dwellers are able to enforce their informal TURFs. This enforcement may be through various mechanisms, including advertisement and overt or covert defense, all of which communicate to outsiders their exclusion. I analyze these mechanisms in the three sections of this chapter. First, I describe the legal and administrative environment in which Lake Titicaca shore dwellers have to operate to enforce their TURFs. Second, I consider the alternative forms of ownership of the aquatic space and its resources (whether private, semi private or collective). And third, I show how these alternative forms of ownership and the laws and regulations for the use of aquatic resources contribute to the enforcement of Lake Titicaca TURFs.

4.1. TURFS LEGAL AND ADMINISTRATIVE ENVIRONMENT

In Peru as in many other countries, it is illegal for a group of fishermen or shore dwellers to enforce territorial fishing rights. Government officials strongly criticize the latter for "not knowing the law" (son ignorantes de la ley). Yet shore dwellers are able to take advantage of various laws and regulations to protect some of their customary rights. Among these are the Legal Statute of the Peasant Communities, a 1947 law dealing with the ownership of the bottom in the shallows of the lake and various official texts dealing with the conservation of totora reeds and fisheries organization, all of which I consider here.
4.1.1. Land and water laws

The Peruvian Law of Agrarian Reform (Decreto Ley No. 17716 de Reforma Agraria 1969) and the Legal Statute of the Peasant Communities (Decreto Supremo No. 37-70A 1970) formally recognize private, cooperative and communal land ownership. According to the Water Law (Ley General de Aguas, Decreto Ley No. 17752, 1969) and to the Fisheries Law (Ley General de Pesqueria, Decreto Ley No. 18810, 1971), aquatic space and resources belong to the state. The Water Law also includes in the public domain a fifty meters wide strip of land above the highest tide line (Articulo 5a) and all land gained on rivers, lakes and oceans, by natural or by artificial means (Articulo 5g). However, a special law grants ownership of the submerged littoral fringe of Lake Titicaca to its shore dwellers. The following sections of these laws and of the corresponding regulations are relevant to TURFs enforcement.

a) Official Statute of Peasant Communities

Various sections of the Official Statute of Peasant Communities (Decreto Supremo No. 37-70A) deserve attention because they correspond to some of TURFs' dimensions. The legal definition of the peasant community corresponds to their human dimension. The identification of its territory and of its communal resources corresponds to their resource dimension. And the section defining the powers formally granted to the community for the management of its resources, corresponds to their legal dimension.

According to their Official Statute, Peasant Communities are territorial groups of families linked by common social and cultural features (Article 2 and 13 to 16). A peasant community has a juridical personality, exclusive ownership of its territory and the right to elaborate and enforce an internal set of rules (Article 4 to 6). It is entitled to have rules for the "appropriate use of its natural resources" (Article 8). The statute
stipulates the conditions for membership (article 23 and 24), the rights and duties entailed by this membership (Article 25 and 26) and the penalties incurred for lack of compliance (Article 27 to 30).

The official statute also deals extensively with the administrative organization of the peasant community and with the creation of its three administrative bodies, each consisting of a limited number of elected representatives: the General Assembly composed of all community members (Article 33 to 39), the Administrative Council (Article 40 to 50) and the Committee of Vigilance (Article 51 to 55). In addition to these three essential bodies, ad-hoc or special committees can be created to assist the Administrative Council on specific issues, particularly technical ones, such as the building of physical infrastructures and issues related to the exploitation of communal resources (Article 58 to 62). Similarly, Local Administrative Committees (Juntas Locales) can be created to assist the Administrative Council in the administration of certain parts of the communal territory (called Annexos) (Article 63 to 66).

Finally, the statute specifies the elements of the peasant community's patrimony (Article 89), its sources of labour (Article 106 to 108), and of income. The latter may include among others "the fees paid for the usufruct of community property or communally-owned services" (Article 90). It also indicates that the peasant community is responsible for the identification and inventory of its communal resources and of the accounting of their rents, under the supervision of various national agencies (Article 93 to 102).

b) Ownership of the lake shore

During the mid 1940s, after a long period of drought, the level of Lake Titicaca was as much as 5 meters below its highest recorded level (Collot
1980: 11). After much debate a law was passed in March of 1947, declaring as Indian property all newly exposed shore lands (Davies 1970: 140-141). This law gave preferential treatment to shore dwellers, particularly landless ones, and limited adjudications to ten hectares per family (Law No. 10842, 1947: articulo 2). It also legalized the transfer of these lands by inheritance, but prohibited their sale or embargo (articulo 3).

Since then the lake level has been rising until it reached its maximum present level. The plots of land distributed have been submerged again and planted with totora by their original owners or by their heirs (Chirapo 1982; Sur 1979a: 17-18). Even if these individual plots have been submerged for more than two decades, their exact location has not been forgotten. However, more recent laws and regulations have either modified law No 10842, or indirectly affected its application.

c) Laws of forestry and wildlife

The Forestry and Wildlife Law (Decreto Ley No. 21147, 1975) defines the terms under which state-owned forest and wildlife resources can be used (Articulo 1) and the appropriate measures for the conservation of these resources (Articulo 14 to 20). It defines subsistence, scientific and commercial exploitation, and stipulates the conditions under which each can be undertaken under the control of the Ministry of Agriculture (hereafter referred to as MINA). But it does not stipulate the conditions under which one can extract these resources for subsistence purposes.

Since the promulgation of this law, concerns over conservation issues in Peru and over the future of the large totora beds of Lake Titicaca have led to the creation of Lake Titicaca National Reserve, in late 1978 (D.S. No 185-78-AA, 1978). This reserve was established "to conserve natural resources and esthetic values, while contributing to the socio-economic development of local
populations through a rational use of animal and vegetal resources and the
promotion of local tourism" (D.S. No 185-78-AA 1978: 1, my translation).

The creation of this reserve has brought a considerable amount of
confusion for people who had traditionally considered the totora as theirs
because they or their forefathers have planted it or otherwise contributed to
its dissemination on submerged land to which they have legal title. They
feared that with the creation of the reserve, the harvesting of totora reeds
would become illegal or that it would be taxed (Sur 1979b: 13-14).

The Decreto Supremo creating Lake Titicaca National Reserve "does not
affect shore dwellers rights (of ownership over the bottom of the lake
shallows) established by Law No 10842" (D.S. No 185-78-AA, 1978). It does not
affect their rights over the totora either. But since totora reeds are
officially considered as forestry resources, and since official texts indicate
that aquatic resources (D.L. No 17752, 1969), forestry and wildlife (D.L. No
21147, 1975) are state owned, shore dwellers have actually been legally
deprived of their traditional rights over the totora.

Shore dwellers have not lost the right to use forest and wildlife
resources for subsistence, however. The latter is merely defined as "use for
home consumption by the extractor's family" (Ibid.) and is subject to the
general regulations promulgated by the MINA for management purposes, though no
special licence or authorization is required for its undertaking.
Furthermore, the Forestry and Wildlife Law gives priority for extraction
permits (for commercial use) to owners of land adjacent to the areas involved,
particularly when the latter are involved in tree planting. According to this
law, local TURF holders should therefore be given preferential access to the
totora reeds (which they have planted).
FIGURE 14: MAP OF THE "LIGA DE DEFENSA DE LA TOTORA DE CATURA PAMPA" (Reduced to 75% of the original and slightly enhanced)

Note: No scale on the original.
The decision of the regional director of the MINA in Puno "to protect the free use for subsistence purposes of totora reeds in the temporary laguna of Ccota Lacka Pampa by the communities and settlements of Yanaque Catura Pampa" (Resolucion Directoral No 0593-77-DZA-XII, 1977, my translation) confirms that priority is actually given to TURF holders (Figure 14). This decision is subject to the conditions that "(such a) subsistence oriented extraction will only be carried out by members of the communities and settlements indicated (...) according to customs, traditions and internal rules, providing that they do not conflict with the rational use of the resource" (Ibid.). Although it involves only a dozen communities from the Lago Sur, it does illustrate the discrecional power of local administrators in interpreting existing laws and in protecting shore dwellers access rights to local aquatic resources.

Administrators are careful to stress that preferential access rights do not entail ownership of the resources involved, as repeatedly indicated in the documents granting official recognition to Peasant Communities. The document corresponding to the community of Ramis, for example, stipulates that "the territory of the community is partially encircled by Lake Titicaca, but does not include the submerged lands nor the existing flora." (Informe final No 127-75 de Reconocimiento de la Comunidad de Ramis 1975, my translation).

4.1.2. Fisheries laws

Among the numerous Peruvians laws and regulations dealing with fishing (Rendon and Rendon 1969), two are of major relevance for the pursuit of small scale fishing. The first one is the General Fishing Law (Ley General de Pesqueria, Decreto Ley No. 18810, 1971). It updates to some extent but mostly confirms the second one (Articulo 12). The second one corresponds to the by-laws of the Coast Guard, which deal both with navigation and fishing (Reglamento de Capitania y de la Marina Mercante Nacional, Decreto Supremo No.
A third one dealing with fishermen's guilds is worth mentioning because it indicates, among other things, the conditions under which fishing guilds can be created and how they can operate (Decreto Supremo No 3, 1955; Resolucion Ministerial No 2430, 1955).

a) General Fishing Law.

The General Fishing Law (Ley General de Pesqueria, Decreto Ley No. 18810, 1971) asserts that all Peruvians have the right to fish. It confirms that only the government has the power to deliver the authorizations and licenses required to undertake the corresponding activities (Articulo 7). And it transfers to the Ministry of Fisheries (hereafter MIPE) the responsibility of managing all Peruvian fisheries (Articulo 8).

According to this law, the regional office of the MIPE in Puno is legally in charge of fisheries management on Lake Titicaca, although the latter has done little in this respect. Since its creation in the late 1960s, it has trained a number of fishermen and of fishing extension agents, but it has not developed special functions for the latter, such as the collection of catch statistics. As for the fishing regulations it promotes, they involve minimal sizes of capture for four fish species (13 cm for suche and mauri, 14 cm for boga, and 25 cm for trout), and closed seasons from April to July for the trout and August to November for boga, suche and mauri).

b) By-laws and regulations of the Coast Guard.

The by-laws and regulations of the Coast Guard (Reglamento de Capitania y de la Marina Mercante Nacional, Decreto Supremo No. 21, 1951) control the conditions under which small scale fishermen can operate their craft. They reiterate that fishing is an activity in which all Peruvian citizens can freely participate (Articulo 744b). Each fisherman has to be registered at
the Coast Guard's headquarters, or Capitania, of the jurisdiction to which he belongs (Articulo 506). All fishing craft have to be registered at the Capitania (Articulo 748), and theoretically at least, verbal authorization from the Capitania is required to undertake a fishing trip (Articulo 757).

The Coast Guard regulations also include some by-laws designed to minimize interferences between fishermen (Capitulo IV). They give complete jurisdiction to the Coast Guard over all navigable waters within the national domain (Articulo 6), over private and state-owned landing or docking facilities (Articulo 8c). In addition, they give the latter the responsibility of registering land ownership within their jurisdiction (Articulo 8q), including the fifty meters wide strip of land above the highest level reached by the sea (Ley No. 17752, 1969: Articulo 5a). The Coast Guard is thus the organization that would be in charge of the formal registration of TURFs, if the latter were granted a legal status. In the meantime the Coast Guard supports unrestrained fishing operations by registered fishermen.

The Coast Guard's internal regulations require each fishing settlement to be represented Beach Sargeant or Sargento de Playa. The Sargento is often an older fisherman appointed by the Coast Guard, who is expected to perform his duties on a voluntary basis. The most which is expected from Lake Titicaca Sargentos is to keep an up to date list of local fishermen, to encourage them to get their fishing licence or to matriculate their crafts at the Capitania in Puno, and to inform other fishermen of the fisheries regulations promulgated by the MIPE.

A brief analysis of the Peruvian legislation dealing with fishing would lead one to believe that both aquatic space and shoreline areas are under the exclusive control of the state. Although professed by many urban
professionals in Puno and elsewhere in Peru, this view fails to reflect actual practices. Laws leave ample margin for local government officials to use their discretionary powers for the interpretation and implementation of these laws and of the corresponding regulations. In addition the perceptions by local communities of the rights they hold over the resources within their territorial boundaries are more effective in governing the behaviour of their members than the laws and regulations weakly and erratically enforced by a distant and often careless administration. Finally, shore dwellers do hold a number of legal and customary rights over parts of the shore space which allows them to control access to the shoreline and thus to fishing.

4.2. TURF-RELATED FORMS OF OWNERSHIP

Various customary forms of control or ownership over aquatic and shore space, or over fishing intangibles such as fishing techniques and fishing rituals, can and do affect the enforcement of Lake Titicaca TURFs. I consider each of them successively here to determine their impacts on the enforcement of TURFs and on fishing effort level.

4.2.1. Ownership of intangibles.

Private or semi-private ownership of intangibles, such as fishing songs, fishing rituals and fishing techniques, has never been reported for Lake Titicaca, contrary to other regions of the world such as the South Pacific islands (Johannes 1979; 1981; Petit-Skinner 1983; Carrier and Carrier 1983). Various ethnographic accounts describe the rituals associated with fishing around Lake Titicaca (Bandelier 1910; LaBarre 1948; Tschopik 1946; Nunez 1982; Chirapo Cantuta 1982), but none indicates that the latter are privately owned.

Andean fishing rituals were and still are often carried by specialized
diviners, who may either come from neighbouring communities or travel from
distant regions of Bolivia (Tschopik 1946; Bastien 1978). Informants from
Laguna Arapa, for example, indicated that up until the early 1950s, the major
fishing ritual of the year was performed during the first three days of August
by transient Qollahuaya diviners from the distant region of Charazani in
northern Bolivia. The trade of these diviners might have begun in the early
Tiahuanaku times, some 2000 years ago (Browman 1981). Since the same diviners
could direct or perform the fishing ritual of any fishing community, I infer
that ownership of rituals is more likely to have been a trade secret of the
diviners, than of the fishermen themselves.

The amulets, charms or utensils required for the performance of these
fishing rituals were (and probably still are) individually owned. These
amulets were found while fishing in privileged spots, or obtained from luckier
kin fishermen or from the Qollahuayas diviners themselves (Tschopik 1946).
The supply of ritual objects and amulets was (and still is) unlimited and
local fishermen had no control over access to these amulets. Today all the
amulets, utensils and ingredients necessary for the successful completion of a
fishing rite can readily be purchased from commercial sources (Nunez 1982)
thus eliminating most of the secrecy which surrounded this paraphernalia and
minimizing whatever control of access to fishing it gave to local fishermen.

Similarly, ownership of such intangibles as technical knowledge does not
occur around Lake Titicaca, although fishermen are reluctant to share
information about fishing techniques. Ownership of intangibles is thus
unlikely to have any impact on TURFs enforcement.

4.2.2. Ownership of live fish containers.

Some fishermen from a couple of communities in the Lago Norte and
Northern area of Bahia de Puno keep live fish in small pens or bolsas of less than one cubic meter capacity. Four out of seven interviewed fishermen from Escallani in the Lago Norte, for example, use cylindrical pens made of a cheap wooden frame wrapped with small-mesh nylon netting bought second hand. In other communities of the same area, fishermen use modified fishing baskets or collanchas, normally used for ispi fishing.

Native fish species are kept in these pens, until enough of them has been collected to justify a trip to the market, or until the market day comes (Farfan 1974; Bustamante and Trevino 1976). Fishermen report that native species survive in these pens, from a couple of days for the carachis, to more than a week for the local catfish. The pens are sunk by their owners in discrete locations, though close enough to their home compound to keep an eye on them while taking care of domestic and agricultural chores. Although a pen is relatively vulnerable to tampering in the absence of its owner, none of those interviewed complained of this sort of problem.

In a couple of instances, both in Laguna Umayo, some fishermen have built small fish holding tanks by raising a wall around a submerged plot of land. In both cases the fish held captive had been captured previously, and the submerged plot of land was clearly owned by the fishermen involved. Since in all cases observed the ownership of live fish containers does not restrict access to fish resources before they have been harvested, it is unlikely to affect fishing practices. Although, it occurs infrequently and only involves small scale operations, it is worth mentioning because it may involve the private ownership of aquatic space.

4.2.3. Ownership of fishing sites

A common form of aquatic space ownership is that of individual fishing sites. It may be derived from the historical practice of fence fishing, once
common among the Uros (Labarre 1946; Palavecino 1948), which entailed individual or household property rights over fixed fishing traps and the neighboring totora beds (Vellard 1949: 100). In the early 1940s fence fishing was "perhaps the most common technique used at night", with "fences owned individually and rebuilt each year" (Tschopik 1946: 525). Individual ownership of weirs has been reported for the Bolivian part of the Lago Pequeno as late as the early 1960s (Solc 1969: 51). Today, it is hardly practiced anymore (Bustamante and Trevino 1976). Yet the individual rights over the corresponding fishing sites may have persisted in many places.

The individual ownership of plots of land submerged by the rising level of the lake is also responsible for fishing site exclusivity. Totora reeds transplanted by the owners reinforce their claims of exclusive use over the resources within a plot. However, the major purpose of these claims is to protect the totora reeds themselves, rather than the fish which hide between their stems. Individual ownership of patches of totora reeds is most commonly observed in type I and type II TURF areas. There it is frequent enough to involve a majority of the shore dwellers (more than 70% of 53 individuals from 10 shore communities). Given that these fishing sites are included within communal fishing zones, their private ownership is likely to reinforce existing TURFs.

4.2.4. Ownership of landing sites and navigation channels

Landing sites and navigation channels commanding access to deeper waters are customarily owned privately or semi-privately. They are usually found in association, and are particularly common in type I TURF areas (Pacori 1976). There, because of a mild bottom slope, boats and balsas loaded with fish, harvested macrophytes or passengers would not be able to come close enough to
the shore without small channels. People would then have to carry their goods, wading in cold water and mud for up to a few hundred meters.

Landing sites and navigation channels also exist in type II TURF areas, although the ownership of the landing site becomes predominant then, since the navigation channel shortens as the bottom slope becomes steeper. In Yapura and Capano on the western side of the Capachica peninsula, for example, fishermen turn their private landing sites into tiny individual harbours for their balsas, using small floating islands of totora reeds or kyles which have drifted to the shore.

To understand the impact of landing sites and navigation channels on fishing activities, one must conceive of the shoreline in the areas with a weak bottom slope as a zone up to a few hundred meters wide. The edge of the water moves up and down across this zone, according to seasonal and long term annual fluctuations of the lake level. This fringe area is divided into plots of land over which individuals and their families have legally recognized usufructory or ownership rights.

