TOWARD THE FORMULATION OF A METHOD TO ASSESS THE SOCIO-ECONOMIC IMPACT OF ARTIFICIAL REEFS

BY

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The intention of this paper is to report on a methodological approach for evaluating the economic impact of artificial reefs. Part of a research project (1), the intention was to chart the potential impact of artificial reefs in Languedoc-Roussillon.

1. FRAME OF REFERENCE

Artificial reefs were placed at five sites in 1985 for experimental purposes (Agde, Gruissan, Port-la-Nouvelle, Canet and Saint-Cyprien). The programme, carried out by the Languedoc-Roussillon Region, proposed to assess the biological impact by site and module type, and to test the capacity of artificial reefs to maintain or even develop small-scale fishing (2). The specific sub-objectives were to (3):

- reduce conflict between small-scale fishing boats and trawlers;
- provide a more stable and dependable income for small-scale fishermen;
- rationalize fishing through a selective fishing policy and management of the fishing effort;
- maintain or develop a specific economic activity along the entire coastline, mainly through improved working conditions and access to the profession;
- provide an opportunity for reconversion for other fishermen with economic problems, such as small-scale trawlers.

This was to be achieved through "intermediate" objectives such as the creation of zones of species assemblage (4) and diversification of the species caught.

2. THE PROBLEM

The research done on artificial reefs has been mainly biological (5). The impact of artificial reefs is assessed in terms of colonization, fish behaviour, and the impact of concentration. Such analyses usually compare reef and non-reef zones, or else reef types in terms of the shape of the modules, how they are placed and the materials used. The impact of artificial reefs cannot be assessed in terms of the biological impact alone, however, even assuming the socio-economic impact to be heavily dependent on the transformation of the natural environment. The net social benefit (6) and usefulness of the reef are also important questions. Our approach to the estimate has therefore been to identify the potential socio-economic impact of artificial reefs in Languedoc-Roussillon. The prior identification of the potential impacts of a programme of this nature is of course fundamental if the objective is to alter the environment at the lowest possible social cost and, of fundamental importance, avoid conflicts of interests between protagonists.

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From the socio-economic standpoint, the "usefulness" of artificial reefs can be approached in two complementary ways. First, reefs can be the mainstay of a management policy (7). The specific scope of the reefs in this instance is regulatory, within the more general context of resource management policies. The objective is to regulate the resource and/or reduce inter-fishery conflicts. The "usefulness" of artificial reefs cannot, however, be limited to the management role (8). Reefs also have a fairly substantial impact on the organization of the fishery. They may lead to specialized fishing tecniques which call into question the characteristic artisanal fisheries concept of the mobility of fishing grounds and gear. Another impact of fishing artificial reefs is a reduction in costs (9) and/or more predictable catches. Reefs can modify the behaviour and strategies of fishermen. An assessment of the impacts of an artificial reef programme thus boils down to an evaluation of the impact of a new form of management and a new form of organization of the fishery.

3. PREMISE OF THE EVALUATION

3.1 Clarification of objectives. Any evaluation is based on the assumption of clear and measurable objectives. The objectives must be clarified and classified in terms of their national usefulness, where possible. A formal statement of objectives, and of quantifiable working sub-objectives, is even more necessary where expectations and power relationships deviate between the time the objectives are defined and the stage at which they are accomplished. The definition of objectives (10), by arousing expectations and modifying the behaviour of the protagonist, plays a self-subjective role (indeed a self-dissuasive role in case the objectives are not credible which is crucial to programme impact and, indeed, programme success or failure. In addition to the objectives, a target group must be defined. The homogeneity and accessibility of this target group are decisive to the adaptatrion of the programme and the evaluation must take this into account.

Policies on artificial reefs fall into two major categories depending on whether the objective is short-term financial gain, e.g., artificial reefs for sports fishing in North America, or a longer-term, macro-economic objective such as the development of an occupational fishing activity, or environmental and resource protection.

