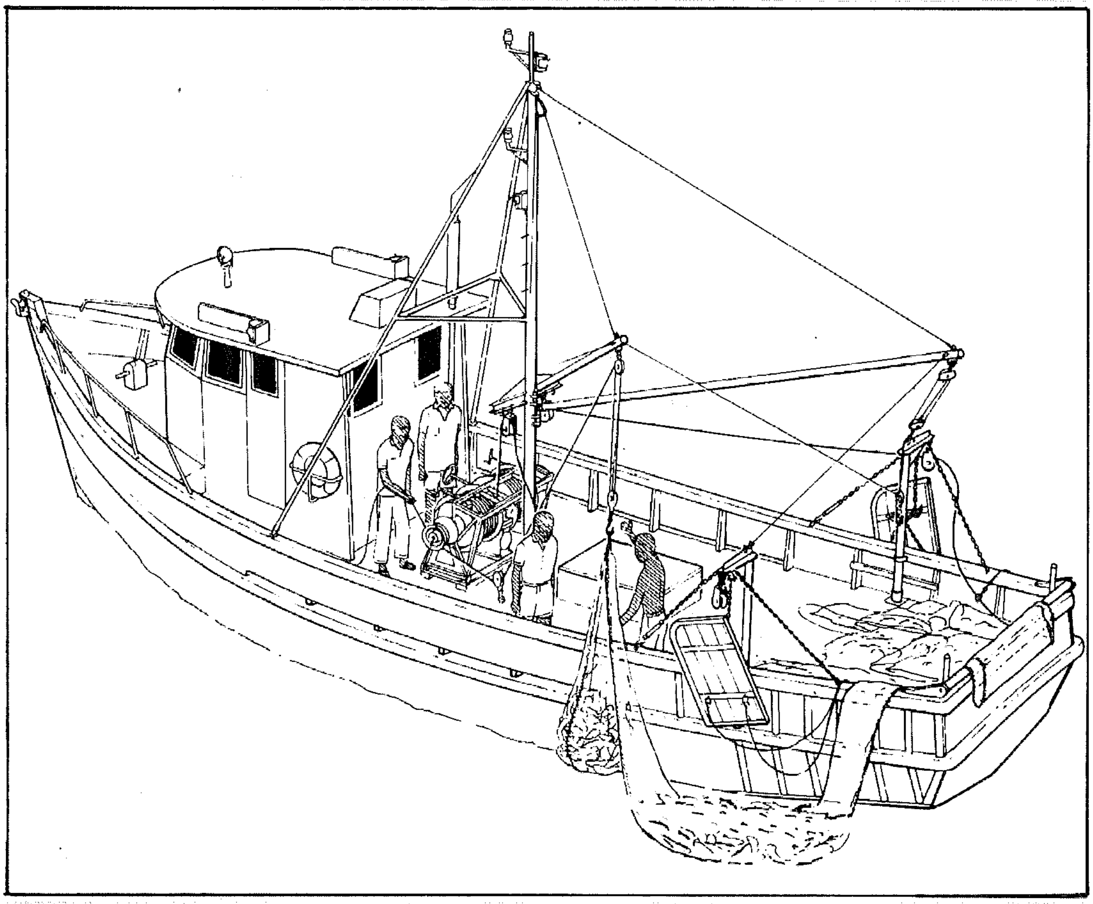
# Fishing boat designs: 3
# Small trawlers

FAO FISHERIES TECHNICAL PAPER 188



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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# Small trawlers

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FAO
FISHERIES
TECHNICAL
PAPER
188

FOOD
AND
AGRICULTURE
ORGANIZATION
OF THE
UNITED NATIONS
Rome, 1991

Reprinted 1984, 1991

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M-41
ISBN 92-5-100700-4

## PREPARATION OF THIS PAPER

The paper contains designs of a range of small trawlers suitable for operation in coastal waters, and was prepared to provide detailed technical information and guidance on the choice of appropriate vessels to fisheries officers, vessel owners and boatbuilders in member countries.

Acknowledgement is made to individual naval architects for the designs shown, to Robin Perry for the perspective illustrations and Adriana Barcali for draughting and layout.

Distribution:

FAO Fisheries Department
FAO Regional Fishery Officers
FAO Fisheries Field Projects
Selected Boatbuilders and Naval Architects

For bibliographic purposes this document should be cited as follows:

Fyson, J.F., Fishing boat designs: 3. Small trawlers. FAO Fish.Tech.Pap., (188):51 p.