When plots of land are submerged because of a rising lake level, small channels have to be dug between contiguous plots for craft access to the deeper waters of the lake. The families which own or cultivate a plot along this channel can use it, providing they contribute to its maintenance. Although the channel may be ending in the plots of one set of families this year, next year it may end up in those of another set of families. One thus has to grant use of a channel to people from whom reciprocity can be expected. Since every channel user is expected to contribute to the channel maintenance, additional users reduce the original users' contribution to the task.

Because it entails control of access to the aquatic space, this form of ownership is likely to play a significant part in determining who can fish in
type I and II TURF areas. Given the relatively high degree of endogamy or inbreeding in the communities of the Altiplano (Bolton and Mayer 1977), any community member should be able to find access to a landing site or a navigational channel in those areas, by activating his or her kinship ties. Members of inland communities are more likely to face difficulties in getting access to such landing sites, although they could always try to establish some fictive kinship ties, or offer compensation. Rights of indirect economic gain thus exist for these channels, although they may not be the source of substantial advantages for the channel owners.

4.2.5. Ownership of docking facilities

The last type of fishing-related ownership refers to the restriction of access to docking facilities and to the small harbours they protect. These facilities are only found in type III TURF areas where small harbours are necessary to protect boats and balsas from the waves. Access is usually restricted to the people who have contributed their resources and labour to the construction and maintenance of these facilities. This may include the members of a community, or it may be restricted to the members of one sector of a community, as in Huarisani (Huancane), Llachon (Capachica), and on the islands of Soto, Amantani and Taquili. Though uncommon communal docking facilities are likely to play an important role in the control of access to fishing, since the fishing crafts of outsiders unable to use them would be destroyed by the waves. [Footnote: There is also a number of docks in type II TURF areas which do not protect any harbour and are used primarily for the landing of goods and passengers, as those of Cariquita (Moho), Vilquechico, Chucuito, Parina, Carana, Tacasaya, Luquina, Juli, Pomata and Yunguyo.]

Having demonstrated that along Lake Titicaca's shores, there exist other forms of ownership over aquatic space than TURFs, I can now try to determine...
how Lake Titicaca shore dwellers use these forms of ownership and existing laws to enforce their illegal TURFs.

4.3. ENFORCEMENT OF TURFS

Because legal documents dealing with aquatic resources and official practices do leave room for interpretation, Lake Titicaca shore dwellers are able to use a variety of legal means to enforce their illegal TURFs.

4.3.1. Importance of aquatic macrophytes

Totora reeds contribute to the enforcement of Lake Titicaca TURFs in a number of important ways. First they are the most visible markers of TURF boundaries and one of the most valuable resources within these areas. Second they legitimize the special rights of shore communities over the lake area immediately adjacent to their shores. As mentioned earlier, the rights of these communities to the totora beds planted in their littoral area is officially recognized. This allows communities with totora beds to discourage outside fishermen from operating within their areas. Outsiders usually stay at least 200 meters away from the outer edge of these totora beds, not to be accused of damaging or stealing totora reeds. And third, dense totora beds ensure greater freedom for the enforcement of local TURFs, by hindering access to the shore for the coast-guard.

Llachu weeds also contribute to the enforcement of local TURFS. Because they are considered as communally owned grazing resources, support from the administration is expected for the protection of TURF holders right to them. The community of Sajo (Pomata), for example, appealed to the MINA in Puno, during the drought of 1983 to repel trespassers from the neighbouring communities of Chatuma and Villa Santiago de Ccama (Sajo, Letter to the
4.3.2. Role of fishermen guilds and associations

For the enforcement of their TURFs, the members of various shore communities take advantage of the fishermen's associations which they have created, as in Occosuyo (Amantani), Barco (Chucuito), Ccota (Plateria), Chimu (Puno), Escallani and Llachon (Capachica), Pusi (Pusi), Socca (Acora), Taquili island, Kajsi and Patas (on Laguna Umayo), and of the Comite Jose Olaya de Arapa. These associations may promote and enforce some regulations for the orderly conduct of fishing or for local resource conservation with the approval of the MIPE, although the latter has demonstrated little interest in supporting or in collaborating with these associations.

The performance of the annual fishing rites, usually in the first week of August (Nunez 1982), is a major concern of fishermen's associations. The enforcement of communally-held TURFs and the minimization of conflicts between fishermen also run high on their priority list. The "Asociacion de Pescadores Menores de Consumo Humano de Escallani (distrito de Capachica)", for example, which was created in the early 1970's, listed as objectives "the protection of its fishing areas, the setting of fishing schedules approved by the Sargento de Playa to avoid net theft, and that of fishing turns for groups of four or five fishermen at a time, to fish in Sejnajachi area, during the low season" (Bustamante and Trevino 1976: 78, my translation).

The "Comite de Pescadores Jose Olaya de Arapa", which started to organize fishing activities for the boga in the western half of Laguna Arapa in the early 1970s, deserves particular attention because of its success in maintaining traditional TURF areas. The leaders of this association agreed on prohibiting nocturnal fishing activities (between 5pm and 5am) to avoid
fishing accidents and nets' stealing under the cover of darkness. Although TURFs enforcement was never an explicit objective of this federative committee, its prohibition of nocturnal fishing activities forced the members of its nine local sub-committees to stay within their own fishing areas. This contributed to TURFs prorogation, despite the strong denials of the persistence of traditional fishing zones by its most educated member (Alberto Gonzales Urquiaga 1984: personal communication). Although extreme this is not the only example of fishermen's ability to take advantage of existing regulations to protect their TURFs.

4.3.3. Role of Sargentos de Playa

To minimize conflicts, the Sargentos de Playa can use their official status to discourage outsiders from operating in their area of jurisdiction which usually coincides with the TURF area of their community. Although a Sargento has no legal power to exclude an outsider from his area of jurisdiction, it is quite easy for him to accuse even fully licensed intruders of not respecting fishing regulations, of stealing nets or of creating disturbances. No outside fisherman would be foolhardy enough to disregard the opposition of a Sargento backed by his fellow community members (or a fishermen association) when setting his nets and getting ready to spend the night in his boat, far away from his home and his own friends. If verbal abuse did not discourage him, surreptitious violence would soon follow.

4.3.4. Role of control to shore access

Private or semi-private channels and landing sites are well respected, first because they are easily enforced and second, because one has no choice but to use them where they exist. They are easily enforced because one's craft is exposed to easy retaliation from the owners of the channel and
landing site whose prerogatives have not been respected. And one has to use
them because it is quite difficult to navigate across dense beds of totora
reeds. In addition, communal authorities, locally known as rescatistas,
vigilantes de campo or vigilantes de chacra, have the power to give penalties
to people who trespass on others' totora plots, either cutting totora reeds or
damaging them by pushing their boats through. Because it is well respected,
this form of ownership plays a significant part in determining who can fish in
a particular area. Although it would be exceptional for any member of a shore
community to be unable to find access to a landing site or a navigational
channel, members of inland communities have much more difficulty getting
access to such landing sites. Some informants reported that channel owners
required compensation for the use of their channel.

There are very few public landing sites or docking facilities along the
shores of the lake, with the notable exceptions of the small dock of Barco
(Chucuito) and the large jetty of the port of Puno. As mentioned earlier,
small docks protecting tiny harbours have been built in type III TURF areas by
local residents who have retained control over the use of these facilities.
Road access to the shoreline is often limited to small foot paths, which
reinforces local residents' control over their small docks. This also applies
to private landing sites and the small navigation channels to which they are
associated. Dirt roads do lead to shore communities but one often has to
follow a narrow foot path across the land of the local resident's to reach the
lake. In communities holding TURFs of type I this may mean a walk of a couple
of kilometers, which invariably leads one close to the dispersed houses of the
residents and subjects one to their control (or that of their dogs!).

It is thus hard to think of any shore area to which anybody can have free
physical access. Even the fishermen's association of Barco (Chucuito) has
discouraged outsiders from using the local dock of the Ministry of Fisheries. As for the large jetty of Puno harbour, none of the dozen of fishermen who operate from the shores of the Inner Bay of Puno uses it to store his craft (Avila et al. 1985), because of excessive risks of theft in an area frequented by many transients.

In conclusion, the wide distribution of TURFs implies an almost total control of access to the shoreline by onshore communities. Very few public facilities (roads and docks) provide access to the lake for inland dwellers. Even for existing public docks competition for limited space with present users effectively discourages outsider's interference. And where shore access seems physically more practical, such as along the Panamerican road between Puno and Chucuito for example, outsiders' craft and gear are also more vulnerable to transients' larceny.

4.3.5. Comparison of enforcement for different types of TURFs

For each of the three types of TURFs identified, the width of the exclusive fishing area, that is the distance from shore to which these TURFs apply is determined not only by a combination of natural, whether physical or biological factors (presence of resources and of visual markers for boundaries), but also of human factors (ease of enforcement, type of fishing technique used). Natural factors are usually though not always determinant. In type III TURF areas, for example, human factors may become predominant because of the absence of totora beds thus of clear boundary markers. The respect of TURFs then becomes a matter of active enforcement by local fishermen. Human factors also become predominant when communities sit on opposite sides of narrow bodies of water, because they have to divide the corresponding water space between themselves.

Enforcement on the outer edge of type I TURF areas poses obvious
logistical problems. It is difficult to spot intruders hiding among totora reeds which grow up to 3 m above the water surface (Collot 1980) from a low shoreline. To solve this problem, the inhabitants of the Uros floating islands in the Bahia de Puno build small platforms, one or two meters high, from which they can keep an eye over their territory. Still, detection of trespassers is not sufficient to protect one's resources, for one also needs to repel or at least to discourage them, and the wider TURFs are, the more difficult enforcement on their outer edge is. It is thus common for type I TURF holders to tolerate some degree of trespassing, and to request some compensation, as commonly done by the residents of the Uros floating islands of K'api in the Bahia de Puno.

Enforcement is not quite so difficult for type II TURFs, because the area they encompass is not as wide. In addition the steepness of the slope of the bottom of the lake is related to a stronger relief on the shoreline, which allows TURF holders to keep a watchful eye over their territory almost permanently. Outsiders who trespass under the cover of darkness have a chance of slipping away before being caught, but they are very likely to be spotted and well advised to make an arrangement with local TURF holders, if they want to avoid losing their nets, or being abused. For type III TURFs, the extension of the fishing zone is very much influenced by the presence of schools of ispi. Only when the latter are detected, do TURFs holding fishermen bother to repel outsiders.

4.3.6. Enforcement practice

TURFs can be enforced in two major ways. Trespassers may be repelled verbally by TURF holders who shout "Out! Out!" (Jota! Jota!) to them, and who "play stupid and refuse to make any deal" (se ponen brutos y no quieren saber nada de compromiso). Stealing nets is the other common tactic to discourage
trespassing. Among the 50 collaborating fishermen, for example, 27 (11%) lost at least one net during the five year period between 1980 and 1984. Subsequently, the reputation earned by some fishermen from protecting their TURF may be advertised to discourage outsiders from showing up, as I was told during field work about some communities of the northeast shores of the Puno Bay and of the Lago Grande.

These two forms of enforcement are by far the most commonly used, as indicated by 40.6% of the 251 fishermen interviewed in 1976. The majority of them (79.4%) acknowledged that verbal or physical interference ("se atajan") and net theft or destruction ("rompen y roban redes") were the most common tactics to repel trespassers. More violent forms of retaliation may also be used occasionally, and rumor has it that a few trespassers were beaten to death. It is unclear, however, whether such events actually took place, or whether the rumor is an advertisement strategy to discourage trespassing.

In conclusion, despite their informal status, the antagonism of official texts and the opposition of government officials, TURFs are still widely enforced around Lake Titicaca. Currently, shore dwellers are able to take advantage of various legal and administrative loopholes to extend them. They are successful at it because they use effective though illegal threats of retaliation to protect their resources against competing interests. This shows that exclusive use of aquatic resources within territorial areas does not arise from a lack of competition for these resources, nor from a widespread social prejudice against fishing, but from TURF holders willingness and ability to enforce their territorial rights. This demonstrates that Lake Titicaca TURFs do exist and are not merely a convenient myth among shore dwellers. Having demonstrated TURFs existence, I can now consider the effectiveness of these TURFs.
CHAPTER 5

EVALUATION OF FISHING RENTS

Because the net return to fishing labour is greater than its opportunity cost, Lake Titicaca fishermen receive an additional revenue over what they need to cover their fixed and variable costs, including an implicit wage for themselves and their helpers. This additional revenue represents the rent from local fisheries. To demonstrate the capture of such rents by Lake Titicaca fishermen, I have estimated the opportunity cost of labour with the net return from activities available to Lake Titicaca shore dwellers, and compared it with the net return from fishing and fishing-related activities. To calculate the latter, I have deducted the costs entailed by these activities from the gross return of fishing, and divided the resulting net return by the corresponding amount of labour.

5.1. FISHING COSTS AND FISHING RETURNS

5.1.1. Fishing costs

The costs involved in fishing and fishing-related activities include the depreciation and maintenance costs of the fishing craft, gear and outboard engine, the operating costs of the latter, the expenses for retailing the catch, and some miscellaneous expenses such as registration costs. I have calculated these material and labour costs (Appendix D) and listed them in table 7.
5.1.2. Fishing returns

To calculate the gross return from fishing I have multiplied the monthly catch figures by the corresponding retail prices (Appendix D). For these calculations I have taken into account the sale of trout and silverside in Bolivia by 16% of the fishermen, for prices 2 to 2.5 times the Peruvian ones respectively (Appendix D). In my calculations of the net return to fishing labour, I have accounted for the labour dedicated to fishing-related activities by members of the fishermen's households and that dedicated to fishing by the fishermen themselves. However, I have not accounted for the labour of their helpers (which is equivalent to assuming that the latter has no opportunity cost) because helpers are learning as much as they are helping, and because they would be unable to participate in another activity in view of their age. Table 8 lists the corresponding hourly returns to labour.

The profitability of fishing varies substantially with the type of FEU considered (Table 8). FEUs of type 8 (boats with outboard engines and gillnets) have the highest hourly return to labour, which is hardly surprising
since all FEUs of type 8 sell their catch on the Bolivian market. FEUs of type 10 (boats and huayunaccanas) have the second highest profitability, and FEUs of type 4 (boats with gillnets for native species) and of type 6 (boats with gillnets for both groups of species) have the third and fourth respectively. Finally, FEUs of type 1 (balsa reed boats with gillnets for native species) have the lowest hourly return for labour.

TABLE 8: RETURNS TO FISHING AND FISHING-RELATED LABOUR PER FEU TYPE IN LAKE TITICACA SMALL-SCALE FISHERIES (IN PERUVIAN SOLES, JANUARY 1980).

<table>
<thead>
<tr>
<th>FEU type</th>
<th>1</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross return</td>
<td>266,909</td>
<td>287,299</td>
<td>424,746</td>
<td>989,176</td>
<td>453,841</td>
<td>421,638</td>
</tr>
<tr>
<td>Fishing costs</td>
<td>77,028</td>
<td>92,708</td>
<td>90,959</td>
<td>315,370</td>
<td>91,697</td>
<td>110,554</td>
</tr>
<tr>
<td>Net return</td>
<td>189,881</td>
<td>194,590</td>
<td>333,787</td>
<td>673,806</td>
<td>362,144</td>
<td>311,083</td>
</tr>
<tr>
<td>Return/hour</td>
<td>68</td>
<td>72</td>
<td>133</td>
<td>206</td>
<td>175</td>
<td>121</td>
</tr>
</tbody>
</table>

5.2. FISHING RENTS

The difference between the net profitability and the opportunity cost of fishing labour determines the size of the fishing rents. The opportunity cost of labour is measured by the return this labour could have brought in the best alternative activity available. Because this availability depends upon each fisherman's personal contacts, education, or community of origin, the opportunity cost of labour is not the same for all FEUs. I demonstrate here, that for each type of FEU, the return to fishing labour is higher than its opportunity cost, thus that fishing yields substantial rents.
5.2.1. Opportunity cost of labour

To estimate the opportunity cost of labour for each type of FEU, I had to determine which was the most profitable of the alternatives to fishing, for the FEU considered. Lake Titicaca shore dwellers participate in a variety of cash-generating activities such as mining, bricklaying in urban areas of the coast, coffee growing in the jungle, artisanry, trade and transport activities across the border with Bolivia, seasonal wage labour on the plantations of the coast, cattle raising, daily wage labour on the Altiplano and music playing. By discussing the availability of these activities for the fishermen of each type of FEU, starting with the most profitable (Table 9), I determine the corresponding opportunity cost of fishing.

a) Coffee growing in the jungle

The opportunity cost of fishing for most FEUs of type 8 may be derived from the return to coffee growing in the jungle. Because the latter requires the investment of substantial amounts of labour and capital, and a supportive network, it is only available to shore dwellers from the districts of Moho and Conima along the eastern side of the Lago Norte (Collins 1982; Painter 1982), where most type 8 FEUs are found (Bustamante and Trevino 1976).

b) Mining, brick laying, civil service

The return from mining or from brick laying provides an estimate of the opportunity cost of fishing for most FEUs of type 10. These trades require long term migrations to distant urban areas of the coast and skills not usually mastered by agriculturalists. They also require good connections because such rewarding and prestigious jobs are in high demand (Brown 1978).
<table>
<thead>
<tr>
<th>Activity</th>
<th>Return to labour (Soles/hour)</th>
<th>Conditions of availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coffee production in jungle</td>
<td>138</td>
<td>Available only to those with access to land, five years after planting</td>
</tr>
<tr>
<td>Mining, brick laying and civil service</td>
<td>120 - 110</td>
<td>Available year round, but only to a minority of shore dwellers</td>
</tr>
<tr>
<td>Trade and transport across the border</td>
<td>107</td>
<td>Available mostly to those with capital and protections</td>
</tr>
<tr>
<td>Basic legal salary and artisanry</td>
<td>88</td>
<td>Only for urban employment and for skilled workers (e.g. boat builder)</td>
</tr>
<tr>
<td>Cattle raising on reeds and weeds</td>
<td>70</td>
<td>Available year round to those who can purchase cattle</td>
</tr>
<tr>
<td>Seasonal wage labour on coast</td>
<td>45 - 40</td>
<td>Available from December to January and May to July, but with migration</td>
</tr>
<tr>
<td>Daily wage labour on Altiplano</td>
<td>25</td>
<td>Available from February to April and August to November</td>
</tr>
</tbody>
</table>

(Sources: Verliat 1978; Painter 1986; INE-Puno)
Since fishermen belonging to FEUs of type 10 are the only ones with such connections, the corresponding return provides an estimate of the opportunity cost of their labour. However, for those type 10 FEUs which do not have these connections, the return from mining, bricklaying and other urban trades overestimates their opportunity cost of labour.

c) Trade and transport across the border

Trade and transport of goods across the border between Peru and Bolivia is usually at the margin of legality (Painter 1986). It is available primarily to shore dwellers who can afford the investment it requires, and who can count on a number of sympathies or on patronage. Furthermore, it is not the most profitable activity available to those who can practice it, because of the significant risks it involves which imply a lower expected value for its returns than suggested by available estimates (Ibid.). Finally, smuggling and fishing can be easily combined, thus suggesting that the two activities are not alternative but complementary. The corresponding returns should thus not be used to estimate the opportunity cost of fishing.

d) Artisanry

The return from artisanry could be used to estimate the opportunity cost of fishing for some FEUs, because handicrafts such as hat making, weaving, balsa or boat building are common activities around Lake Titicaca (Galdo 1981). Along the shores of the Bahia de Puno, for example, 40% of the households rely upon handicrafts for cash (CENFOR-Puno 1982-83, unpubl. data). And artisanry may contribute as much as 37% of the cash income of a household (Figueroa 1984: 45). However, many of these handicrafts activities are not available to the fishermen themselves, because they are considered to be female activities (e.g. weaving, knitting). I have approximated the return
from artisanry with the basic legal salary because the only rural dwellers who are able to ask for such a salary are boat builders and carpenters. However, this approximation can only be used to estimate the opportunity cost of fishing labour for those fishermen who are actually able to build a boat, most of whom operate type 6 FEUs.

e) Cattle raising

The income from cattle raising might have been used as an estimate of the opportunity cost of fishing labour because it is available to most fishermen, and because it is the most profitable activity available to those who can neither build a boat, get a job on the coast, or grow coffee in the jungle. The practice of purchasing scrawny cattle to resell for slaughter after 8 to 10 months of raising on totora reeds, llachu weeds and stubble is widely available among shore dwellers (Lewellen 1977: 48; Figueroa 1984: 49). More than 90% of them own at least one head of cattle and more than 80% own at least two (Levieil and Goyzueta 1984). This practice is also more profitable than alternative cash generating activities such as seasonal wage labour, because it yields a return which I have estimated at 70 soles/hour, using data from previous studies (Lewellen 1977: 62; Levieil and Goyzueta 1984). In addition to this return, cows contribute their offspring and milk to the household economy (Lewellen 1977) and bulls contribute their work when bought in pair and trained for team ploughing (Hickman 1963; Brown 1978: 39).