3.2 Identifying and measuring impact. The evaluation assumes that impacts can be circumscribed by sector and area. This implies a comparative approach with respect to the initial programme objectives or potential impact of substitute programmes. The advisability of the programme is thus being evaluated and therefore the "theoretical"nature of the impact of alternative programmes is a major limiting factor (11). For a proper comparison, the impact and objectives must be measurable, and the relative indicators definable.

4. METHODOLOGY

4.1 The review of the operations of the non-reef "fishing-system" is the first phase (definition of the frame of reference). This requires a direct definition of the protagonists (the target group) and an indirect definition of other types of fishing involved and of the branch as a whole (12). Once the internal logic of the "fisheries system" within the non-reef situation has been analysed one can:

- identify the operations and dynamics of the "fishing-system". Structural tendencies can indeed act as constraints to the transformations inherent in the programme (13);
- identify the facts which have a bearing on the future (14) and which can shape the dynamics of the system and thus affect some of the consequences;
- formulate working hypotheses to narrow down the impacts to the more probable and more important ones and thus best define the indicators.

4.2 The exploration of the foreseeable consequences of artificial reefs then leads to several scenarios. The point is to bring out all expected impacts in respect of two assumptions as to how the reefs work:

- Reefs act to concentrate fishes. The impact for fishermen may be to modify fish diversity (for reefs over sandy bottoms) and catch volume (by reducing uncertainty, not by increasing productivity, a hypothesis which is deliberately excluded). Modifications with respect to the regularity and size of catches have also been envisaged as a secondary impact.

- The reefs confer physical protection, making it possible to prevent trawler access to the 3-mile coastal strip, thus reducing competition for small-scale fishermen.

Charts summarizing the main changes in the "fishing system" list the principal relevant variables and how they interact. These show possible effects but not the degree of probability and as such are an exploratory, not a predictive, tool.

4.3 The identification of monitoring levels thus makes it possible to suggest monitoring indicators in accordance with variables perceived as important. The point at this stage is to anticipate the establishment of an economic monitoring system so as to measure these impacts. The indicators are defined in accordance with their simplicity and ease of implementation – not forgetting reliability. Variations in jobs and value added permit economic monitoring, but indicators of social changes have been deliberately limited due to constraints time and available information. For example, the number of nets destroyed, official complaints, regulatory measures, control methods and, to some extent, the species composition of trawler catches can help to evaluate the potential for reducing conflict. Furthermore, improvement in working conditions, the duration of work at sea and on shore, the number of new fishermen and the number of reconversions can give some idea of positive social trends.

5. RESULTS

5.1 The scenarios. A summary chart (Figure 1) articulates the main expected impacts for the three assumptions retained (protection, concentration and reconversion of small trawlers - under 18 m). More detailed sub-charts then attempt to list the impacts for each assumption. One such example is given in Figure 2.

5.2 Presentation of monitoring levels. The purpose of the evaluation is to measure the impact of reefs in terms of the disparity with respect to employment and value added, compared to a non-reef situation. Several "intermediate" indicators have been defined for this purpose. The following table lists some indicators for each level.

6. LIMITS

The evaluation is made by comparison with the objectives. There may be negative effects independently of these objectives which are difficult to identify and measure. Furthermore, the implementation of a programme is contingent upon other concurrent changes in the system (variation of natural conditions, interdependence with other activities, structural evolution of the fishing system) and other regulatory, economic and social measures which may be taken during the same period. This makes it difficult to individualize the impacts linked to a particular programme. The qualitative nature of certain impacts does not lend itself to the definition and quantification of indicators. This is true of the capacity of reefs to induce a structuration of the fishermen's environment. In addition, the low cubic volume of reefs imparts a "confidential" nature to certain impacts which makes them difficult to identify. The wide variation in biological findings due to the locations of the reefs limits the extent to which the findings from these five experimental sites can be generalized.