## ABSTRACT

This, the third of the FAO fishing boat design handbooks deals with the subject of small trawlers. The publication is intended to serve the fisheries planner, who is often directly concerned in the choice and introduction of an appropriate fishing vessel type, the vessel operator/owner who requires guidance on the type of vessel suitable for his own local conditions and finally for the boatyard manager or boatbuilder who has to build the chosen vessel.

Sections 2-3 discuss suitable conditions for the introduction of a trawl fishery and what influences the choice of a particular trawler.

Sections 4-5 contain technical information for the planning of the vessel and its equipment while sections 6-7 outline methods of costing and evaluation of different vessels.

A range of perspective and constructive drawings are included to assist in the choice of suitable trawlers.

# FISHING BOAT DESIGNS: 3

## SMALL TRAWLERS

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# 1. INTRODUCTION

This, the third of the FAO fishing boat design handbooks, deals with the subject of small trawlers. Unlike its predecessors, which were concerned exclusively with the technical questions relating to design and especially construction of small wooden fishing boats for the small boat builder, this publication is intended for three separate individuals - the fisheries planner, who is often directly concerned in the choice and introduction of an appropriate fishing vessel type, the vessel operator/owner who requires guidance on the type of vessel suitable for his own local conditions and finally for the boat yard manager or boat builder who has to build the chosen vessel.

There are many publications describing exclusively, or in part, vessel and gear arrangements of "large" trawlers, but there is little published information dealing in book form with "small" trawlers. For the purposes of this publication the definition of a small trawler has been arbitrarily chosen as a size of vessel suitable for trips of up to seven days with a maximum operating range of around 200 nautical miles and a total fish hold capacity of up to 20 $m^3$. This in practice limits us to a maximum length of around 16 m (55 ft).

The first part of the book discusses suitable conditions for the introduction of a trawl fishery, and what influences the choice of a particular trawler type, its size and deck arrangement.

The perspective illustrations of Figs. 1 to 9 are included to assist fisheries planners and vessel operators (who may not be familiar with naval architectural conventions in drawing) to appreciate the advantages and disadvantages of the various vessel layouts proposed.

Sections 5 and 6 contain more technical information for the planning of construction of the vessels concerned, while Sections 7 and 8 outline methods for costing and evaluating the vessels chosen.

The design drawings provided in Figs. 10 to 19 show the general arrangements of the vessels, together with certain construction details of rigging and deck equipment (not usually illustrated in outline design drawings).

These drawings are intended as a basis for preliminary planning and costing.

Boat yards, fisheries services or independent vessel operators intending to build to these designs should write to the Fisheries Technology Service, Fishery Industries Division. Fisheries Department, FAO, Rome, for a set of plans and construction details.

All vessels illustrated are designs prepared by FAO naval architects and have been built and operated in the developing countries. Some variations in rig have been included to meet the design criteria set for the book as a whole.

The designs chosen are intended for local construction and as such are planned for ease of building and show the use of deck equipment and rigging, which can either be locally constructed from the detail drawings provided or if imported can be fitted, maintained and repaired by local workshops. Because of this requirement of simplicity, low cost and ease of local maintenance (necessary in areas without well equipped workshops or shipyards), layouts which by their nature require more sophisticated equipment such as split hydraulic winches, hydraulic crane arms for power blocks, etc., are not included. All the deck equipment shown can be mechanically driven from the main engine if required, although this does not preclude the use of hydraulic equipment where workshop facilities are available to service them.

## 2. WHAT IS A TRAWLER?

A trawler as a specific boat type is equipped to tow a wide mouthed net through the water in such a way as to herd any fish it encounters into the path of the main bag of netting and thence into the collecting area known as the cod end.

The wings of the trawl which carry out the herding function mentioned above are held open in one of three ways:

(1) by a horizontal beam;

(2) by means of rectangular boards which are rigged to be towed through the water at an angle, the sideways force so produced opening the mouth of the trawl and holding it open as it moves through the water;

(3) by two boat trawling in which each boat tows one wing of the net mouth and the separation of the boats holds the net open.

Because of this special net towing function trawlers have different design requirements from those boats engaged in the handling of static fishing gear, such as traps or lines, or again those boats which must encircle a school of fast moving pelagic fish as a primary function of the fishing operation.