In spite of the above, the return from cattle raising should not be used to estimate the opportunity cost of fishing because these two activities are complementary rather than alternative. They do not interfere but contribute to each other. This complementarity may actually explain why fishing households have more heads of cattle (3.35) than shore households as a whole (2.85). On one hand, a fishing craft can be used to collect totora (3.3
times/month) and llachu fodder (5.2 times/month), after retrieving fishing nets (Levieil et al. 1986). On the other hand, cattle raising contributes to the undertaking of fishing, because cattle is a form of saving (Montoya 1979: 785) which fishermen often use to finance the purchase of their boat. Finally, both activities can be scheduled fairly easily within the normal working day of a shore household.

f) Seasonal wage labour on the coast

The income from seasonal wage labour in the plantations of the coast provides an estimate of the opportunity cost of fishing labour for type 1, 4 and most of type 6 FEUs, because of the widespread availability of this activity and because of its incompatibility with fishing. High rates of participation demonstrate that it is a widely available option for Lake Titicaca shore dwellers. In the mid 1970s, the proportion of household heads involved ranged from 36 to 74% depending on the community (Lewellen 1977: 48; Brown 1978: 151). In the early 1980s, this proportion was estimated at 60% for a sample of 8 communities around the Bahia de Puno (CENFOR-Puno 1982-83, unpublished data). Furthermore, this activity is incompatible with fishing because to hire themselves as seasonal labourers on the plantations of the coast, shore dwellers have to become involved in a pendular or circular migration (Hickman 1963; Brown 1978).

g) Daily wage labour and music playing

Finally, the least profitable option for shore dwellers to earn some cash is to hire themselves for daily wage labour. The corresponding return to labour cannot be considered as the opportunity cost of fishing because almost all fishermen have the better option of working for seasonal wage labour in the plantations of the coast. Furthermore, it is not a major activity on the
Altiplano where households have traditionally relied upon the reciprocal exchange of labour for the peak periods of the agricultural cycle (Figueroa 1984: 46). Even nowadays, only 20% of the households in the southern Andes contract farmhands (Brown 1978: 179; Aramburu and Ponce 1983: 103). The hiring out of labour for daily wage salary uses less than 8% of the total labour force available per household (Gonzales 1984: 182), and less than 1% of the labour of Lake Titicaca fishermen.

Music playing in one of the bands which hire themselves out for local celebrations, or fiestas, is fairly common in some shore communities (Hickman 1963; Lewellen 1977). However, the corresponding income does not yield an estimate of the opportunity cost of fishing either, because it is only an occasional source of cash for members of a few specialized shore communities (Ibid.). Furthermore, music playing and fishing can easily be combined, since the former is only an occasional undertaking.

5.2.2. Capture of fishing rents

The opportunity cost of fishing is thus determined by the return to labour from seasonal labour on the coast for FEUs of type 1, 4 and most of type 6, by the return from artisanry for some FEUs of type 6, by the return from coffee growing for most FEUs of type 8, and by the return from mining and construction for most FEUs of type 10. As table 10 shows, for each type of FEU the relative difference between the hourly return from fishing and the opportunity cost of labour is positive and ranges from 50 to more than 100%. For the fishermen of type 6, 8 and 10 FEUs who do not meet the requirements for participating in artisanry, mining, bricklaying or other urban trade, or coffee growing, this relative difference is even greater (from 200 to 500%), since the opportunity cost of their labour is determined by the return from
seasonal wage labour on the coast. All this demonstrates that Lake Titicaca fishermen are able to capture substantial fishing rents.

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**TABLE 10: RELATIVE DIFFERENCE (%) BETWEEN HOURLY RETURNS TO LABOUR FOR FISHING ON LAKE TITICACA AND FOR ALTERNATIVE ACTIVITIES AVAILABLE TO SHORE DWELLERS, ACCORDING TO FEU TYPE (JANUARY 1980).**

<table>
<thead>
<tr>
<th>FEU type</th>
<th>1</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishing return (S/hr)</td>
<td>68</td>
<td>72</td>
<td>133</td>
<td>206</td>
<td>175</td>
<td>121</td>
</tr>
<tr>
<td>Coffee growing (*: 138 S/hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>78</td>
</tr>
<tr>
<td>Mining, misc. (*: 120-110 S/hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55-67</td>
</tr>
<tr>
<td>Basic legal salary (*: 88 S/hr)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51 134 99 38</td>
</tr>
<tr>
<td>Seasonal labour (*: 45-35 S/hr)</td>
<td>51-94</td>
<td>60-106</td>
<td>195-232</td>
<td>358-415</td>
<td>290-340</td>
<td>170-203</td>
</tr>
<tr>
<td>Daily labour (*: 25 S/hr)</td>
<td>172</td>
<td>188</td>
<td>432</td>
<td>724</td>
<td>600</td>
<td>384</td>
</tr>
<tr>
<td>(*: Sources: Verliat 1978; MINA-Puno 1983; Painter 1984; 1986)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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5.3. DISCUSSION

5.3.1. Evaluation of non-market side-benefits

Comparing the hourly returns from fishing with those from alternative activities assumes that fishermen do not consider non-quantifiable side-benefits (i.e. intangible). This reduces their decision-making process to a utilitarian choice between purely monetary benefits, when some other criteria are definitely involved. Fishing, for example, implies a lot of discomfort during the cold nights and early mornings of the dry season when frosts are
common, and some inescapable risk for those who sleep in their open boat drifting with their nets in the middle of the lake. It also entails an unpredictable income, contrary to seasonal wage labour, as one fisherman indicated "work on the coast is preferrable, because wages are secured by contract" (Me gusta mas el trabajo en la Costa, es muy seguro en el contrato).

Migration offers some non-monetary benefits relative to fishing. It brings prestige and opportunities to climb socially (Brown 1978), when there may be some social prejudice against fishing (Levieil 1986), and no opportunity for a rapid social ascension. However, migration requires the head of a household to spend long periods of time away from his family in a foreign and eventually hostile environment. Work in the jungle in particular involves numerous health risks (Painter 1982). When migration lasts for more than a couple of months at a time, it affects the agricultural cycle. In the absence of their husbands, women must hire farmhands, as demonstrated by the high (64%) proportion of households which contract daily wage labour in communities from which numerous household heads migrate to the coast (Brown 1978: 179).

I have not included side-benefits in my analysis, first because they are intangible, and Secondly because I have assumed that they are likely to cancel one another in the shore dwellers decision-making process. Yet, to fully understand the rationale of Lake Titicaca shore dwellers in choosing between fishing and alternative activities, such as seasonal migration, one has to consider that they make choices between various types of benefits.

Similarly, one has to consider that fishermen make choices between combinations of activities, which involve not only their own labour but that of their whole household and eventually, that of the households with whom they exchange labour. During a fisherman's absence, for example, his household
still uses his fishing craft for totora and llachu collection to feed his cattle, or for waterfowl hunting or egg collection (between August and December). A relative may also set and retrieve the nets of the absent fisherman with his own, and bring them back to the latter's wife and children to pick up the fish tangled in the nets. In return, the latter is expected to set the nets of the helpful relative when he himself goes away. Finally, the boat and gear of the absent fisherman may be rented out to a relative. Taking into account shore dwellers' ability to combine fishing with agriculture, for example, implies accounting for the heterogeneity of household labour, and granting a different opportunity cost to the labour spent on fishing and that spent on fishing-related activities.

5.3.2. Accounting for heterogeneity of household labour

The availability of alternative activities is heterogeneously distributed both among fishing households, according to education, connections or community of origin, and within households according to age and sex. Fishing-related activities, for example, are often carried out by women and children while tending sheep, by elders who cannot undertake heavy work in the fields any longer, or by fishermen themselves when there is little else to do. A different opportunity cost of labour could thus be attributed to the labour spent on such activities as craft or gear building, cleaning and maintenance, on the presumption that fishing-related activities are undertaken in the slack periods of the agricultural cycle.

Since the only activity competing with fishing-related activities is daily wage labour, it is logical to estimate the opportunity cost of labour spent on these activities with the hourly return from daily wage salary.
TABLE 11: RELATIVE DIFFERENCE (%) BETWEEN THE RETURN TO FISHING LABOUR AND ITS OPPORTUNITY COST, WITH OR WITHOUT GRANTING A LOWER OPPORTUNITY COST FOR FISHING-RELATED ACTIVITIES THAN FOR FISHING.

<table>
<thead>
<tr>
<th>FEU type</th>
<th>1</th>
<th>4</th>
<th>6</th>
<th>8</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without</td>
<td>51-94</td>
<td>60-106</td>
<td>51</td>
<td>78</td>
<td>55-67</td>
</tr>
<tr>
<td>With (25 S/hr)</td>
<td>89-143</td>
<td>116-177</td>
<td>128</td>
<td>135</td>
<td>104-133</td>
</tr>
</tbody>
</table>

Because it is the least profitable of all the alternatives to fishing, this leads to a larger relative difference between fishing returns and the opportunity cost of fishing labour, as illustrated in Table 11.

This analysis thus shows that accounting for the compatibility of fishing with agricultural activities leads to an increase of the relative difference between the return to labour from fishing and its opportunity cost, and to an increase of the rents captured by Lake Titicaca fishermen. However, it raises the question of whether fishermen would still capture fishing rents, if the opportunity cost of their labour was estimated by the return to labour from the subsistence agriculture practiced on the Altiplano.

5.3.3. Comparison of fishing and subsistence agriculture

To estimate the return to labour from subsistence agriculture, one can use the retail prices per hour of labour for agricultural products, as done by Painter (1984; 1986) and indicated below after correction for inflation.

<table>
<thead>
<tr>
<th>Broad beans</th>
<th>Quinoa</th>
<th>Barley</th>
<th>Dried broad beans</th>
<th>Potatoes</th>
<th>Freeze-dried tubers</th>
<th>Household weighted mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>48</td>
<td>83</td>
<td>94</td>
<td>147</td>
<td>182</td>
<td>320</td>
</tr>
</tbody>
</table>

133
The retail price of the fish catch per hour of labour is as below.

<table>
<thead>
<tr>
<th>FEU type</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>179</td>
</tr>
<tr>
<td>Retail price per hour of labour</td>
<td>113</td>
</tr>
<tr>
<td>1</td>
<td>118</td>
</tr>
<tr>
<td>4</td>
<td>206</td>
</tr>
<tr>
<td>6</td>
<td>251</td>
</tr>
<tr>
<td>8</td>
<td>246</td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Comparing retail prices per hour of labour from fishing and subsistence agriculture reveals that fishing returns are slightly lower than subsistence agriculture returns in general, but higher than those from such crops as broad beans, quinoa, barley and dried broad beans. If the latter were not included in the crop rotation, the land would have to be fallowed, or fertilizer, expensive by local standards, would have to be purchased. Given that Painter (1982) did not include all production costs in his calculations of the returns from subsistence agriculture (Appendix D), and that his sample of agriculturalists came from one of the most productive agricultural areas of the lakeshore, it is likely that the difference between agriculture and fishing returns may be smaller than apparent.

This demonstrates that if one assumes that the retail price per hour of labour provides an index of the value of subsistence agriculture, then it does not make sense economically for shore dwellers to abandon subsistence agriculture and to become specialized fishermen. However, the return per hour from subsistence agriculture does not provide an estimate of the opportunity cost of fishing because these two activities are complementary rather than alternative. The fishermen who fish most often are those who have least land, such as those from Soto island, from Barco-Chucuito, and those from the flooded areas of the Puno bay. Similarly, young single men who have not inherited land from their parents yet may spend more time fishing than most...
married men from the same communities.

5.3.4. Persistence of rents over the long term

Demonstrating that Lake Titicaca fishermen captured fishing rents in 1979-80 is not quite sufficient to argue that local fisheries have not reached their bioeconomic equilibrium. This equilibrium is defined over the long term, with the good years cancelling the bad ones. The capture of fishing rents in 1979-80 could have resulted from a reduction in fishing effort following some bad losses in the previous years. Unfortunately, no historical records of Lake Titicaca fish yields are available. However, circumstantial evidence suggests that fishing rents have been captured in the previous years, and that Lake Titicaca fisheries have not reached their bioeconomic equilibrium.

A comparison between available indices of fish abundance in 1978 and 1979-80, for example, indicates no apparent change. The captures per unit of effort for the months of October and November 1978 (1.34 and .905 kg/net/trip respectively) in the Bolivian part of the Lago Pequeno (Franc et al. 1986: 18) were similar to those encountered by the collaborating fishermen using similar fishing techniques over a one year period (.87 to 1.31 kg/net/trip, depending on the type of FEU). They were also similar to those measured from two random samples of gillnetting fishermen in May (1.58 kg/net/trip) and October of 1980 (1.10 kg/net/trip). Similarly, a comparison between the catch and the fishing effort of individual fishermen (measured by the number of nets per fisherman) suggests that the catch per unit of effort (catch per net per night) has remained approximately constant between 1972 and 1979-80 (unless the frequency of fishing trips has increased substantially). I have estimated that during this period, the annual catch and number of nets per fisherman have approximately doubled (from 1 mt to 2 mt, and from 5.7 to 11.1 nets).
An analysis of fish prices and gear costs over the 1975 to 1980 period shows that gear costs have increased faster than fish prices (Figure 15). Carachi and silverside prices, for example, have increased at a slower rate than the official national consumer price index. Conversely, gillnets and wooden boat prices have increased at a faster rate than the consumer price index and fish prices. If the catch per fisherman (i.e. FEU) has not changed during the 1975 to 1980 period, this implies that fishing costs have increased faster than fishing revenues. Therefore, fishermen must have been able to capture even larger rents in 1975 than in 1980, when their catch rate was the same but their fishing costs were lower. All this suggests that the capture of fishing rents observed in 1979-80 is likely to reflect a long term phenomenon, rather than an exceptional occurrence. Therefore it suggests that Lake Titicaca fisheries are unlikely to have reached their bioeconomic equilibrium. This demonstration leads in turn to an investigation of the contribution of TURFs to the capture of fishing rents.
CHAPTER 6

TURFS AND THE CAPTURE OF FISHING RENTS

So far I have demonstrated that the entire shoreline of Lake Titicaca is divided into territorial fishing zones and that most fishermen are able to capture substantial economic rents. However, it has been argued that most indigenous fisheries management practices, among which TURFs are included, allocate access to fishing space instead of allocating resources (Andersen and Stiles 1973) and that they are unlikely to control fishing effort (McCay 1981: 6). This raises the question of the actual contribution of local TURFs to the control of fishing effort and thus to the capture of existing rents.

The objective of the regulation of fishing effort is to control fishing costs and the total catch from a fishery in order to maintain a high sustainable yield from this fishery. Its logic stems from the assumption that total catch is a function of fishing effort, of its effectiveness and of the size of the exploited fish population (Ricker 1975). Fishing effort can be controlled by limiting the number of FEUs participating in a fishery, the effort each FEU develops within this fishery, or both. I demonstrate here that membership within a TURF holding community promotes the capture of fisheries rents, thus promoting economic efficiency, by controlling the number of fishermen and by constraining their individual fishing efforts.

6.1. EXCLUSION OF INLAND DWELLERS FROM LAKE TITICACA FISHERIES

The enforcement of Lake Titicaca TURFs results in control of fishing access which can be compared to a limited entry program. It implies the exclusion of inland dwellers from Lake Titicaca fisheries, as demonstrated by
numerous accounts (chapter 3) and by the absence of inland dwellers either from an exhaustive census of Lake Titicaca fishermen (Bustamante and Trevino 1976) or from the list of fishermen (1,078) officially registered by the Coast Guard in Puno.

Evidence that by excluding inland dwellers, TURFs have controlled the number of fishermen on Lake Titicaca comes from the apparent stability of this number. There has been various estimates of the latter for the last fifty years (Fiedler 1940; PDS 1959; Vellard 1963; Everett 1967; MIPE-DIE 1970; Terrazas in Laba 1979). The most reliable of these indicate that there were about 3,040 fishermen in 1976 (Bustamante and Trevino 1976), and that this number has not changed between 1976 and 1984 (Appendix B). It is actually the same as the one estimated for 1575 (Ibid.). The stability of this number in the last decade begs the questions of why there are not more fishermen among shore dwellers, and why the latter do not dedicate more resources to fishing. The answers to both must be traced to fishermen's membership in shore communities.