Intermediate monitoring

TECHNICAL	SPATIAL
– Types of gear used – Number of gear used – Vessel features (age, tonnage, etc.) – Engine power – Rate of gear renewal – Frequency of trips – Length of trips – Fishing-time over reef – Number of vessels/fishermen – Number of active vessels	– Location of fishing grounds – Length of travel time – Monitoring conflicts (damage/ gear; number of complaints, etc.) – Number of fishermen over the reef area
ADMINISTRATIVE	SOCIAL
– Total number of fishermen – List of regulatory measures	– Number of sailors – Age of fishermen – Level of training – Number of retired fishermen
ECONOMIC AND FINANCIAL – Volume of catch – Specific nature of catches – Level and type of charges – Price levels – Type of marketing channel – Productivity of fishing units – Value added	

Furthermore, the lack of information on small-scale fisheries in Languedoc-Roussillon raises questions about the working hypotheses. In the case of our research, for example, the lack of data on "biological" impacts (15) and on the way the fishery was organized prior to the introduction of the reefs proved to be severe constraints. It is assumed that the introduction of reefs will entail some behavioural modifications but, beyond the gear used, some of the indicative variables of fishery strategies such as regularity of the activity (number of days at sea), pluriactivity among fishermen, their attitudes toward risk, the traditional rate of gear renewal, the degree of structuration and cohesion among fishermen, etc., (16) were not known. Lastly, the total absence of hypotheses concerning reef fishing methods made it impossible to explore the "regulatory" impacts which are, in fact, closely tied in with the way reefs are managed.

NOTES

(1) The point of the research was to establish a framework for monitoring and estimating the economic impact of artificial reefs. Our methodology was influenced by the estimative nature of the monitoring, forcing us to adapt the traditional tools of economic evaluation to the context of the research.

(2) J. Duclerc, J.R. Lefevre, L. Hardy. Les récifs artificiels, une technique de gestion et d'aménagement de l'espace littoral marin. Franco-Japanese Seminar on Oceanography, 16–25 September 1985, Marseille. Paper 6, Coastal developments and coastline management.

(3) Another complementary objective was to establish an observation post to centralize and update collected data.

(4) The programme deliberately excluded any possible impact of reef productivity.

(5) Of 413 references analysed by Bohnsack and Sutherland in 1985, only 15 concerned economic aspects, mainly just cost evaluation. (D. Ody. Les peuplements ichthyologiques des recifs artificiels de Provence. Master's thesis. December 1987).

(6) The economic evaluation is an assessment of the usefulness and social cost of a project based on the net social benefit (updated net cost/benefit from the standpoint of the community). The analysis generally distinguishes between direct and indirect primary impacts measured in terms of new net value added, and the secondary effects concerning the utilization of supplementary income generated from new value added. (M. Chervel and M. Le Gall. Manuel d'évaluation économique de projets. La méthode des effets. Planning methodology of the Ministry of Cooperation).

(7) Artificial reefs are often cited as a specific management tool. Artificial reefs do in fact assume the introduction of strict fisheries management. The social conflicts arising from the placing of open fish weirs, for example, illustrate the need to spell out collective management measures. Artificial reefs can have a wider incentive effect because of their inherent regulation (periodicity and/or types of gear and/or number of fishermen and/or volume catch).

(8) Economic impact studies, in addition to evaluating costs, frequently focus solely on the role of reef management, citing the incentive capacity of reefs in resource management (Hiroaki Yonesaka. Socio-economic Ramifications of Artificial Reef Development in Southeast Asia).

(9) Reduced fuel costs where travel time is shorter or where the fisherman changes to a set fishing ground (the reef) after a moving itinerary.

(10) Of equal importance with the periodic dissemination of intermediate results. The impact of monitoring monetary aggregates on the inflationary expectations of agents and the behaviour of secondary banks is the most incisive proof (J.P. Patat. Banque de France. Monetary Statistics Analysis Service. Conference on monetary policy tools and constraints. Montpellier. February 1989).

(11) The evaluation is then framed in terms of optimum targeting in a context of relatively rare resources.