Towing a net through the water or over the bottom requires an engine horsepower chosen to provide enough thrust to overcome the resistance of the trawl and its gear and to propel the boat at the desired trawling speed (which depends on the species to be caught). The final determination of hp is the responsibility of the designer; however, in order to arrive at a decision on vessel size and a preliminary assessment of economic feasibility, an approximation of the probable hp requirement is needed and the subject is further discussed in Sections 5 and 7.

In addition to increased hp requirements for towing, the position from which the net is towed, the method of hauling the net and the handling of the cod end with its catch, dictate the deck layout and the mechanical equipment needed. The reasons for the various arrangements chosen for the small trawlers, illustrated in this publication, are described in Section 4.

## 3. FACTORS INFLUENCING THE CHOICE OF A SUITABLE SMALL TRAWLER

Fishing boats represent one of the largest investments in any fishing industry, and his boat is usually the most important financial outlay for the individual fisherman; hence the importance of basing the choice of a suitable fishing boat for introduction into a developing fishery on the widest possible range of information available. Fishermen have the reputation of being extremely conservative in the acceptance of new vessels, and this is not surprising when it is considered that the average fisherman has insufficient resources to permit experiment so that investment in an unsuitable boat can mean financial disaster.

In this section we will look at the various types of information needed by the fishery planner, potential private investor or vessel operator in order to arrive at correct decisions as to vessel size, engine power and fishing arrangement.

Successful interpretation of this information in technical and economic terms is discussed in later sections.

### 3.1 Extent and Composition of Trawlable Resources

As any choice of a fishing vessel depends on the quantity and selling price of the fish caught all decision making information gathered should begin with a study of the resource. Small bottom trawlers using the various types of high opening bottom trawl, referred to in Section 5, will be able to concentrate their catch effort on any one, or a combination, of three categories of fish.

(1) Shrimp and the smaller species of bottom fish.

(2) Bottom fish of the medium and larger species.

(3) Pelagic fish schooling relatively close to the bottom.

Information on species in these three categories will be needed to build up a sufficiently accurate picture of the potential resource.

If commercial trawlers of similar size and hp have already been operating in the area, it should not be difficult to obtain from landing statistics, an indication of catch composition and size, seasonal variations in availability, etc. If small trawlers are not already operating then government fisheries services, or one of the aid organizations, may have operated experimental fishing or research projects, whose reports can provide sample data on available species, seasonal variations in abundance, suitable trawl grounds and fishing conditions. Discussions with captains and crews of vessels operating in the area (both fishing vessels and other commercial work boats - tugs, underwater salvage operators, etc.) may provide information on areas with trawlable possibilities, while a study of hydrographic data, nautical charts and pilotage handbooks will assist in identifying continental shelf areas with depths and bottom conditions favourable to trawling operations.

### 3.2 Operational Information

After resource information and an estimation of likely catch rates, operational conditions in the fishing area will be the third major factor to consider in making decisions on vessel size and design. Vessel operations will be affected by geographical and climatic considerations, infrastructure available to support the fishing operation, social conditions in the fishing community, available fishing experience and supporting skills, legal and regulatory requirements, which may affect the vessels and their crewing.

#### 3.2.1 Geographical and Climatic Considerations

Related to the position of suitable trawl grounds on the continental shelf will be an examination of what harbour facilities or sheltered anchorages are available, and suitable, as operational bases for small trawlers. Plans for construction of harbours in the area should also be taken into account. Distance from such bases to the trawl grounds will decide the radius of operation of the vessels with considerable bearing on vessel size, due to the need for greater fuel capacity for increased steaming time, more accommodation for crew, rest on longer trips, etc. Depth of water on the fishing grounds, in harbours or anchorages, or over bars which must be crossed to gain shelter, may result in draft limitations which will restrict the depth of hull and propeller diameter, with consequent limitations on engine hp and towing performance, thus influencing the size of vessel which can be operated.

Weather conditions will also influence decisions on vessel size and operation. Frequent rough weather may require a daily operation, or a larger vessel, capable of staying at sea and continuing to fish in the more adverse conditions likely to be met.

The nature of the sea bottom and the depth of water will influence the weight and complexity of gear necessary for the operation. Rough bottom conditions for example will require heavier and more bulky gear, with the greater weight calling for either larger crews or stronger and/or more sophisticated handling arrangements. Increased depth means longer warps and larger winches to handle the amount of wire required.