6.2. COMMUNAL CONSTRAINTS ON INDIVIDUAL FISHING EFFORT

Membership in a TURF holding community results in control of individual fishing effort because to be a member of such a community, one has to hold land in this community and to keep it productive. Individuals who wished to fish without farming would face the possibility of losing their land, their status within their community and eventually their membership in this community. The constraints resulting from the undertaking of agricultural activities thus determine how much labour is available for fishing or other activities. Membership in a TURF holding community also results in control
of fishing investments.

6.2.1. Constraints on labour availability

Most shore dwellers do not have enough cultivable land to cover the subsistence needs of their household. They have to combine complementary activities with agriculture which they cannot neglect for fear of losing their land or their status within their community. But, because agriculture takes precedence over fishing and because it is seasonal, it constrains the amount of labour which they can dedicate to fishing or to other activities.

a) Agricultural requirements

All fishermen own at least some land, the cultivable part of which is generally insufficient to support their household. The best estimate of the minimum of cultivable land for a family of 5 is 1.3 has, to which another 1.2 has of unavoidable waste (fallow land, home compound) must be added, thus yielding a total of 2.5 has (Ferroni 1980: 154) a figure well within the 2 to 3.5 has range of other estimates (Lewellen 1977: 44; Poe 1979: 212; Ccama 1981: 122). Few shore dwellers own this minimum (Ccama 1981: 81; Montoya and Burgos 1981: 32; Painter 1986: 227). This land shortage generates a permanent competition for land among shore dwellers.

Given this hunger for land, its legal ownership by the peasant community as a whole, and the tradition of its redistribution (Fuenzalida 1970: 78; Brush and Guillet 1985: 26), shore dwellers cannot afford to neglect whatever land they control, for they might lose it. The community may repossess unused land (Painter 1982: 123). Other siblings may force a redistribution of the inheritance. A neighbour may push his own furrows further every year, and later claim possession of the land, an easy practice given that many plots are no more than a few furrows wide by a few meters long (Verliat 1978).
b) Labour supply per household

Communal obligations such as celebrations, participation to communal projects, administrative responsibilities determine the size of a household labour supply. An Altiplano household comprises slightly less than 4.1 members (INE 1981). It can generate about 3 mandays of labour per work day (Figueroa 1984; Gonzales 1984: 246-7). However, there are only about 250 work days per calendar year because of numerous celebrations, or fiestas, within Andean communities (Brush 1977: 132; Gonzales 1984: 174). The celebration of fiestas is a consumptive and festive requirement for community members and a counterpart of their access rights to communal resources (Sherbondy 1982). If the Andean community as a corporate structure were to disappear, many of these celebrations would simply vanish. A standard Altiplano household thus generates approximately 750 mandays of labour per year, which is similar to estimates for the Cuzco area (Gonzales 1984: 174).

Some of the household labour is dedicated to the communal projects and administrative responsibilities entailed by community membership. Community members have to participate in communal projects, or faenas, for the construction and maintenance of collective infrastructures such as roads, fences, irrigation ditches, docks, or communal buildings such as schools. Faenas require about 7% of household labour (Brush 1977: 132; Gonzales 1984: 174). Administrative and symbolic responsibilities, or cargos, are rotated on an annual basis among community members. I have estimated that faenas and cargos require about 50 mandays of the household labour supply, which leaves about 700 mandays per household for food and income producing activities.

c) Agricultural labour

Agricultural activities are a counterpart of community membership, which determine the size of the household labour surplus available for complementary
activities. The seasonal availability of this surplus imposes further constraints on the labour and resources shore dwellers can actually dedicate to fishing. To determine the size of this surplus, I have deducted the total amount of labour required for agricultural production from the total household labour supply.

To determine how much time a shore dwelling household requires for agricultural production, I have multiplied for each crop type the cultivated area per household by the corresponding labour input per hectare, and summed up the labour inputs across crop types (Table 12). For this purpose I have used data on labour inputs per hectare from a sample of 23 shore communities (Brown 1978; Verliat 1978; Painter 1982; 1986), and data on the distribution of cultivated areas per crop type from a sample of 45 Altiplano communities (Brown 1978; Ccama 1981; Lescano et al. 1982; Painter 1982; 1986). For comparison purposes Table 12 indicates separately the time spent on agricultural activities in three communities (Luquina, Camacani and Sarata) and in a sample of 20 communities (Ccama 1981: 70-1).

The estimate of 1,251 hours (Table 12) for the time spent per household on agricultural production seems the most appropriate, because it is based upon a sample of 20 Altiplano communities (Ccama 1981), and because it falls within the range calculated for those communities for which data were available. However, it does not include harvest processing activities such as the drying of beans and the freeze-drying of potatoes. The latter have to be taken into account because they are necessary for harvest conservation for future household consumption, thus an integral part of the agricultural production process. Using Painter's data from Sarata (1986: Table 4 and 5), I have estimated that a total of approximately 72 hours per household was used each year for harvest processing.
Given that only 6.5 hours are actually available per working day for heavy agricultural duties (Painter 1982: 205), a household spends about 203 mandays on agricultural activities: 192 mandays for field labour and 11 mandays for harvest processing. This compares favorably with estimates from various Andean communities (Brush 1977: 130; Gonzales 1984: 174). After these 6.5 hours of heavy work, agriculturalists can still spend 2 more hours on miscellaneous time consuming but light activities such as tool-making, the construction and maintenance of containers for crop storage, or the training of children (Ruddle and Chesterfield 1977: 122; Painter 1982: 205).

As for the remaining 2 hours of labour available per day, shore dwellers normally dedicate them to their livestock (Painter 1982: 205). This labour must be accounted for as agricultural labour because of the role cattle play in the agricultural production process. Teams of bulls are used for ploughing and cattle dung is an important source of fertilizer and of fuel. I have calculated that it takes shore dwellers about 50 mandays per year to feed and tend their livestock, to train their team of bulls (Hickman 1963), or to reciprocate the loan of a team if one is not owned.

Summing up the labour used in all the agricultural activities undertaken by a standard shore household yields an estimate of about 253 mandays per year. Once deducted from a supply of 700 mandays of labour, it leaves a surplus of 447 mandays available for complementary activities such as fishing. However, this surplus is not uniformly distributed during the year because of agriculture seasonality.
<table>
<thead>
<tr>
<th>Crop</th>
<th>Labour/ha (hrs/ha)</th>
<th>Luquina (hrs)</th>
<th>Camacani (hrs)</th>
<th>Ccama's (hrs)</th>
<th>Sarata (hrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potatoes &amp; Tubers</td>
<td>1,660</td>
<td>460</td>
<td>481</td>
<td>697</td>
<td>714</td>
</tr>
<tr>
<td>Beans &amp; Peas</td>
<td>1,290</td>
<td>108</td>
<td>103</td>
<td>103</td>
<td>478</td>
</tr>
<tr>
<td>Wheat &amp; Barley</td>
<td>445</td>
<td>77</td>
<td>102</td>
<td>254</td>
<td>76</td>
</tr>
<tr>
<td>Quinoa &amp; Canihua</td>
<td>808</td>
<td>61</td>
<td>97</td>
<td>97</td>
<td>32</td>
</tr>
<tr>
<td>Other Crops</td>
<td>1,000</td>
<td>1</td>
<td>--</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Total (hours)</td>
<td>707</td>
<td>784</td>
<td>1,251</td>
<td>1,306</td>
<td></td>
</tr>
<tr>
<td>(mandays)</td>
<td>112</td>
<td>116</td>
<td>190</td>
<td>205</td>
<td></td>
</tr>
<tr>
<td>Area cultivated (has)</td>
<td>.61</td>
<td>.71</td>
<td>1.29</td>
<td>1.02</td>
<td></td>
</tr>
<tr>
<td>Area owned (has)</td>
<td>1.69</td>
<td>2.25</td>
<td>2.22</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Sources:  
(1) : Brown 1978; Verliat 1978; Painter 1982; 1986  
(2a) : Lescano et al. 1982  
(2b) : Lescano et al. 1982  
(3) : Ccama 1981  
(4) : Painter 1982; 1986
FIGURE 16: AGRICULTURAL WORK REQUIREMENTS IN A SHORE COMMUNITY OF LAKE TITICACA, PERU (Luquina Grande, Chucuito; Source: Lescano 1982)

<table>
<thead>
<tr>
<th></th>
<th>Ploughing</th>
<th>Planting</th>
<th>Cleaning</th>
<th>Harvesting</th>
</tr>
</thead>
<tbody>
<tr>
<td>TUBERS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEAS &amp; BEANS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEREALS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>QUINOA, ETC.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LABOUR

MONTH

0 1 2 3 4 5 6 7 8 9 10 11 12
d) Seasonality of labour surplus

The 447 mandays of labour surplus are available during the two slack periods of the agricultural cycle (Figueroa 1984; Gonzales 1984), as demonstrated by the demand curves (Figure 16) for agricultural labour in the community of Luquina (Platería) (Lescano et al. 1982: 144) which is very similar to the one from the community of Sarata (Painter 1982: 243). The first one corresponds to the peak of the dry season (June to August), the second one to the early part of the rainy season (December to March).

To take advantage of this labour surplus, Lake Titicaca fishermen may either fish exclusively during the slack periods of the agricultural cycle (i.e. seasonally), or they may fish year-round. In the mid 1970s, for example, 68% of a sample of 251 fishermen, fished year-round though not daily, and 32% fished seasonally for an average of 3.3 months a year (IMARPE-Puno 1976: unpublished data). Most (75%) of the seasonal fishermen fished during the rainy season (January to March) which is often considered the most productive of the year and sometimes called the "fish season", or Ch'awlla Phajsi in Aymara (Cordero 1966: 32).

i - Year-round fishermen: Year-round fishermen use a large proportion of their household's labour surplus in fishing. Using data from 1979-80, I have calculated that they spend a total of 396 mandays on fishing and on related activities: 296 mandays on fishing and 100 mandays on fish retailing, craft and gear maintenance (assuming that one can spend 8.5 hours a day on such activities). This begs the question of why year-round fishermen do not fish for the remaining 51 mandays, but use this remaining surplus labour for other complementary activities.

The explanation for the use of the remaining 51 mandays on non fishing activities comes first from the seasonality of the agricultural cycle. These
51 mandays are actually available during the few weeks of the agricultural slack periods. They do not come in driblets of a few hours at a time every so many days, but in series of days during which there is no agricultural task to carry out with the exception of cattle feeding, for which no more than 2 hours of labour by one adult are necessary. Even if this remaining labour was available in short daily or weekly lapses uniformly distributed along the year, I demonstrate here that it would still not be possible for year-round fishermen to use it to intensify their fishing activities either by multiplying their fishing trips or by lengthening them.

Multiplying their fishing trips is not possible for year-round fishermen because with 296 mandays spent fishing they already operate on almost all the working days of the year (cf. section b above). The oldest son of the household could go fishing in a second craft, if he was old enough, but this would require major investments which would not be worthwhile for 51 mandays only. Lengthening fishing trips is difficult, although it could be done either by travelling further or by multiplying the number of nets used.

Travelling further is not worthwhile if it increases fishing costs without increasing fishing returns. Moreover, it is not possible for fishermen normally operating in the littoral zone (FEUs of type 1, 4, 6 and 10), because it would mean trespassing into neighbouring TURF areas and exposing oneself to retaliation, unless some deal was struck. If the latter travelled further offshore, they would have to become involved in a pelagic fishery which requires a completely different set of investments: a sea worthy craft, gillnets of meshsizes larger than 63 mm, eventually an outboard engine. As for huayunaccana fishermen (type 10 FEU), towing is too strenuous and dependent on wind and wave conditions to be carried out for much more than 6.6
hours a day. Finally, fishermen operating offshore on type 8 FEUs already have longer fishing trips because they can stay offshore for 11.8 hrs/trip and spend the night in their craft.

Using more nets does not necessarily entail an increase in fishing labour, because setting one's nets represents a much smaller proportion of a whole fishing trip than the rowing time. It is the latter which determines the length of the trip rather than the number of nets set, as suggested by a comparison between number of nets and time spent fishing for different FEU types. Type 4 FEUs with a mean of 9.7 nets and type 6 with one of 10.3 nets have shorter trips (5.9 and 6.5 hrs/trip respectively) than type 1 FEUs with a mean of only 6.9 nets (7.3 hrs/trip).

ii - Seasonal fishermen: Seasonal fishermen only use a small proportion of their labour surplus for fishing. I have calculated that they use about 120 mandays during the slack of the rainy season: 70 for fishing and 50 for fishing-related activities. This leaves them with about 327 mandays available for other complementary activities. Intensifying their fishing effort would not allow them to absorb this large labour surplus, unless they became year-round fishermen.

Four hypotheses could explain why seasonal fishermen do not become year-round fishermen to use the surplus labour of their households. Either they actually have more land than the year-round fishermen thus a smaller surplus labour, or they have much less land thus a much greater need for cash which prevents them from saving enough to intensify their fishing activities, or they come from smaller households with a much smaller labour supply. Finally, the opportunity cost of their labour may be higher than their fishing return because they have the necessary connections and training to work in a
lucrative and status-enhancing job in an urban or mining area.

None of the first three hypotheses explains the behaviour of the seasonal fishermen. Even with twice as much land as the average year-round fisherman, seasonal fishermen would need at most 506 mandays of labour which would leave them with a surplus of 194 mandays of which fishing would only use 120 days. Land-poor seasonal fishermen would still be able to earn more by fishing from a balsa (type 1 FEU), than by hiring themselves for wage labour. Finally, a household generating only 2 mandays of labour per workday would still have a supply of 450 mandays and a surplus of 197 mandays a year. Only if it had 1.3 times more land than the average shore household, would it use up its 450 mandays of labour: 330 for agriculture and 120 mandays for fishing.

The fourth hypothesis is the most convincing of all, although it assumes that the household of the seasonal fisherman can send one of its members away for a whole year and still be able to carry normal agricultural tasks either by hiring farmhands for a daily wage, or through the reciprocal exchange of labour with other households. Painter (1982) and Collins (1982) show how in similar circumstances, the households of Sarata (Moho) are able to allocate their labour supply between agriculture on the shores of Lake Titicaca, coffee or citrus growing in the Selva, and trade (i.e. smuggling) activities on the Altiplano. Although carried out mostly by women, the latter is for them the equivalent of seasonal fishing.

iii - Synthesis: The seasonal availability of a labour surplus is responsible for the involvement of year-long fishermen in other complementary activities. To use the remaining 51 mandays of surplus labour of his household, which he cannot use in fishing, a year-round fisherman may decide to migrate for a month or two to the Costa and hire themselves for wage labour on some plantation, even though he could theoretically earn more fishing than
migrating. During his absence, his household may still use his fishing craft to collect totora and llachu to feed his cattle. A relative may also set and retrieve the nets of the absent fisherman with his own, and bring them back to the latter's wife and children for them to pick up the fish still tangled in the nets. In return, the absent fisherman is expected to set the nets of the helpful relative when he himself goes away.

As for seasonal fishermen, it is likely that the opportunity cost of their household labour is higher than their fishing return and that it is economically rational for them to send one member of their household away for most of the year. Even then, they still have a surplus of labour during the slack periods of the agricultural cycle. It is then more profitable for them to engage in seasonal fishing, than to send another household member to the Costa to hire himself for wage labour. Their fishing investment is small since they only need a few nets, which they can store or lend for the rest of the year, and a fishing balsa which after 3 or 4 months of fishing can still be used to collect llachu and totora close to shore.

The seasonal availability of a labour surplus also determines the fishery a shore dweller may participate in. Fishermen with the least land are more likely to participate in the most time consuming fisheries. Pelagic gillnetting, for example, is quite time consuming because it involves long fishing trips offshore, with each type 8 FEU spending 11.8 hours per fishing trip compared with a mean of less than 7 hours for other FEU types. Most type 8 FEUs are thus found in communities where agriculture is less demanding because of a lack of land, or because of a lack of water as on Soto island. Similarly, fishing with a huayunaccana requires hours of rowing for at least a couple of adults during daylight hours. It is thus practiced more intensively during the slack of the dry
season, by fishermen from communities with a high population density such as Vilurcuni (Yunguyo). The constraints considered so far may not be the only ones to affect the practices of local fishermen. Membership in a TURF holding community may also constrain shore dwellers' fishing investment.

6.2.2. Constraints on fishing investments

Available evidence indicates that community membership results in few direct or indirect constraints on individual fishing investments. There is little evidence of direct constraints. For example, fishermen are not normally prevented from introducing a new fishing technology in their own communities. Even if the first boat brought to the community of Cachi Pucara (Ilave) was destroyed by angry balsa users (Castillo 1978), technical innovation has generally been well accepted around Lake Titicaca, once its particular merits had been demonstrated (Appendix B). There is no evidence either that net theft is a form of communal control of individual fishing investments. Although Lake Titicaca fishermen lose some of their nets relatively frequently (11% of them lose at least one net a year), it is unclear what proportion of these is actually stolen. Fishermen with more nets may be more likely to set some of them in fishing areas in dispute and thus more likely to have them stolen. Yet I could find no indication that fishermen steal one another's nets to keep numbers down.

More indirect forms of constraint on fishing investments may result from shore dwellers' hunger for land. Those short of the minimum requirement of 1.3 has of cultivable land, are more likely to invest into land even of marginal productivity when it becomes available, than in fishing craft or gear. However, this constraint is unlikely to be a major one simply because only a small amount of land is ever available for sale. About 90% of the
totorales, for example, were obtained through inheritance rather than purchase. The sponsorship of fiestas by which many comuneros gain prestige and status within their own community and which requires very large expenditures by local standards (Equipo Juli 1974), are also likely to curtail investments in fishing gear, even if mechanisms have been devised to cope with such large expenses (Brown 1978).

As for technological knowledge, although it is not readily available, there is no control on this form of investment. Members of TURF holding communities can easily learn to fish from a relative. Most fishermen (72.3%) have learned to fish from a male member of their community or from one of the community of their wives, either from a male kin (63.2%), or from an in-law or affine (9.2%), few (17%) have learned by themselves. This control on crew formation and on training does reinforce existing TURFs, however. The Uros fishermen from Lago Poopo in Bolivia, for example, purposely restrict the dissemination of technical information to one's kins as a conscious strategy against potential competition from their Aymara neighbours (Horn 1981).