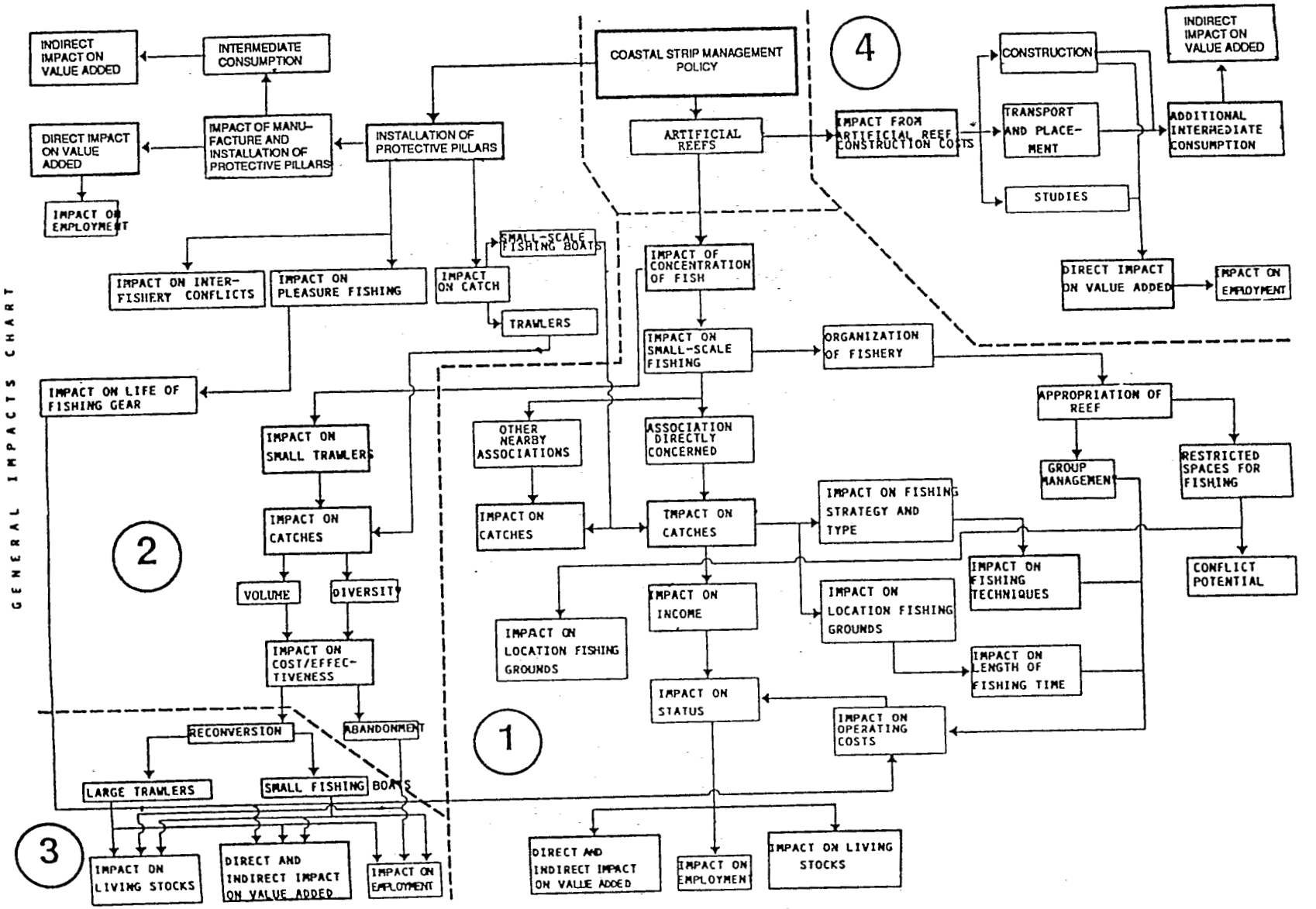
(12) Branch is used here to refer to a chain of complementary activities, interlinked by operations of purchases and sales (J. Monfort. Economie et statistiques. N° 151, 1983).