Tides and currents in the fishing area may require more horsepower for towing, with increases in depth of hull, engine room size and fuel capacity.

3.2.2 Supporting Infrastructure

In addition to sheltered harbours and anchorages, fishing vessel operations require facilities to land, sell and distribute the catch. A decision on operational bases must therefore take into account berthing space available for discharge. Can the vessels land easily on to a quay which is of a suitable height to permit the operation? Will tidal range restrict the unloading to set times daily? If there are no berths available, or available berths are likely to be taken up by larger commercial vessels without notice, can fish be landed by smaller boats directly on the beach, and how will this affect the cost of the operation?

When landed, how will the fish be sold, and is there a transport and distribution chain that can absorb increased catches?

Harbour dues in larger ports dealing principally with deep sea commercial cargo vessels may well be such that it is uneconomic for a small vessel to use them.

Answers to all these questions must be found before a decision on operational bases and hence radius of operations can be made.

3.2.3 Social Conditions in the Fishing Community

Planning a vessel, estimating its likely radius of operation and then the probable number of days at sea may well run counter to established social practices in the fishing community in a developing country. Reluctance to leave family alone over night, or the influence of a well established subsistence fishery may well affect the time that can be spent at sea and extended trips may not be possible in the short term. Also to be considered is the fisherman who has an agricultural as well as a traditional seasonal fishery activity. Even when the introduction of a new trawl fishery will permit him to fish year round the fisherman is unlikely, at least in the initial years, to abandon his agricultural interest and this may well affect vessel operations to the point where a larger vessel may prove uneconomic. See Section 7 for further details of the importance of correctly calculating the available sea time.

Allied to these considerations are the present skills of the community. Fishermen's experience in trawl fishing and/or the instructional facilities available to train fishermen in new methods, mechanical ability and the necessary trained personnel to keep machinery in operation, will affect the introduction, or expansion, of a trawl fishery. Where fishing and mechanical skills are not readily available, choice of vessel size and type should be based on the simplest hull and mechanical arrangement that can carry out the planned operation. In such cases, possible increases in potential catch by means of greater mechanization and vessel complexity, should be viewed with caution unless training facilities can be made available and there is a pool of labour receptive to such training.

3.2.4 Legal and Regulatory Requirements

Laws concerning the design, construction and operation of different classes of vessels are enforced in most countries. The laws are intended to ensure that vessels are seaworthy and that lives and health of crew are safeguarded and, in the event of accident, breakdown or loss at sea, safety measures are available for the protection and rescue of the crew. Where either local or international regulations are applicable to fishing vessels of the sizes we are considering, they may well have a bearing on the space needed for functional operation of a trawler and hence on the vessel size chosen.

Laws to protect the environment may influence the discharge of fish and waste products, while international conventions and/or national legislation may well affect fishing areas and their exploitation by the vessels.

### 3.3 Construction Materials, Building Facilities and Costs

In the choice of a suitable material for the construction of the hull, deck, superstructure and deck houses of fishing vessels, five materials can be considered as currently in use - wood, steel, fibre-reinforced plastic (FRP), ferro-cement and aluminium. No single material can be said to offer definite advantages over the others in all size ranges and each material has its advantages and disadvantages which should be considered.

One of the primary considerations in choosing a construction material is the question of comparative costs, and a method for estimating construction costs is given in Section 6.

Another factor which should be taken into account is maintenance costs for the various materials. Considerable savings in operational maintenance costs can be expected with fibreglass, ferro-cement and aluminium when compared to either steel or wood. However, increased first cost and need for additional investment capital may reduce or cancel out these advantages (see Section 7).

Comparative costs apart, probably the most important factor in the choice of a construction material, is local availability of the raw material and experience and facilities for its use in the construction of vessels. Where one particular material can combine local availability, manpower skilled in its use, established shipyards which are accustomed to building in the material, and the cost of construction is competitive (or nearly so) with the cheapest alternative, then this material should be chosen, unless a deliberate decision has been made to experiment with alternatives. In the latter case, if a new material is involved, it should be accepted that prototype construction is likely to prove considerably more expensive than vessels built in an established yard, and some time and experiment will probably be necessary to gain acceptance by the local fishermen.