6.3. DISCUSSION OF ALTERNATIVE CONSTRAINTS

It has been argued in the literature that various factors not related to fishermen's membership in shore communities are responsible for the underfishing of Lake Titicaca fish resources. I show that these factors do not prevent local fisheries from reaching their bioeconomic equilibrium, either because they do not occur in the present situation, or because, even if they did, they would not prevent the bioeconomic equilibrium of local fisheries from being reached.
6.3.1. Cultural constraints

The secrecy over fishing locations and techniques by which fishermen may try to protect their trade and resources may also be reinforced by a prevalent social prejudice against fishing which may refrain successful fishermen from reinvesting their profits into fishing. Some may instead purchase more cattle, or more land if any is available, or even a tricycle which can be used for the transport of goods and passengers in Juliaca or in Puno. Finally, some may use their fishing income for consumption rather than production. However, it appears that the prejudice against fishermen and fishing which was prevalent on the Altiplano a few centuries ago and up to the late 1950's (Vellard 1957: 58-9; Matos 1964: 137) has now withered away. Fishermen are often considered to be better off than other shore-dwellers (Pacori 1976), and their cash-earning abilities are sometimes looked upon with envy.

It has also been hypothesized that other cultural factors, such as a prohibition of fishing for women, and certain dietary preferences may constrain fishing effort. However, neither occurs on the Altiplano. Women do participate in fishing activities, whether wading in the flooded areas with a push net, or rowing a boat while their husband sets his nets. A strong enough woman may even row one of the two boats trawling a huayunaccana. I could not find any evidence of fish avoidance either. Even the aquatic toads (Telmatobius) found in the lake are occasionally consumed for medicinal purposes. Moreover, dietary preferences would only lower fish prices and the exploitation level at which the bioeconomic equilibrium of the corresponding fishery is reached.

6.3.2. Economic constraints

Orlove (1979) has argued that economic disincentives, such as ineffective fishing techniques, the lack of well developed and accessible urban markets,
relatively low fish prices compared to other food items (which could result from local dietary preferences), or the unavailability of cheap credit, may be responsible for underfishing on Lake Titicaca. However, these factors would only be responsible for higher fishing costs or for lower fishing returns. The bioeconomic equilibrium of the fishery considered would still be reached, although at a lower level of fishing effort (Anderson 1978).

In any case, most of these factors do not apply to the situation encountered on the Peruvian Altiplano. Fishermen have access by truck or boat to a large number of weekly local markets (Orlove 1986). Their catches are also exported to most of the large urban markets of the southern Andes (Avila et al. 1985). During the drought of 1983, some fish vendors even tried to export it as far as Lima.

Credit is relatively inexpensive on the Altiplano, although some fishermen complain that it may be hard to obtain at times. Most (77%) of those who use credit rely upon their biological and fictive kins for it, while some (5%) use credit from the Agrarian Bank (Banco Agrario del Peru) normally granted for the purchase of cattle. Many fishermen rely upon their cattle as a source of cash (40%) while others use their income from wage labour on the Costa. Furthermore, a young man may be able to purchase his own craft and gear he has been given by his parents and godparents, as he grew up. In exchange for this form of credit, he is expected to perform menial tasks when still a child (Michaud 1973; Lambert 1977) and to help his parents in their old age (Collins 1982). Therefore, Lake Titicaca shore dwellers have access to a large enough market to sell their catch, and to the technical and financial ability to increase their fishing effort
6.3.3. Biological constraints

Loubens and Sarmiento (1986) have argued that, because *O. agassii* reaches sexual maturity at smaller sizes than those at which it is usually captured, it is unlikely to become overfished with the existing fishing technology and in particular with the meshsizes local fishermen use at present. However, their findings only explain why a steady increase of fishing effort may not lead to a drastic reduction in the numbers of *O. agassii* caught. Such an increase in fishing effort may actually lead to a reduction of the average size and value of the *O. agassii* caught which fishermen would probably try to compensate for by reducing the meshsize of their nets. These authors only indicate that biological overfishing of *O. agassii* has not occurred yet, but they do not indicate whether this has led to the capture of economic rents.

The capture of undersized fish has been prohibited in a handful of communities. If it were widely enforced, it could prevent biological overfishing by guaranteeing that most fish are able to spawn at least once before being caught. It would maintain a high biological productivity for the fishery considered, thus conserve its resources. But it would not prevent the bioeconomic equilibrium of this fishery from being reached.

To sum up, I have demonstrated here that Lake Titicaca fishermen are able to capture substantial economic rents. I have suggested that these rents are likely to have persisted over the last few years. And I have traced the origin of these rents to shore dwellers' enforcement of communal TURFs, and to the obligations entailed by fishermen's membership in shore communities (Figure 17). Chief among the constraints on the labour they can dedicate to fishing is that of keeping agricultural land in production.
7.1 CONCLUSIONS

In trying to determine whether TURFs could be used for the management of small-scale fisheries, I have demonstrated first, that TURFs exist along the shores of Lake Titicaca; second, that they are actively enforced by shore dwellers; third, that substantial economic rents are captured by local fishermen; and fourth, that the capture of these rents is a direct consequence of fishermen's membership in TURF holding communities and of TURF holders' control of fishing access.

7.1.1. Existence of TURFs

I have demonstrated the existence of Lake Titicaca TURFs with historical evidence and the acknowledgment by at least 90% of the fishermen interviewed that they restrict their operations to the fishing area of their own community. I have also shown that fishermen agreed on the dimensions and customary rules governing these TURFs, and on the conditions under which outsiders could gain access to the corresponding resources. Finally, I have found evidence of the existence of such TURFs for virtually all units within a sample of 80% of the shore communities, thus confirming the widespread distribution of TURFs along the shoreline. Since TURFs extend the terrestrial territories of the shore communities to the aquatic environment as far as several hundred meters off the outer edge of the communal totora beds, they include virtually the whole shore area of the lake, most of its littoral area, and even part of its pelagic area.
7.1.2. Enforcement of TURFs

I have documented how Lake Titicaca shore dwellers take advantage of a number of legal arguments to enforce their illegal TURFs, and how they use threats and overt or covert violence, including net theft, to repel outsiders. Chief among these arguments is the control they hold over access to the shoreline through semi-private ownership of landing sites and navigation channels, communal ownership of docking facilities, and physical control of the roads and trails leading to the shore. Communal rights over nearshore totora and llachu beds are also a legal argument TURF holders frequently use to repel outsiders. To keep the latter at bay, TURF holders frequently accuse them of damaging or stealing the reeds. Finally, TURF holders rely upon their Beach Sargents and fishing associations, both officially recognized, to expel outsiders from their fishing grounds under the guise of minimizing conflicts and net theft by outsiders.

7.1.3. Capture of fishing rents

I have demonstrated that Lake Titicaca fishermen are able to capture substantial fishing rents. These rents are proportional to the difference between the return to labour from fishing and the opportunity cost of this labour, which is measured by the return to labour from alternative activities available to shore dwellers. Because the availability of such activities depends on shore dwellers' education, connections and community of origin, the difference between the returns to fishing labour and the opportunity cost of this labour ranges from 51 to 106%. Assuming a different opportunity cost of labour for fishing and fishing-related activities on the grounds that the latter are undertaken when there is little else to do, increases this range to 90-180%. Limited evidence on the stability of fishing yields and on a slower rate of increase of fish prices relative to input costs suggests rents'
persistence over the long term, thus confirming that local fisheries have not reached their bioeconomic equilibrium.

7.1.4. Community membership and the capture of fishing rents

Finally, I have demonstrated that the rents captured by Lake Titicaca fishermen result from the obligations entailed by their membership in TURF holding communities, and from the exclusion of inland dwellers from local fisheries (Figure 17). Communal obligations are counterparts to one's membership in a community. Their undertaking is necessary to guarantee one's access to communal resources, among which the aquatic resources protected by local TURFs. They include such obligations as participation in communal projects and festive celebrations, and the undertaking of administrative and ceremonial responsibilities which reduce the annual supply of household labour from 940 to 700 mandays approximately. But chief among these obligations is the necessity for shore dwellers to keep their agricultural land in production. This requires about 353 mandays per year of their household labour thus limiting to 447 mandays per year the amount of household labour available for fishing and fishing-related activities. I have also shown that alternative explanations proposed for underfishing on Lake Titicaca are either not relevant to present circumstances, or that if they were, they would not prevent local fisheries from reaching their bioeconomic equilibrium anyway. This demonstrates the fundamental contribution of the communal structure to the effectiveness of TURFs, and the need for an interpretation of this effectiveness to determine how TURFs could be used for the management of local fisheries.
7.2. INTERPRETATION OF THE EFFECTIVENESS OF TURFS

To be effective in controlling fishing effort TURFs should incorporate four basic rights: the right of exclusion, the right to extract benefits from the use of the resources within the territory, the right to determine the amount and kind of use of these resources, and the right to future returns from these resources (Christy 1982). The effectiveness of Lake Titicaca TURFs can be traced to their satisfaction of these requirements.

Lake Titicaca TURF holders consider that they have the right to exclude outsiders, as demonstrated by their enforcement activities. Only shore dwellers are able to fish in Lake Titicaca, because they belong to the TURF holding communities. They also have the right to extract benefits from the use of the resources within the territory, thanks to their rights of direct use and of indirect economic gain. The former entitles them to go fishing at will, as long as they comply with the obligations entailed by their membership within a TURF holding community. The latter allows them to receive a compensation from outsiders who are allowed to operate within the TURF area, or to keep their fishing craft on the community's shoreline.

TURF holders also have the right to future returns from the resources within their territory, because the TURFs they hold are permanent, although threatened by official opposition. Finally, their control right allows them to determine the amount and kind of use of the resources within the TURF territory. Lake Titicaca shore communities, like most Andean communities (Mayer 1985), rely heavily on their right of control over the exploitation of terrestrial resources (such as communal pasture and fallow lands) and lakeplants beds. However, I found that very few actually control the exploitation of their fish resources, even to a minimal extent.
Chief among the additional conditions which a TURF system should satisfy to be effective is that harvest outside a TURF area should not affect the value of the resources within it (Christy 1982). This means that the fish yield within the TURF-controlled zone should not be reduced to such a level that TURF holders would be unable to capture any rents, because an excessively high rate of exploitation would be applied either to the portion of a fish stock outside this zone, or to that within the TURF area of a small number of communities. Excessive harvest of adult trout migrating to spawn up the six major tributaries of Lake Titicaca, for example, anihilated the positive effects of TURF-associated constraints on fishing effort, thus contributing largely to the collapse of the trout canning industry in the late 1960s (Appendix B).

Similarly, heavy fishing of the umanto, the suche and the boga outside the TURF-controlled littoral zone is likely to have contributed to their depletion. Fishermen overexploited these valuable species with an increase in fishing pressure resulting from the introduction of new fishing technology (Appendix B), at the same time as these resources had to suffer heavy predation from the rainbow trout. A similar situation could also arise in the future for the ispi if a large urban-based commercial fishery were to develop on the lake. Because the ispi spends most of its life cycle outside of the TURF-protected littoral area, existing TURFs and the constraints resulting from fishermen's membership in TURF holding communities would not affect fishing effort within such a fishery.

The effectiveness of Lake Titicaca TURFs in controlling fishing effort is limited, as demonstrated by their inability to protect some valuable species from depletion. This effectiveness is determined to a large extent by fishermen's membership in TURF holding communities. Formally recognized TURFs
would thus not be very effective if fishermen did not have to respect the constraints resulting from their membership in shore communities. Granting TURFs a formal status would not address these limitations and would thus be insufficient by itself to take advantage of TURFs limited effectiveness. Instead, existing TURFs should become a component of a fisheries management strategy. Such a strategy would capitalize upon the advantages of traditional fisheries management practices (Alexander 1980) and contribute to the emergence of a new model of resource management which various authors have advocated (Berkes 1985; Lamson and Cohen 1984; Smith and Panayotou 1984; Pinkerton 1986). The recent evolution of planning and development theories suggests a number of principles for the formulation of such a strategy.

7.3. TURFS AND THE MANAGEMENT OF LAKE TITICACA FISHERIES

A TURF-based management strategy for Lake Titicaca small-scale fisheries would capitalize on the advantages of local TURFs. These advantages include (cf. section 1.3.4.) the effectiveness of TURFs in controlling fishing effort, their potential for the promotion of equity in the distribution of fisheries' benefits, of administrative efficiency and accountability in the resource management process, and of a higher fishing yield. By reviewing the advantages a TURF-based management strategy would entail, I indicate here how congruent with the recommendations from planning and development theories the implementation of such a strategy would be.

7.3.1. TURFs and planning theory

The management of natural resources is a form of planning since both can be defined by their central concern with the linkage between knowledge and action in the public domain (Friedmann and Hudson 1974). A TURF-based
fisheries management strategy should thus follow the principles of planning theory which has evolved toward decentralization and self-management in the last two decades (Arnstein 1969; Grabow and Heskin 1973; Friedmann 1980). Although self-management has received some scathing criticisms for its political naivety and practical infeasibility (Etzioni 1973; Flyvbjerg and Petersen 1982; Hebbert 1982), it has been argued that planners should incorporate its principles into their professional practice (Bolan 1980; Forester 1982; Kemp 1982) and use it whenever appropriate (Hudson 1979).

The implementation of a TURF-based management strategy would contribute to the adoption of the principles of a decentralized approach to fisheries management in three major ways. First, it would allow the interests of small-scale and subsistence fishermen to be better represented in a system which has lent itself to accusations of insensitivity to the needs of the latter (Alexander 1975). By contributing to the incorporation of the plea of the less favoured resource users into the management process, it would make this process less bureaucratic (Maziotti 1974; Davidoff 1978). And providing no small group of fishermen is allowed to monopolize TURF benefits and to behave as sealords (Christy 1982), it would promote social justice.

Second, it would give fishermen long term rights over the resources in the TURF area of their community, which would entice them in participating to the gathering and sharing of valuable information without which no management is possible. In addition, the control rights of TURF holders over fishing activities within their TURF area would allow them to become active participants in the resource management process. A TURF-based management strategy would thus foster a greater involvement of resource users in the information-generating and decision-making processes by allowing them to become effective and autonomous participants in the planning process (Arnstein
1969), thus contributing to the decentralization and democratization of resource management and to the descaling of social life (Friedmann 1974). Furthermore, TURFs would lead to the combination of fishermen's personal knowledge (i.e. knowledge resulting from subjective experience) with scientists' processed knowledge (i.e. experts' knowledge resulting from factual observation and objective analysis), a key objective of self-management (Ibid.).

And third, it would promote the deregulation and self-control of small-scale fisheries, which would shift the burden of the enforcement of TURFs and of the implementation of fishing regulations from administrative agencies to resource users themselves. This would not only reduce bureaucratic inefficiencies and administrative costs, but it would also enhance autonomy and individual freedom (Kemp 1982; Forester 1982) by giving TURF holders control over their means of production (Rosenvallon 1976; Beauregard 1978), and by transforming the regulatory role of administrative agencies into a new role much more supportive of TURF holding communities.

In addition to implementing the principles of decentralization, the adoption of a TURF-based management strategy would also contribute to the implementation of the principles of adaptive resource management (Walters 1986). By delineating TURF areas as discrete management units, it would allow for the undertaking of experimentation within these areas, which would generate useful scientific information. Different effort and catch levels may be purposely adopted by different TURF holding communities, for example, to generate more information on the population dynamics of their fish resources. The resulting scientific information would thus lead to improved estimates of the biological parameters of the resources harvested, to a better adaptation of harvest rates to the production potential of these resources and eventually
to higher fish yields.

7.3.2. TURFs and development theory

Because the ultimate purpose of fisheries management is to contribute to socio-economic development by increasing the utility that society derives from its resources, the principles of development theory should also guide the formulation of a fisheries management strategy. In the last decade, development theory has evolved away from a broad and functionally oriented framework, toward a localized and territorially oriented one (Friedmann and Weaver 1979; Stohr and Taylor 1981). Although the territorial model of development has been strongly criticized for its economic and political infeasibility (Flyvbjerg and Petersen 1982; Hebbert 1982) and for its adoption of inappropriate assumptions (Gore 1984), its recognition of the importance of a self-reliant approach to development is gaining wider currency (Stohr and Taylor 1981) and recommendations have been made to modify widely used development strategies accordingly (Cremer et al. 1984).

A TURF-based fisheries management strategy would contribute to territorial development in three major ways. First, by reducing or eliminating overfishing and by improving data collection and effort control, it would increase the contribution of fisheries resources to the local economy. This would help in meeting the needs of the local population and promoting the diversification of the local economy through the use of local resources, both of which are key objectives for territorial development (Weaver 1984). In an area like the Peruvian Altiplano, where few alternative resources are available locally, these objectives are of particular relevance.

Second, by institutionalizing a cooperative, locally based approach to fisheries management (Christy 1982; Panayotou 1982), it would foster communal decision-making not only at the implementation stage, but also at the
conception stage where significant orientations for community development are selected (Rondinelli 1979). It would thus promote willful community action within TURF-holding communities instead of exogenous motivation, and cooperative instead of competitive behaviour, both of which are also key objectives for territorial development (Stohr 1981).

And third, by conferring the official status of TURF holding group to existing communities of shore dwellers, it would contribute to their strengthening as social institutions on which territorial development could be based over the long term. Given that these communities are local membership organizations according to the definition provided by Esman and Uphoff (1984) and given that the latter are economically rational, administratively efficient and politically wise for development purposes (Ibid.) their strengthening would be a particularly worthwhile objective.

7.3.3. Recommendations for a TURF-based fisheries management strategy

Presently, fisheries management in Peru involves the IMARPE, the MIPE and the Coast Guard (Figure 17-A). Theoretically the IMARPE gathers and processes the information required to formulate scientific recommendations to the MIPE. The MIPE is responsible for the formulation of such regulations as fishing seasons, minimum sizes or harvest rates, and the collection of catch statistics at landing sites and markets. Finally, the Coast Guard is responsible for the enforcement of the regulations promulgated by the MIPE and for the collection of statistics on the fishing fleet. In practice, however, neither of the three agencies has the expertise or budgetary means to carry out its responsibilities. Data collection is poor (Appendix C), the formulation of regulations is tentative and their enforcement is arbitrary.

To capitalize on the effectiveness of TURFs, a fishery management
strategy should strengthen their most important dimensions. For this purpose official recognition of customary TURFs could be granted to shore communities in such a way as to reinforce the necessary rights of exclusive direct use, or indirect economic gain and of control. By entrusting only those rights which are necessary for the promotion of economic efficiency, the state could retain ownership over the aquatic territory of a TURF, as in the case of the terrestrial territory of the officially recognized Peasant Communities.