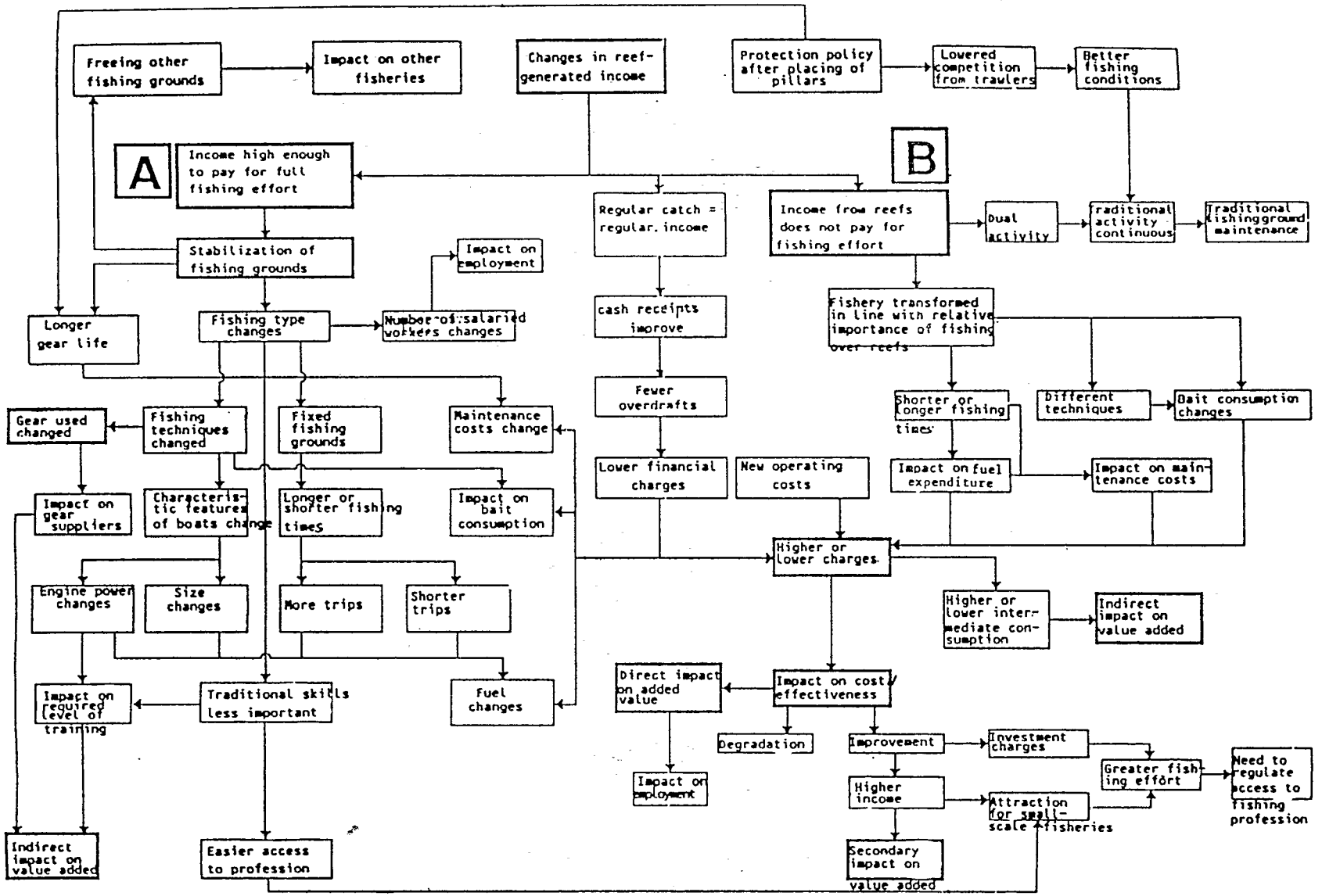
(13) The introduction of reefs, as an innovation with reference to fishing customs obliges the "fishing system" to bring forward its possibility to adapt. Indeed the constants and the flexibility of the fishermen with respect to the innovation must be taken into account.

(14) "Facts bearing on the future" refers to modifications with lasting consequences which can have a structural impact (A. Tiano. Le méthode de la prospective. Dunod, 1984).

(15) The year prior to the placing of the reef was devoted to collecting the data which was to comprise the reference situation. The delayed laying of the reef made it impossible to collect the same data after immersion. We therefore proceeded to make comparisons with control zones.

(16) A study of the economic operation of fishing enterprises is currently being undertaken by the Centre d'études de projets. Based on a survey made from a representative sampling, it proposes to identify types of behaviour, the explanatory variables of these behaviours and to establish a typology of the units.