The formal recognition of existing TURFs would imply the recognition of shore dwellers' right of exclusion, either through the confirmation of TURFs physical and human dimensions, or their re-definition in ways acceptable to TURF holding communities. It would automatically reinforce their right of direct use, and that of indirect economic gain. However, the latter may have to be reconfirmed as a collective right, so that the benefits of local fisheries accrue to a shore community as a whole, rather than to a few of its members. As for the communal right of control, it would have to be reinforced so that TURF holding communities could implement local regulations for the conservation of their aquatic resources. Finally, these TURFs would have to be granted to their holders for a long enough period so that they would be guaranteed that by restricting their own fishing effort, they would be investing in the resources of their TURFs, for their own future benefit, or that of their heirs. Moreover, TURFs should be made non-transferrable, so that a shore community may not risk losing its fishing territory to outside private interests or to a small group of sealords.

The creation of federations of TURF holding communities would be required to deal with the problem of use outside of TURF areas, and of the allocation of catch quotas for each TURF holding community for the more heavily exploited species. The role of such federative organizations would be to coordinate
FIGURE 17: ORGANIZATION OF FISHERIES MANAGEMENT ON LAKE TITICACA.

A: EXISTING SYSTEM

IMARPE-Puno → MIPE-Puno → COAST-GUARD, Puno
Recommendations
Registration taxes
Data collection
Fishing regulations
Enforcement of regulations

Shermen

167

TURFs

SHORE COMMUNITIES

B: TURF-BASED ALTERNATIVE

IMARPE-Puno → MIPE-Puno → COAST-GUARD, Puno
Recommendations
Registration taxes
Catch statistics
Catch statistics
Recommendations
Regional Federations

Sheron Communities

TURFs

Catch statistics
Control of fishing activities

FISHERMEN
management practices between shore communities sharing transboundary stocks. It would have to be organized in a way suitable for the management of each transboundary stock, with a division for each major ecological zone of the Lake. It would also have to be suitable to foster intercommunity negotiation and to keep transaction costs low, with subdivisions following the model of the multicomunal associations already functioning for development purposes on the Altiplano (Caceda 1984).

Under a TURF-based management strategy (Figure 17-B), fishermen would play a much more prominent part in the collection of data, the formulation of regulations and their enforcement. Given the impact of environmental factors particularly changes in the lake level, on local fish resources, harvest levels will have to be adjusted. This, and the need to negotiate a share of the harvest from transboundary stocks within the federation would require fishermen to gather information on their own catches, for which the technical assistance of local scientists would be useful. In a TURF-based management strategy, the IMARPE would still have a major role to play but instead of formulating recommendations on harvest rates to the MIPE, it would make them directly to the fishermen themselves, while the MIPE would have to provide the latter with the needed assessment for the selection of appropriate forms of effort control and harvest regulation. Finally, the Coast Guard would remain responsible for boat registration, for the mitigation of conflicts between communities sharing transboundary stocks and for the adjudication of territorial disputes.


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**APPENDIX A: ORESTIAS SPECIES ENCOUNTERED IN LAKE TITICACA WATERSHED**  
(TCHERNAVIN 1944; LAUZANNE 1982; PARENTI 1984)

<table>
<thead>
<tr>
<th>COMPLEX</th>
<th>SPECIES</th>
<th>VERNACULAR NAME</th>
<th>FEEDING TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cuvieri</td>
<td>O. cuvieri</td>
<td>umanto</td>
<td>midwater predator</td>
</tr>
<tr>
<td></td>
<td>O. pentlandii</td>
<td>boga, bella, ccesi.</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. ispi</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. forgeti</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td>Gilsoni</td>
<td>O. gilsoni</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. taquiri</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. mooni</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. uruni</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. minimus</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. minutus</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. tchernavini</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. tomcooni</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. imarpe</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
<tr>
<td></td>
<td>O. robustus</td>
<td>ispi</td>
<td>midwater planktivore</td>
</tr>
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<td>O. mulleri</td>
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<td>benthic feeder</td>
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<td>O. gracilis</td>
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<td>benthic feeder</td>
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<td>O. crawfordi</td>
<td>carachi amarillo</td>
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<td>O. tutini</td>
<td>carachi amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. incae</td>
<td>carachi amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td>Agassii</td>
<td>O. agassii</td>
<td>c. blanco, ch'awlla</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. frontosus</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. jussiei</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. puni</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. tschudii</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. ctenolepis</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. richersoni</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. multiporitis</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. silustani</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
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<td>O. luteus</td>
<td>c. amarillo, pongo.</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. rotondipinnis</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. farfani</td>
<td>c. amarillo</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. albus</td>
<td>c. amarillo, khano.</td>
<td>benthic feeder</td>
</tr>
<tr>
<td></td>
<td>O. olivaceus</td>
<td>c. enano, punkhu</td>
<td>benthic feeder</td>
</tr>
</tbody>
</table>
APPENDIX B: HISTORY OF LAKE TITICACA FISHERIES

Formative and Tiahuanuco periods

Recent archeological evidence indicates that a succession of sophisticated regional cultures developed in the vicinity of Lake Titicaca between 2000 and 100 BC, despite its harsh natural conditions (Browman 1981). During this formative period, local populations made the transition from hunting and gathering, to a combination of camelid pastoralism, tuber agriculture, and lacustrine resources harvesting, which was sufficient to support sedentary villages (Ibid.; Kolata 1978).

Because fish, waterfowl and lake-plants played such a major role in the subsistence of these early cultures (Kent 1983), it has been hypothesized that Lake Titicaca may have acted as a "catalyst for the complex set of economic interactions that resulted in the evolution of civilization (in the region)" (Kolata 1978: 248). This evolution culminated with the Tiahuanuco (or Tiwanaku) commercial and religious empire which flourished between 100 BC and 1250 AD. The latter's sphere of influence spread over the entire Altiplano, and even included economic colonies along the warmer valleys of the Pacific coast, or Costa, and of the Amazonian slopes of the Andes, or Selva, to which Altiplano residents migrated periodically (Mujica 1985). Exchange of goods transported by llama caravans between the Altiplano and these colonies, and massive land reclamation programs in the nearshore area contributed to the development of the rich Tiahuanuco economy (Kolata 1978).

Little is known of the importance of lacustrine resources during the Tiahuanuco period, although the location on the periphery of Lake Titicaca of most Tiahuanuco sites seems to indicate the persistent use of these resources (Mujica 1985). Moreover, a substantial increase in the number and average size of these sites suggests a considerable increase of population (Ibid.), and quite possibly of lacustrine resources use. Finally, evidence of aquatic transportation of large blocks of stone on totora-reed boats across the lago Pequeno indicates that 2000 years ago, people already knew how to make seaworthy crafts (Browman 1981) that could have been used for fishing.

Inca period

The Tiahuanuco empire disintegrated sometimes between 1200 and 1300 AD when it was replaced by a number of small Aymara kingdoms. A period of chronic wars ensued, to which the Inca conquest put an end around 1450 (Browman 1981; Murra 1984). The end of continuous warfare meant that the Inca administrators could get local populations to abandon their strongholds in the hills where they had sought refuge and to settle back on the lakeshore (Murra 1985). This suggests that after a transition period, lacustrine resources might have regained their importance.

The Altiplano, or Qollasuyu, was the most populated quarter of the Inca empire, or Tawantinsuyu. Because of its wealth in camelids and in mineral deposits, it remained under the direct control of the Spanish crown after the conquest (Hyslop 1976). Because of this, some documentation on local conditions in the early colonial period is available. The official tax rate set in 1575, for example, provides information on the wealth and sources of...
income of different sectors of the Altiplano population. It indicates that during the Inca administration of the Altiplano, fishing on Lake Titicaca was carried exclusively by Uros Fishermen (Diez de San Miguel [1567] 1964). Given the Inca administrators' common practice of adapting existing social structures rather than replacing them, it may be hypothesized that this caste-like organization might have predated the Inca conquest of the Altiplano.

It is commonly believed that the Uros were early settlers of the Altiplano, later pushed into the vast marshes of Lake Titicaca and of the Desaguadero river by the Aymaras (La Barre 1948; Manelis 1973). Uros fishermen were poor and landless: they belonged to a caste of inferior social status (Vellard 1963; Manelis 1973). However, not all Uros belonged to this inferior caste of landless fishermen, many were at least as rich as their Aymara neighbours in land and in camelids (Wachtel 1978). In the early colonial period, for example, only 40% of the Uros were expected to pay their taxes in fish, the others had to pay them in precious metal, agricultural or weaving products (Wachtel 1978).

Colonial period

Lake Titicaca fisheries may have been an important part of the local economy, during the colonial period, even though Uros fishermen's contribution in fish represented only 3.5% of the total tribute paid by the region. It is likely to have been low simply because only a small part of fishermen's taxes could be paid directly in fish, since the colonial administration preferred precious metal to fish (Julien 1983). A hundred years later, the contribution of Lake Titicaca fisheries to the regional economy became more obvious as increasingly large quantities of dried fish had to be shipped to the growing contingent of laborers forced to work in the silver mines of Potosi (Soldi 1978). For later periods, however, available documents offer only sketchy information on the exploitation of lacustrine resources in the 18th (Mino 1984) and 19th century (Forbes 1870).

Evolution of the number of fishermen

Although there is no historical record of the number of fishermen on Lake Titicaca, there is some evidence that neither the number of fishing settlements, nor the number of fishermen have changed since the Spanish colonization. Under the Inca administration, localized kinship groups, or ayllus, were granted formal recognition, and exclusive rights over the resources within their territories (Murua, in Ramirez 1985: 430). During the colonial period these territories have been reorganized, but the number of human settlements along the shores of the Lake has not been modified since then, as demonstrated by the correspondence between traditional ayllus, and modern administrative units (Martinez 1981).

Using information drawn from the lists of tributaries, all Uros, who had to pay their taxes to the Spanish Crown in fish (Wachtel 1978; Julien 1983), I have estimated the total number of fishermen on the whole Altiplano at 6,394 in 1575. This indicates that the number of fishermen was the same in 1575 and in 1976 when the total number of fishermen on Lake Titicaca was estimated at 6,000: 3,040 for Peru (Bustamante and Trevino 1976) and about as many for Bolivia (B. Orlove 1984: pers. com.).
This apparent stability cannot be credited to the enforcement of TURFs alone. The decimation of indigenous populations following the Spanish colonization might well be responsible for most of it. Successive epidemics of European diseases, wars, rebellions, forced labor in dangerous mines and excessive taxing reduced the native populations of Peru and Bolivia from 3 millions in 1532 to 608,000 in 1796 (Grieshaber 1977: 49). In the dioceses of Cuzco and La Paz, corresponding to the Altiplano itself, the number of tributaries was reduced by 52% between 1591 and 1754 (Ibid: 51). This decimation continued well into the 19th century, as demonstrated by a decrease of 23% in the Indian population of the Bolivian Altiplano between 1838 and 1877 (Ibid: 294).

In the case of the Peruvian Altiplano, this demographic trend seems to have been reversed at the beginning of the 20th century, when the population of the department of Puno increased by 62% between 1896 and 1980 (INE data). However, because of a general urbanization tendency, the lakeshore population (excluding the city of Puno) increased only by 18% between 1940 and 1981, compared to 35% for the rest of the department. Still, an analysis of the change in the number of fishermen during the latter period, suggests that it has changed little.

Estimates of fishermen numbers since the beginning of this century are rare and widely fluctuating. An estimate of 300 nomadic fishermen living in totora beds in 1940, for example, seems limited to the Uros fishermen of the Bahia de Puno (Fiedler 1944) and is thus unreliable. Various estimates for the late 1950's range from 2,800 (PRDSP 1959) to 10,000 fishermen (Terrazas in Laba 1979), although a range of 2,000 to 3,000 fishermen seems more realistic (Vellard 1963: 65). Estimates for the mid and late 1960s, range from 1,000 (Everett 1971a) to 1,800 fishermen (MIPE-DIE 1978), but the latter are probably underestimates, because they seem to take into account only those fishermen participating in the trout fishery. For the mid 1970s, a reliable estimate indicates that 3,040 fishermen operated on Lake Titicaca in 1976 (Bustamante and Trevino 1976). Finally, a more recent estimate of 3,122 fishermen for 1981 is based on the assumption that the proportion of fishermen in the total shore population has not changed since 1976 (Avila et al. 1985), and is of little help here.

My analysis of the results of two partial censuses of the fishing population conducted in 34 and 38 communities, in 1980 and 1984 respectively, suggests that the total number of Peruvian fishermen is unlikely to have changed recently. Summing up the total number of fishermen for each sample and comparing these sums with those for the corresponding communities in 1976, indicate that the total number of fishermen for these communities might have declined by 17% between 1976 and 1980, but increased by 40% between 1976 and 1984. However, a comparison of fishermen numbers on a community basis reveals that there is no statistically significant difference between average numbers of fishermen per community, either for the 1976-1980, or the 1976-1984 period. This suggests that the rates of change in the number of fishermen calculated above, are unlikely to apply to the whole fishermen population, and that the total number of fishermen is unlikely to have changed noticeably either between 1976 and 1980, or between 1976 and 1984.

To sum up, all the evidence presented here suggests that the total number of fishermen on Lake Titicaca has remained fairly stable during the last forty
years, and that even if it has increased, it has done so from the growth of the shore dwelling population rather than from an influx of inland dwellers. This indicates that local TURFs may limit entry to local fisheries.

Recent biological and technical changes

Since the middle of this century some major changes have affected Lake Titicaca fisheries. Exotic fish species were introduced to the lake in the early 1940s for the trout (Salmo gairdneri) and late 1950s for the silverside or pejerrey (Basilichthys bonariensis). Subsequently, a successful trout fishery developed in the early 1960's. This fishery supported up to five artisanal canneries and reached a peak production of 400 mt in 1965, however, overfishing brought its collapse and forced the canneries to close down in 1969 (Everett 1971a). After its introduction against experts' advice (Taft 1954) the silverside became the object of a limited fishery in the early 1970s (Wurtsbaugh 1974) which has kept increasing ever since (Alfaro et al. 1982; Avila et al. 1985).

Fish marketing has also changed considerably in the last 30 years. Urbanization, transportation improvements and the multiplication of markets on the Altiplano have opened new opportunities for fish traders, with a consequent increase in their number. Up until the early 1960s fish vendors used to be rare on local markets. Fishermen's wives would only sell a little bit of fish on the beaches (Vellard 1963). But by 1980, there was at least one fish vendor in 76% of the Altiplano markets, and at least 7 in 54% of them (Orlove pers. comm.). Furthermore, the number of markets had almost doubled from 73 in 1961, to 118 in 1974 (Appleby 1978), so that by 1984 more than 670 fish vendors were officially registered at the Ministry of Fisheries in Puno. Fish traders have also found new markets in neighbouring departments. They now ship Lake Titicaca fish to the mining centers (eg Toquepala, Cuajone) and urban areas of the Southern Andes (eg Cuzco, Arequipa) and even of the Pacific coast (eg Tacna, Moquegua) (Avila et al. 1985).

Technical innovation has generally been well accepted among Lake Titicaca fishermen, once its particular merits had been demonstrated (Vellard 1963). Balsa reed boats, for example, had been the only craft used on Lake Titicaca, for more than a thousand years, yet their number has steadily declined since the introduction of wooden boats. The latter became more widely used in the 1940's, first for transport, because of a dramatic drought during which the supply of totora reeds dwindled (Avalos 1951; Vellard 1963; Matos 1964), and later for fishing, with the development of the trout canning industry. Because boats are lighter and faster than traditional balsas, their adoption has meant a greater range of operation for local fishermen, now able to travel further in the same amount of time. The proportion of balsa among the fishing crafts used on Lake Titicaca went from 100% in the early 1940's (Schweigger 1930; Fiedler 1944), to about 50% in 1976 (Bustamante and Trevino 1976) and 28% of a sample of 96 fishermen in 1980.

Local fishermen have adopted nylon gillnets even more rapidly. The latter were introduced on the lake in 1952 (Laba 1979), and twenty years later had replaced almost all cotton nets (Farfan 1974; Bustamante and Trevino 1976). Their adoption is likely to have implied a large surge in fishing effort, because it has allowed local fishermen to increase the size and number of their nets, or the dimensions of their traditional trawls. Moreover, it
has allowed them to fish more often, since fewer operators were needed, and since drying was no longer required in-between fishing expeditions. In the case of the huayuna, for example, the replacement of cotton with nylon has meant a large increase in the size the mouth (from 15 to more than 500 square meters in some cases). Moreover, the nylon huayuna can be used everyday, even during the rainy season if so desired, and still last longer than a cotton one. Finally, because it is now made by assemblage of ready-made nylon mesh panels, its construction has become easier and less time consuming. Conversely, huayunas are now easy to dismantle and to turn into gillnets.

Status of fish resources

Environmental factors, the introduction of exotic species, the expansion of urban fish market, and a large increase of fishing effort following changes in fishing technologies are all likely to have affected the status of local fish resources. For example, it has been claimed trout were responsible for the demise of the native species, through predation, competition, and the simultaneous introduction of parasites because the introduction of the trout in Lake Titicaca approximately coincided with a decline in Orestias catches, (Villwock 1972; Laba 1979). The disappearance of the umanto (O. cuvieri) and a strong decline in boga (O. pentlandii) catches in particular, were blamed on the trout. After the collapse of the trout fishery and the closure of the trout canneries in the late 1960s, it has been claimed that the trout had all but vanished from the lake (Everett 1977; Laba 1979), and that the more recently introduced silverside (B. bonariensis) was at least partially to blame for it, as well as for the continuously low catches of native species (Wurtsbaugh 1974; Alfaro et al. 1982; Orlove 1986).

Limited available evidence, however, shows that a substantial increase in total fishing effort, following the introduction of new fishing technologies and the expansion of local markets, did contribute to the decline of the native species. In the Lago Pequeno for example, this decline was at least initiated before the introduction of the trout. Its occurrence has been attributed to the development of truck transportation and of a large urban market for fish in the neighbouring city of La Paz (James 1936). As for trout responsibility in the infestation of native species with various types of parasites, it had been recorded much earlier in the century (Neveu-Lemaire 1906). Finally, the simultaneous introduction of wooden boats and of nylon gillnets, which allowed the modification of the huayunaccana traditional fishing trawls are likely to have lead to a surge in fishing effort.

Finally, environmental factors such as the dramatic drought of the early 1940s are likely to have had a major impact on Lake Titicaca fisheries, for at least three different reasons. First, because of its lowering of the lake level, a drought concentrates fish in a smaller fishing area where it is easier to catch. Second, it reduces spawning and feeding areas for perimacrophytic species such as the carachis. During the drought of 1983, for example, a decrease by one meter of the level of Laguna Arapa reduced the spawning area of the boga to less than half its original size (DIREPE-Puno 1984). And third, a drought pushes shore dwellers into fishing, because there is little else for them to do. Again during the drought of 1983, fishing increased so much that the amount of lake fish marketed in the city of La Paz increased by 300% (Coutts and Rojas 1984).
Catch estimates

Data collected for this study indicates a total catch in the Peruvian part of Lake Titicaca of 8,160 mt in 1980 (95% confidence interval: 6,490 to 9,830 mt). The bulk of it came from the Orestias genus (69%), followed by the silverside (15%), and the trout (14%), and the Trichomycterus, mostly mauri, only contributed 2%. This confirms the scarcity of the suche, and that of the boga (O. pentlandii) while supporting the claim that the umanto (O. cuvieri) is now extinct (Bustamante and Trevino 1976; Lauzanne 1981; Parenti 1984).