GENERAL IMPACTS CHART
COASTAL STRIP MANAGEMENT POLICY
4
ARTIFICIAL REEFS
IMPACT FROM ARTIFICIAL REEF CONSTRUCTION COSTS
CONSTRUCTION
TRANSPORT AND PLACE-MENT
STUDIES
INDIRECT IMPACT ON VALUE ADDED
ADDITIONAL INTERMEDIATE CONSUMPTION
DIRECT IMPACT ON VALUE ADDED
IMPACT ON EMPLOYMENT
INSTALLATION OF PROTECTIVE PILLARS
IMPACT OF MANU-FACTURE AND INSTALLATION OF PROTECTIVE PILLARS
INTERMEDIATE CONSUMPTION
INDIRECT IMPACT ON VALUE ADDED
DIRECT IMPACT ON VALUE ADDED
IMPACT ON EMPLOYMENT
IMPACT ON INTER-FISHERY CONFLICTS
IMPACT ON PLEASURE FISHING
IMPACT ON CATCH
SMALL-SCALE FISHING BOATS
TRAWLERS
IMPACT OF CONCENTRATION OF FISH
IMPACT ON SMALL-SCALE FISHING
ORGANIZATION OF FISHERY
APPROPRIATION OF REEF
GROUP MANAGEMENT
RESTRICTED SPACES FOR FISHING
IMPACT ON LIFE OF FISHING GEAR
IMPACT ON SMALL TRAWLERS
IMPACT ON CATCHES
VOLUME
DIVERSITY
IMPACT ON COST/EFFEC-TIVENESS
2
OTHER NEARBY ASSOCIATIONS
ASSOCIATION DIRECTLY CONCERNED
IMPACT ON CATCHES
IMPACT ON FISHING STRATEGY AND TYPE
IMPACT ON FISHING TECHNIQUES
CONFLICT POTENTIAL
IMPACT ON LOCATION FISHING GROUNDS
IMPACT ON INCOME
IMPACT ON LOCATION FISHING GROUNDS
IMPACT ON LENGTH OF FISHING TIME
IMPACT ON STATUS
IMPACT ON OPERATING COSTS
1
RECONVERSION
ABANDONMENT
LARGE TRAWLERS
SMALL FISHING BOATS
3
IMPACT ON LIVING STOCKS
DIRECT AND INDIRECT IMPACT ON VALUE ADDED
IMPACT ON EMPLOYMENT
DIRECT AND INDIRECT IMPACT ON VALUE ADDED
IMPACT ON EMPLOYMENT
IMPACT ON LIVING STOCKS


Freeing other fishing grounds
Impact on other fisheries
Changes in reef-generated income
Protection policy after placing of pillars
Lowered competition from trawlers
Better fishing conditions
A
Income high enough to pay for full fishing effort
B
Regular catch = regular income
Income from reefs does not pay for fishing effort
Dual activity
Traditional activity continuous
Traditional fishing ground maintenance
Stabilization of fishing grounds
Impact on employment
Longer gear life
Fishing type changes
Number of salaried workers changes
cash receipts improve
Fishery transformed in line with relative importance of fishing over reefs
Fewer overdrafts
Shorter or longer fishing times
Different techniques
Bait consumption changes
Gear used changed
Fishing techniques changed
Fixed fishing grounds
Maintenance costs change
Lower financial charges
New operating costs
Impact on fuel expenditure
Impact on maintenance costs
Impact on gear suppliers
Characteristic features of boats change
Longer or shorter fishing times
Impact on bait consumption
Higher or lower charges
Engine power changes
Size changes
More trips
Shorter trips
Higher or lower intermediate consumption
Indirect impact on value added
Impact on required level of training
Traditional skills less important
Fuel changes
Direct impact on added value
Impact on cost effectiveness
Degradation
Improvement
Investment charges
Greater fishing effort
Need to regulate access to fishing profession
Impact on employment
Higher income
Attraction for small-scale fisheries
Indirect impact on value added
Easier access to profession
Secondary impact on value added

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