This estimate can be compared with an earlier one based on a very extensive household survey, for which food consumption per household in the Southern region of Peru was recorded over a one year period (ENCA 1972). This survey demonstrated that fish accounted for only 2% of the per capita consumption of 66 grams of protein per day in the Puno department (Ferroni 1980). Taking into account the contribution of marine fish to this consumption, and the exportation of lake fish to urban markets outside the Altiplano, or in Bolivia, the ENCA data yields an estimate of 3,301 mt for the year 1972, thus indicating an average catch of about 1 mt/year for each of the 3,040 fishermen censused (Bustamante and Trevino 1976). [Footnote: This may be underestimated by as much as 1,000 mt, because the shore dwelling population with the highest rate of fish consumption was not sampled separately from the rest of the rural population of the department.]

Although higher than official catch figures of about 1,000 mt for Peru (MIPE 1980), and of 500 mt for Bolivia (Vergara 1980), the 1979-1980 figure is still very low in comparison to estimates of 120,000 mt for the standing biomass (Johannesson et al. 1981) and of 20,000 to 160,000 mt for the annual productivity of the lake (Richerson et al. 1977). This leads to the hypothesis that local fish resources are globally underfished, or utilized below their maximum biological potential (Orlove 1979). Even if more valuable species may be rare or extinct, it is likely that only a small proportion of the standing stocks of pelagic species found offshore (eg ispi, silverside), is subject to fishing when they come to shore for feeding, or for spawning.
APPENDIX C: RESEARCH METHODS

1) Field research

For this study, I have gathered information on fishing territoriality, fishing practices, and a number of fishing related activities not previously described, through direct observation and in-depth interviewing. Although a number of ethnographic studies did mention the importance of fishing in the local economy, few documented the practice of fishing itself, and most only alluded to fishing territoriality (Levieil 1986). Even the description of Lake Titicaca fisheries by IMARPE biologists which provided a wealth of information on the various types of craft and gear used by local fishermen had little to say about TURFs and fishing yield (Bustamante and Trevino 1976).

I have used direct observation to gather information on the operation of specific techniques, including boat building, balsa building, reed and weed collection (Levieil et al. 1985), trout aquaculture, trawl fishing (Trevino et al. 1981), gillnet fishing, and fish retailing (Avila et al. 1985). Unobtrusive observation proved impossible without first securing a verbal authorization from some locally elected representative, and enlisting the collaboration of at least a few fishermen. Because I rarely attempted observation in communities where I had not FIRST obtained such guarantees, I encountered few problems, still I was told to leave two different communities.

In-depth interviewing of a number of shore dwellers, most of them fishermen, also proved a very fruitful endeavour. Although reserved initially especially with a white foreign observer, casual acquaintances were willing to share some of their knowledge, and to voice their concerns. Finally, I interviewed shore dwellers not involved in fishing for comparison purposes and members of the local bureaucratic elite to verify shore dwellers' accounts.

Given TURFs' illegality, questions related to them proved fairly sensitive and I had to use considerable probing and indirect questioning to obtain non evasive and reliable answers. I asked shore dwellers to report trespassing instead of enforcement in order to avoid self-incrimination. For cross-checking purposes, I subsequently visited the communities from which trespassors came from and asked local fishermen to indicate the areas from which they had been repelled.

2. Statistical data from official sources

In addition to the information gathered during field work, official statistics were collected whenever available. However, they proved of poor validity and reliability, an unfortunately common problem in Third World fisheries (eg: Munro and Loy 1976).

a) Official registration lists

The fishermen's registration list held by the Coast Guard (Capitania) includes about 1,000 fishermen, or about a third of the total (Bustamante and Trevino 1976), because fishermen avoid registering themselves, since it costs them time and money. Since this list lacks comprehensiveness, it could not be
used as a sampling frame. The boat registration list also suffers from this same problem, although it appears that a large proportion of boats is registered because boats may be confiscated by the Coast Guard. Even, the official fish vendors held by the Puno office of the Ministry of Fisheries (MIPE-Puno) suffers from a lack of comprehensiveness. Moreover, it is biased because it records a higher proportion of urban vendors from the cities of Puno and Juliaca.

b) Official catch statistics

Lake Titicaca official catch statistics are invalid because they indicate the amount of fish traded in the cities of Puno and Juliaca instead of the total amount of fish harvested from the lake. They are also unreliable because of the data collection technique used. An untrained MIPE employee visits a couple of markets, once a day at best, and estimates the total amount of fish being traded by counting the number of retailers and visually estimating the amount of fish for sale in front of a non-random sample of vendors. This method overlooks fish retailing on all the other markets of the Altiplano, self consumption by fishing households and fish export to distant markets. It even fails to accurately estimate fish trade in Puno and Juliaca cities, because it samples a variable proportion of vendors on a non random basis, and because with one visit per market per day the MIPE misses the fish sold prior to the visit as well as the fish of vendors still to come.

c) Official price list

The MIPE establishes and enforces a list of official prices for each fish species and even some waterfowl. This list provides a conservative estimate of fish prices because, except for the larger fish, fish vendors dodge price specifications by selling fish by the heap or by units rather than by weight as the list stipulates.

3. Fisheries survey

Because of the unreliability and irrelevance of official statistics, I have used a survey of local fisheries to estimate fishermen's income from fishing. With this survey I have collected data on fishing yields and on the time and resources fishing households invest in fishing and fishing-related activities. This survey included three components, each represented by a different type of questionnaire: a Catch Assessment Survey (or CAS) to evaluate the annual catch of a sample of fishermen, a Coverage Check Survey (or CCS) to check for biases in the CAS, and a socio-economic survey.

The CAS was designed to provide information on the daily catches and on the fishing effort (i.e. duration of fishing trips, number of nets used, number of crew members involved) of a sample of fifty collaborating fishermen, over a twelve month period (August 1979 to July 1980). Two CCS were conducted approximately at six month intervals, to determine whether the fishing yields and efforts of the collaborating fishermen were representative. The socio-economic survey was used to gather data on fishermen's investments in fishing craft and gear. The same sample was used for the CAS and the socio-economic survey, and a special sample was drawn for the CCS following the recommendations of a statistical consultant (Chapman 1979).
a) Population, sampling frame and sampling units

For this study, the primary unit of analysis was defined as an individual fisherman (a craft operator owning at least a few nets, or a pushnet in the case of a foot fisherman) rather than either a Fishing Economic Unit (FEU) or a household, although most fishermen operate within the framework of a household economy, and although most fishery surveys focus upon fishing firms or FEUs. This particular unit was selected for three reasons: First, because focusing upon the individual fisherman still allowed for the calculation of fishing costs and returns at the household and FEU level; Second, because I had to compare the return to fishing labour with the opportunity cost of individual fishermen's labour; Finally, because a comprehensive sampling frame was already available (Bustamante and Trevino 1976), thus facilitating the adoption of a frame survey (Bazigos 1974a; 1974b).

Although all boat operators had a chance of being selected, foot fishermen did not. Women and children in particular, who commonly engage in pushnet fishing in flooded areas, were excluded from the population studied. Male fishermen were asked about the involvement of the members of their household in such a practice, but this practice may be more common in households which do not include an adult male fisherman, thus leading to its underestimation. Finally, the fear that fishermen might refuse to answer questions because of their involvement in illegal activities proved unfounded, since more than one collaborating fishermen acknowledged his involvement in such activities.

b) Sampling procedure

For the CAS and socio-economic surveys, a two-stage cluster sample of full time fishermen was drawn after stratification. For four of these surveys fifty collaborating fishermen (units of analysis) from 13 fishing communities (clusters) distributed in four strata corresponding to the four zones of the lake were selected on a lottery basis (Campbell 1981). For the CCS, a stratified sample of 16 fishing communities, 4 by zone (strata) was selected. However, individual fishermen (units of analysis) could not be selected on a truly random basis, because it was not possible to predict how many fishermen would be coming back from a fishing trip in any given 24 hour period. Field workers were thus recommended to sample fishermen exhaustively, or should that prove impossible, to sample them systematically. In either case, the field workers missed the foot fishermen because the latter did not operate from the beach where the former were standing.

The rationale for stratifying the fishing population in four strata stemmed from geographical differences between the four zones of the Lake. It was thought that a fairly standard-sized sample of 50 fishermen (Smith 1983) would be appropriate given that only 5 basic types of FEUs could be identified. Clustering was adopted for budgetary reasons, with only 3 clusters or fishing communities per zone being selected for practical reasons. The 50 fishermen selected out of 3,040 (a proportion of 1.6%) were thus distributed between 13 communities, with an average of 4 fishermen per community. For each strata, they were selected in proportion to the number of fishermen censused in 1976 and assumed to be still present.
### SAMPLING FRAME FOR THE SELECTION OF 50 COLLABORATING FISHERMEN (1979-80)

<table>
<thead>
<tr>
<th>Zones</th>
<th>Clusters</th>
<th>Units</th>
<th>Fishermen</th>
<th>Sampling ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puno Bay</td>
<td>3</td>
<td>11</td>
<td>680</td>
<td>16.2</td>
</tr>
<tr>
<td>North Lake</td>
<td>3</td>
<td>15</td>
<td>936</td>
<td>16.0</td>
</tr>
<tr>
<td>South Lake</td>
<td>4</td>
<td>13</td>
<td>768</td>
<td>16.9</td>
</tr>
<tr>
<td>Small Lake</td>
<td>3</td>
<td>11</td>
<td>656</td>
<td>16.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13</strong></td>
<td><strong>50</strong></td>
<td><strong>3,040</strong></td>
<td><strong>16.4</strong></td>
</tr>
</tbody>
</table>

Both clusters and fishermen were selected within each zone in such a proportion that each censused fisherman had the same probability of being selected, regardless of the size of the fishing community he belonged to. In the second stage, fishermen from each selected community (cluster) were selected by lottery during meetings attended by a quorum of at least 60% of the fishermen from the communities selected. To compensate for the smaller chance of individual fishermen from large communities for being selected in the second stage, each community was given a chance of selection proportionate to its size in the first stage. And since all fishermen from the same strata had the same probability of being selected, the scheme adopted is equivalent to stratified random sampling.

d) Data collection methods

Three different methods of data collection were used: questionnaires administered by an interviewer for the socio-economic survey, self-administered questionnaires for the CAS, and questionnaires with actual weighing and sorting of the fish by the field worker for the CCS. Interviewing for the socio-economic survey involved the use of detailed questionnaires, usually within the home compound of the informant, by one of the field assistants or by myself. Verbal pledges of confidentiality proved much less convincing for one-time respondents than a pledge of mutual trust and reciprocity through the ritual gift of a handful of coca leaves.

The 50 fishermen who had agreed to participate in the CAS were trained for a couple of days and given spring scales, notebooks, pencils and recording forms. Although not all of them were literate or able to speak good Spanish, most had at least a member of their household who was able to fill his forms. A financial compensation was given to them as an incentive for accurate recording, and as a compensation for their time. In addition the title of "Collaborating Fishermen of the IMARPE" was granted to them, with official letters of endorsement from the IMARPE director and small identification cards. As an additional incentive, fishermen were promised that upon completion of the study, official diplomas would be granted to them and that a number of prizes representing a substantial amount of money would be sorted by lottery during an official ceremony to which those who would report their fishing activities accurately would be invited.
For the CCS, the cooperation of the local Beach Sargeant or, in his absence, that of the President of the Community or that of a local school teacher was sought. Credentials and official authorizations were presented to them and to any suspicious fisherman, and the objectives of the survey were explained. A small monetary compensation was paid to each informant to demonstrate that the field workers were not tax collectors.

For the CAS and socio-economic surveys, the response rates were very high. Of the 50 fishermen selected only three refused to collaborate and had to be replaced before the beginning of the CAS. Of those who started collaborating, about half a dozen got a member of their household to replace them while they migrated to the coast or to the jungle for seasonal labour, but they resumed collaboration upon their return. Although none withdrew before the end of the CAS, attrition reduced the initial sample by 10 between 1981 and 1984 when the last survey was conducted (one died, two were jailed, two moved to nearby towns, three moved to Lima, and two refused to answer questions). The individuals who had inherited the former collaborator's craft and gear were taken as replacement whenever possible.

e) Interviewers

Most of the interviewing for the socio-economic surveys was carried by a research assistant, or an interpreter and myself. The presence of an interpreter did facilitate many an interaction, because foreign looking outsiders are suspicious on the Altiplano, a hardly surprising fact given the tormented history of the region. The first assistant, a retired Adventist school teacher who had previously collaborated on a number of socio-economic studies, spoke both Aymara and Quechua, the two native languages. His past experience with survey work and his knowledge of the area proved invaluable in locating the often elusive fishermen. His Adventist connections proved a mixed blessing, however, since it was not looked at positively by all fishermen. The second research assistant, a trained Quechua speaking anthropologist, also with considerable experience of field work in the area, contributed invaluable knowledge of local kinship systems. He also proved extremely tactful and effective in the investigation of sensitive questions about TURFs' enforcement.

f) Questionnaire design procedure

For the questionnaires' design, I relied upon the advice of a consultant (Chapman 1979), upon the experience of IMARPE biologists with the census of Lake Titicaca fisheries (Bustamante and Trevino 1976), and upon my own experience with the socio-economic evaluation of small-scale fisheries in the Peruvian Amazon. I designed the socio-economic surveys following Bazigos recommendations (1974a), and I conducted pretesting with a few fishermen from Ichu-Raya and Barco (Chucuito), and with former fishermen now working for the IMARPE. Although the information sought dealt essentially with practical aspects of fishing and fishing-related activities, wording was still a source of difficulties, and the help of Dr. B.S. Orlove, an anthropologist specialized in Andean studies with the formulation of questions avoided many a confusion. Units of measurements also proved a constant source of difficulties because fishermen refer to heterogeneous measurements.
g) data processing and methods of analysis

The forms and note books of the collaborating fishermen were collected and checked every month by IMARPE scientists following the instructions contained in a small manual. All the data from the CAS, CCS and socio-economic surveys was processed and analyzed following standard procedures (Sonquist and Dunkelberg 1977) at the Division of Environmental Studies (DES) of the University of California-Davis. First it was coded on standard 80 columns computer forms by assistants specially trained for this task who followed detailed instructions recorded in codebooks prepared for this purpose. The data was then keypunched on standard IBM cards, entered on the computer, and after standard verification procedures, stored on magnetic tapes. Because of the size of the data set involved (about 13,000 records for catch and effort data only) considerable data manipulation was then performed by the specialists of DES computing center (Peter Hunter and Rod Thompson) to prepare easy to manipulate data files.
The various costs involved in fishing and fishing-related activities include the depreciation and maintenance costs of the fishing craft, gear and outboard engine, the operating costs of the engine, catch retailing expenses and some miscellaneous expenses such as boat and fisherman registration costs. For each cost or frequency item I have calculated the arithmetic means, and when appropriate I have indicated its 95% confidence interval and the size of the sample on which these estimates were based.

The evaluation of fishing costs required a number of assumptions. I have had to assume that each fisherman uses a standard balsa or boat, and that the annual cost of each item is equal to its average value in early 1980, divided by the average number of years that it could last (straight line method of depreciation with no residual value). I have considered the material expenses for gill net maintenance but not the occasional loss and theft of nets. For labour, I have calculated the number of man-days necessary for each operation involved in fishing or in related activities. I have neglected the opportunity cost of capital, for three reasons: firstly because there is very little if any money-lending activities for profit on the Peruvian Altiplano, and secondly because in 1980, few banks were accessible for shore-dwellers to invest their savings. Even in the case of those few banks which had offices in the cities of Puno and Juliaca, both about a day away from most fishing settlements, the rates of interest offered were generally lower than the inflation rate. Finally, it was not justified to take into account the opportunity cost of capital in calculations of the hourly return to labour for fishing, when the latter had not been considered in calculations of the hourly return to labour for alternative activities.

Costs have to be borne at a particular point in time but returns are obtained year long. Since the Peruvian inflation rate was 67.7% in 1979 and 59.2% in 1980 (Becker 1983), it had to be taken into account for calculations of fishing profitability. I have thus chosen to estimate fishing costs as if they had been incurred at the middle of the catch reporting period (i.e. January 1980) because it determined two half periods over which the effects of inflation could be expected to cancel one another, which greatly simplified calculations, since it eliminated the need to correct for monthly inflation on fishing costs. It did assume, however, that no significant changes in the inflation or in the catch rates occurred between the two half-periods considered, an assumption which reasonableness is demonstrated by available catch data and consumer price indices.

1. Fishing costs

In my calculations of fishing costs I have incorporated the costs of fishing-related activities carried by the members of the household which owns the FEU. This is equivalent to considering such a household as a vertically integrated fishing enterprise involved in craft building, gear making and maintenance, fishing and fish retailing. Computing the costs of fishing and fishing-related activities jointly implies that the net returns to labour are assumed to be the same for both types of activities.
a) Balsa reed boats

Only 28% of the surveyed fishermen use a 3.8 m long (+ 1.8 m, n=64) balsa for fishing. Few (7.8%) purchase a ready-made one for S/4,850 (+ S/5,276, n=5). Most (90.6%) build their own, collecting reeds from totora beds to which they gain access for a fee or sometimes from their own beds. At least 63% of those who build their own balsa have to purchase the 33 bundles of totora (32.3 + 1.7 bundles, n=59) at S/100 a bundle (+ S/42.2, n=20) for S/3,075 which includes the cost of transportation.

To build their balsa, half of the informants use a rope made out of chillihuash (Festuca dolicophyila), a grass found on the nearby plateau of the Puna. Most (93.3%) of those who use it have to buy two bundles of it, or wawas, each worth S/900. The stems have to be soaked and braided (in 46% of the cases) or twisted (in 17% of the cases) to make about 100 meters of grass rope (107 + 6 m, n=57). The whole process takes slightly longer for braiding than for twisting but makes a stronger rope which makes the hull of the balsa smoother, thus slightly faster and less tiresome to propel. Braiding or twisting the chillihuash is usually performed by women or elders while tending cattle in three or four days, but full time it takes about one day.

The other half of the informants use a nylon line which has to be purchased in rolls, or conos, each worth S/1,800. Two rolls are necessary for the construction of a balsa. The same nylon line can be used repeatedly for three successive balsas which reduces the line cost to S/1,200 per balsa, or to S/900 per balsa if used for four balsas. The increasing popularity of nylon can thus be explained by the economy of time and money it represents. Furthermore, the nylon line can be tightened very strongly which allows for the construction of water-tight and long-lasting balsas. Finally, because it offers less resistance to the water, it makes the balsa faster and easier to handle. After the totora has dried for 3 to 4 weeks depending on the season, the construction of the balsa takes 3 days of full time work during one of which the builder needs the help of another adult man. The latter is given food, coca and alcohol, and paid S/200 for his day of labor, or jornal.

There is a discrepancy between the quoted price of a ready-made balsa and that of the materials included in its construction which reflects the inclusion of transportation costs in the price of the reed bundles. Ready-made balsas are purchased in Chimu or Ch'ulluni (Puno) by fishermen living nearby, who row or sail their newly acquired balsa back to their home, and who do not include the value of their time in that of the purchased balsa. Conversely, bundles of totora are purchased by fishermen from the mouth of the Ilave river, who have to pay for the transport of these reeds by truck. Ready-made balsas would be too heavy and bulky to transport by truck and it would take a long and rather unsafe passage to sail them back. Because a balsa becomes waterlogged after a couple of months, thus dangerously heavy and hard to handle, it has to be replaced periodically, and most fishermen do so about twice a year (1.96 + 0.5 times, n=28).

Most balsas (94%) are propelled with a 4.2 meters long (+.3m, n=61) wooden pole, the noquena, usually made of a branch of eucalyptus (E. globulus), or of ccolle (Buddleia longifolia) for the shorter ones. This limits the navigating range of a balsa to the shallow water areas of the totora beds, or totorales, and llachu beds, or llachales. The noquena can

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last an average of three years (2.9 + .5 years, n=56) and is worth approximately S/2,900 (S/2,896 + 900, n=49) and each balsa comes with a couple of them (1.8 + .3, n=64). Ispi fishermen, for their part, prefer a 2.5 meters long sculling oar, the pala, because it can be used at almost any water depth. It is also quieter than rowing, since the sculling blade stays in the water.

Only 22% of the sampled balsas carry a 3.7 m long bipod wooden mast usually made of ccolle and worth S/655, and 44.4% of them carry a totora sail, or ccasana worth S/700. The latter is more often used as a small roof at night or when raining, than as a sail. Plastic sheets have become increasingly popular for this purpose because of their greater versatility and durability. Balsas maintenance costs are almost nil. All a fisherman needs to do is to tighten a balsa which has sat in the sun and out of the water for a long time and to repair broken ropes. The overall expense incurred for the annual operation of a fishing balsa thus corresponds to the renewal of the bare balsa and to the depreciation of the accompanying implements. According to the calculations detailed in the table below the expenditure per balsa can be estimated at S/12,008 per year, and 10 days of labour.

<table>
<thead>
<tr>
<th>Item</th>
<th>Purchase Value (Soles)</th>
<th>Expected Use (years)</th>
<th>Depreciation Cost (Soles/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totora reeds</td>
<td>3,075</td>
<td>.5</td>
<td>6,150</td>
</tr>
<tr>
<td>Chillihua rope</td>
<td>1,800</td>
<td>.5</td>
<td>3,600</td>
</tr>
<tr>
<td>Labour (5 days)</td>
<td>5,126</td>
<td>.5</td>
<td>10 days</td>
</tr>
<tr>
<td>Pole (S/2,896 each)</td>
<td>144</td>
<td>3</td>
<td>1,704</td>
</tr>
<tr>
<td>Mast (22% of S/655)</td>
<td>311</td>
<td>.6</td>
<td>518</td>
</tr>
<tr>
<td>Sail (44% of S/700)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (balsa and gear)</td>
<td>10,456 + 5 days</td>
<td></td>
<td>12,008 + 10 days</td>
</tr>
</tbody>
</table>

b) Wooden boats

The majority of Lake Titicaca fishermen (72%) own a wooden boat 4.75 m long (4.73 + .2 m, n=69), 1.5 m wide (1.52 + .1 m, n=69), and 80 cm deep (82 + 4 cm, n=69). Most boats (63%) belong to a single owner, some (15%) to a pair of kins (father and son, brothers), and the remaining few (5%) to three owners. However, in some areas like the northwestern shores of Laguna Arapa, co-ownership is more frequent.

Less than 5% of the boats are built by their owners. Instead, specialized boat builders build them on order, often on a nearshore piece of land belonging to the prospective owner. It is the responsibility of the latter to purchase the material required for the construction of his boat. If the boat builder has to move from his community to that of the buyer to build the boat, the buyer must give hospitality, in addition of a salary to the builder and to provide help whenever necessary.
A prospective buyer may also order a ready-made boat from one of the specialized boat builders of Jacantaya (Moho), Huancane, Isla Taquili, Cachipucara (Pilcuyo), Juli, Yunguyo, Isla Anapia (Yunguyo), and the Bolivian island of Suriqui. The buyer does not have to provide hospitality then. Only in rare opportunities, involving a few boat builders from Huancane, do boat builders actually build a boat and later look for a buyer. Second-hand boats can also be purchased at a fraction of their original cost, as demonstrated by the proportion of second-hand boats (30.5%) in the registration list of the Coast Guard in Puno. The following table details the costs involved in the purchase of a boat.

<table>
<thead>
<tr>
<th>Boat construction expenses</th>
<th>Cost (Soles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood (50 ribs, 10 side boards, keel, transom, etc)</td>
<td>17,760</td>
</tr>
<tr>
<td>Nails and screws</td>
<td>4,910</td>
</tr>
<tr>
<td>Putty and glue</td>
<td>3,300</td>
</tr>
<tr>
<td>Caulking and Painting material</td>
<td>13,410</td>
</tr>
<tr>
<td>Labour (4 weeks at S/500 per day for the boat builder and S/200 per day for his helper)</td>
<td>19,600</td>
</tr>
<tr>
<td>Transport of material</td>
<td>10,720</td>
</tr>
<tr>
<td><strong>Total value of 5 meter fishing boat</strong></td>
<td><strong>69,700</strong></td>
</tr>
</tbody>
</table>

Fishermen expect their boats to last about 10 years (9.9 + 1.6 years, n=72), which is probably an underestimate, since many identify the remaining years of use of their boat with those before a major overhaul, 5 to 8 years after launching, depending of the quality of the wood used and of the construction. In addition, informants can rarely judge how long a boat could last, since few (16%) have owned a boat for more than 7 years.

About 40% of the boats use sails for propulsion. Most of them (77%) are made of tocuyo, a cheap fabric used to make potato sacks, the others (13%) are made of a cotton material used to make flour bags, and some are made of plastic (10%). An average-sized sail is worth S/3,635 (+ S/2,315, n=19) and can last 7.5 years (+ 1.8, n=28). In addition to the sail, a mast and some additional rigging is necessary. Almost all masts (97%) are made of eucalyptus wood and the total value of the rig, including the 5 meters long mast (+.6 m, n=28) is worth about S/1,000 (+ S/300, n=20) and can last about 8 years (8.4 + 2.4 years, n=27).

Most boats (92%) are propelled with a combination of pole and oars. The pole is particularly useful to push the boat to, or away from the landing spots, or along the channels crisscrossing the totora beds. Most poles (91%) are made of eucalyptus wood. Like those used to propel balsas, they are about 4.5 meters long (+.3 m, n=70) and worth S/1,335 (+ S/145, n=42) each, although more than one can be found in a boat (1.4 + .2 poles per boat, n=27). Boat lloquenas last for almost five years (4.8 + 1 years, n=68), one and a half times more than balsa poles, because they are used only when the water is too shallow, or the macrophyte vegetation too thick, for the oars to be used.
Oars are usually (66%) made of eucalyptus, although ccolle is also used (22.5%). Fishermen expect their 2.5 meters long oars (+.2 m, n=70) worth S/1,620 a pair (+ S/330, n=37), to last for 4 years (+ 1.1, n=65). In addition to the oars, a pair of iron oarlocks or chumaceras worth S/997 (+ S/186, n=37), which can last for 16.5 years (+ 4.7 years, n=55) is needed. The annual expenditures incurred by a boat owner are summarized below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Purchase Value (Soles/)</th>
<th>Expected Use (years)</th>
<th>Depreciation cost (Soles/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hull</td>
<td>69,700</td>
<td>10</td>
<td>6,970</td>
</tr>
<tr>
<td>Sail</td>
<td>3,635</td>
<td>7.5</td>
<td>485</td>
</tr>
<tr>
<td>Rig</td>
<td>1,003</td>
<td>8.5</td>
<td>118</td>
</tr>
<tr>
<td>Pole (1.4 pole)</td>
<td>1,870</td>
<td>5</td>
<td>374</td>
</tr>
<tr>
<td>Oars (1 pair)</td>
<td>1,620</td>
<td>4</td>
<td>405</td>
</tr>
<tr>
<td>Oarlocks (1 pair)</td>
<td>997</td>
<td>16.5</td>
<td>60</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>78,825</strong></td>
<td></td>
<td><strong>8,412</strong></td>
</tr>
</tbody>
</table>

Wooden boats must be painted twice a year, although fishermen paint them less often (1.4 + .2 times a year, n=40). Expenditures in material for painting include paint, oil and caulking material for a total of almost S/6,984 (+ 2,032, n=20). Each painting and caulking session requires about 9 man-days (9.1 + 2.6 days, n=35). Boats also have to go through a major overhaul six years after launching, during which rotten ribs and boards are changed. This overhaul is generally combined with boat painting. It requires about S/5,678 (+ S/2,191, n=30) of wood and nails and 3.65 man-days (+ 1.2 days, n=40) of work. The expenses for boat maintenance are listed below.

<table>
<thead>
<tr>
<th>Expenses for boat maintenance</th>
<th>Labour (man-days)</th>
<th>Expense (Soles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painting and caulking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency: 1.4 + .2 times/year (n=40)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material: S/6,984 + 2,032 (n=20)</td>
<td></td>
<td>9,603</td>
</tr>
<tr>
<td>Labour: 9.1 + 2.6 days (n=35)</td>
<td></td>
<td>12.8</td>
</tr>
<tr>
<td>Repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency: .17 times/year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material: S/ 5,678 + 2,191 (n=30)</td>
<td></td>
<td>965</td>
</tr>
<tr>
<td>Labour: 3.65 + 1.2 days (n=40)</td>
<td></td>
<td>0.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13.5</strong></td>
<td><strong>10,568</strong></td>
</tr>
</tbody>
</table>
c) Outboard engines

Few fishermen (14%) own an outboard engine which horsepower ranges from 12 to 40 hp, with a mean of about 25 hp (24.75 + 5.5 hp, n=8). Engine owners expect their engines to last only 5 years (5 + 2 years, n=7), because few have owned their engines for long enough to know that they can last 8 to 9 years on the lake. Their yearly expenses are S/15,216 (+ S/7,542, n=12) for maintenance and repair, and their monthly expenses S/8,941 (+ S/5,503, n=8) for gas and S/2,460 (+ S/1,176, n=11) for lubricants. In sum they spend S/152,028 per year on the operation and maintenance of their engines which depreciation cost vary between S/65,000 and 85,000 depending of the initial value of their engines.

d) Gillnets

Lake Titicaca fishermen use nylon gillnets made of imported nylon mesh panels. They purchase those of meshsizes under 63 mm for S/17,000 and divide them in three or four longitudinal sections which they use for native species. And they purchase those of meshsizes equal or larger than 63 mm for S/19,000 and divide them in two or three sections which they use for introduced species. They also divide the large floats which they purchase second hand into smaller units which they use to make the float line of their nets. Finally they use small stones and old batteries as sinkers. Fishermen expect their nets to last for ten years (9.9 + 1 year, n=151). Thus the average value of a net and its yearly depreciation cost can be calculated as detailed in the following table.

<table>
<thead>
<tr>
<th>Cost per item (in Soles)</th>
<th>Native species net (&lt; 63 mm)</th>
<th>Introduced species net (&gt; 63 mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal section</td>
<td>4,960</td>
<td>7,910</td>
</tr>
<tr>
<td>Nylon line</td>
<td>2,700</td>
<td>2,700</td>
</tr>
<tr>
<td>Floats</td>
<td>900</td>
<td>1,350</td>
</tr>
<tr>
<td>Labour</td>
<td>2 days</td>
<td>2 days</td>
</tr>
<tr>
<td>Cost per net</td>
<td>8,560 + 2 days</td>
<td>11,960 + 2 days</td>
</tr>
<tr>
<td>Expected years of use</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Depreciation cost per year</td>
<td>856 + .2 days</td>
<td>1,196 + .2 days</td>
</tr>
</tbody>
</table>

Gillnets do require maintenance, either cleaning the organic detritus which clog the meshes and make the net too visible in the water, or repairing the holes resulting from wear and tear. Interviewed fishermen claim to perform cleaning operations alone (21%), or with the help of an associate fisherman (8.8%), but mostly with the help of the women and children of their household (70.2%). They indicate that they clean their nets every two or
three weeks, and that they repair them only occasionally, though they perform both types of activities more frequently during the rainy season. The following table indicates the mean material and labor expenditure for the cleaning and repairing of the nets of a standard FEU. These estimates also apply to the maintenance of trawl nets or huayunaccanas.

| Net Maintenance Operation (per year) | Labour (Hours) | Material (Soles/)
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleaning (n=50)</td>
<td>133.5 + 5.6</td>
<td>2,840 + 796</td>
</tr>
<tr>
<td>Repairing (n=50)</td>
<td>105.3 + 5.4</td>
<td></td>
</tr>
</tbody>
</table>

These are mean estimates for the sample of 50 collaborating fishermen. The time dedicated by each fisherman to these activities is actually a function of the number of nets he owns. Given the relatively large share of net cleaning and maintenance in fishing expenditures, this has to be taken into account. I have thus used for each fisherman a weighting factor equal to the ratio between the number of nets he owns and the average number of nets owned within the sample of 50 fishermen.

e) Huayunaccana

Fishermen claim to use their huayunaccanas for at least 15 years. Since none is sold brand new, and since fishermen were unable to evaluate the value of theirs, I have had to estimate the value of the material and of the labour involved in the construction of a huayunaccana to estimate its depreciation cost, as detailed in the table below.

<table>
<thead>
<tr>
<th>Expense categories</th>
<th>Labour (Days)</th>
<th>Cost (/Soles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 panels (meshsize &lt;63 mm)</td>
<td>136,000</td>
<td></td>
</tr>
<tr>
<td>7 large floats</td>
<td>2,100</td>
<td></td>
</tr>
<tr>
<td>8 rolls of nylon line</td>
<td>24,000</td>
<td></td>
</tr>
<tr>
<td>160 meters of nylon cord</td>
<td>16,000</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>178,100</td>
</tr>
<tr>
<td>Depreciation (over 15 years)</td>
<td>2</td>
<td>11,873</td>
</tr>
</tbody>
</table>

f) Retailing costs

Fish retailing costs include transportation costs for the vendors and for the fish they sell, a municipal tax and a warm meal, as detailed in the table below. Fish vendors undertake two market trips per week, each of which takes
them a half day to a whole day each according to market accessibility. I have taken this into account in my calculations of the time dedicated by each household to fish retailing according to market accessibility. I have also taken into account the common practice among fishermen of the Lago Pequeno to sell their catch to Bolivian fish buyers who come in their own boats to buy fish right on the lake, thus saving fishermen retailing expenses.

<table>
<thead>
<tr>
<th>Expense categories</th>
<th>Costs per trip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Soles/) (Days)</td>
</tr>
<tr>
<td>Frequency: 93.1 + 6.8 times/year (n=251)</td>
<td>93.1</td>
</tr>
<tr>
<td>Fare: S/328.7 + 55.4 (n=104)</td>
<td>30,592</td>
</tr>
<tr>
<td>Tax: S/23.37 + 3.2 (n=71)</td>
<td>2,175</td>
</tr>
<tr>
<td>Meal: S/229.7 + 44 (n=36)</td>
<td>21,382</td>
</tr>
<tr>
<td>Annual total</td>
<td>54,149 + 9,550</td>
</tr>
</tbody>
</table>

2. Fishing returns

To calculate the gross return from fishing I have had to multiply the monthly catch of each species by the corresponding prices which I gathered from the official price list (Appendix C). However, I used Bolivian prices for the trout and silverside sold by 16% of the collaborating fishermen because prices are 2 to 2.5 times higher in Bolivia (Coutts and Rojas 1981). This lead to a 15 to 16% increase of the hourly return to fishing labour as demonstrated by the table next page.

Assuming that retail prices minus retailing costs represent the value of the fish used for subsistence or for non-monetary exchange, implies assuming that fishermen are free decision-makers, and not subject to any constraint in deciding how to dispose of their catch. Assigning to subsistence goods a value based on what selling brings or could bring is, however, more conservative than assigning one based on what would have to be paid to purchase the same or comparable goods on a retail market. Using the latter implies imputing the vendor's margin of profit to the value of the good.
3. Opportunity costs

To estimate the opportunity cost of fishing, I have calculated the returns per hour of labour for a number of activities from published sources. I have estimated the return from cattle fattening at 70 S/hr, for example, by actualizing previous studies and correcting for inflation (Lewellen 1977: 62; Levieil and Goyzueta 1984). For activities such as trade and transport, and coffee growing, estimates of the returns to labour were already available, and all I had to do was to correct for inflation.

For coffee growing, I have corrected Painter's estimate of the return to labour (Painter 1982; 1984; 1986) for inflation only, although I believed his figures to be overestimated, because it allowed me to calculate a conservative estimate of the relative difference between fishing and coffee growing returns. Painter's figures of the gross value of coffee production are overestimated because he used a mid-season price rather than the much lower price actually obtained by producers for their crop. Coffee prices dropped suddenly at the end of the 1980 season, to the dismay of the producers who had been enticed into holding on to their crop by rising prices. Some of them actually had to borrow money to pay their helpers (Painter 1984).

Painter's figures are also overestimated because he did not include depreciation costs in his calculations. The latter are substantial because new plantations have to be created periodically (Painter 1982: 248). A very large amount of labour is involved in gaining a plantation on the jungle and maintaining it for five years before it becomes productive. After 20 years of production, this plantation becomes unproductive, because of environmental conditions and of the lack of fertilizers and pesticides: the soil fertility is lost, the top soil is eroded, the plants are invaded with pests and diseases. Each prospective coffee grower must also invest a considerable amount of time to learn the trade, to create and to maintain a pool of labour from which to draw help.