### 3.4 Economic Considerations

As a first step to evaluating the effect of the introduction of new trawlers into a national fishery and the likely economic returns for a particular trawler, preliminary investigations should be made as to what effect an increase in landings is likely to have on ex-vessel prices, whether there is an unsatisfied demand for fish and fish products and to what extent the available marketing and distribution chains can absorb an increase in supply, what is the availability of investment capital from various sources for the construction of new vessels and what are the likely interest rates for such capital.

Given a satisfactory answer to these questions there is then a need, in the early stages of planning to estimate whether a particular trawler is likely to be economically viable.

What is required is a simple system of evaluation, which will provide sufficiently accurate results to be used as a guide in preliminary planning.

The most common method of quickly determining whether an investment is likely to be profitable is to calculate the average <u>net</u> profit as a percentage of the investment cost.

Where the most important consideration is the ex-vessel price of fish, where the major part of the catch is composed of one or more equally priced species and, provided there is no significant difference in ex-vessel prices between different vessel sizes, the average cost per ton of fish caught can be used.

In both of these cases a calculation of investment cost, annual revenue and total annual operating outlays must be made.

3.4.1 Investment Cost

Investment costs for a particular size of trawler under investigation can be obtained either from prevailing market prices for equivalent vessels and gear, or on the basis of a cost estimate, as described in Section 6.

3.4.2 Annual Revenues

These will depend on the composition of species, catch volume and ex-vessel prices for each species.

A major problem for investor and planner in the fishing industry is the future catch rate. This is a result of many factors, including the biological and physical conditions in which the stocks of fish live, the stage of development of the fishery, the management measures in operation, the skill of the vessel crews and the operational efficiency of boats and gear.

In the intermediate stages of development of an established fishery it is reasonable to assume that catch rates will follow those of the recent past, but it is important to take into account the effect on the probable rate of additional vessels entering the fishery.

Estimating catch rates in a previously unexploited fishery is particularly difficult. If some exploratory fishing has been carried out and some assessment of total stocks and sustainable yield made, these will provide a guide to likely future catch rates, although it should be taken into account that, in the early developmental stages of a fishery, catch rates are higher than in the later fully exploited stage. Initial catch rates often mean that the first vessels can recover their investment in a few years of fishing and this tends in an open fishery to attract large numbers of new vessels, with the result that the fully exploited stage is reached in a short time. Average returns per vessel are reduced by declining catch rates with total catch being shared among a larger number of vessels.

As an approximate rule of thumb, 50% of initial catch rates obtained in a previously unexploited fishery could be taken as a figure for calculation of rates in a fishery being fished to its maximum sustainable yield.

Where no figures are available on which to base an estimate, an approximation of 50–100 g/h of demersal fish for vessels of 60–90 hp and 120–180 g/h for vessels of 100–150 hp could be used on grounds which have not been overfished, could be used.

As catch rates are also a function of towing power and therefore of hp installed, variations in installed power will influence the rate. This is further discussed in Sections 5.3 and 7.

Catch volume is a function of catch rate and fishing intensity. The latter is calculated by the number of trawling hours per day, multiplied by the total number of fishing days. The total number of trawling hours per fishing day depends on whether trawling is to continue day and night and this is related to fish behaviour and the prevailing practices of local crews of fishing boats. Fish schooling near the bottom may scatter and come up to the surface at night, for example, thus reducing the catch rate to below that at which it is economic to fish. In addition, on smaller vessels crew may not be prepared to operate 24 hours, preferring to anchor for rest periods. Length of tow usually varies from 1 to 2 hours, according to the quantity of fish caught and allowance must then be made for the time required to haul and shoot the gear (see Sections 5.3 and 5.4). An allowance for defective tows and minor breakdowns should also be made and this can vary from 5 to 25% of the total, according to crew experience. The number of days at sea are then calculated, steaming time to the fishing grounds is deducted and the result multiplied by the trawling hours per day to obtain the expected catch volume.

The number of days at sea are frequently overestimated. Theoretically possible sea times of 250 to 300 days are sometimes quoted and used in feasibility studies. When holidays, port turn-around time, maintenance periods and allowances for breakdowns and bad weather are made, a far more realistic total will be a maximum of 200 days per year. Where a choice between a larger or a smaller boat rests solely on the earnings due to an amount of sea time in excess of 200 days, one would be well advised to choose the smaller boat, as additional non-productive time will be much less expensive with smaller annual capital repayment and interest costs.

### 3.4.3 Total Annual Costs

An estimate of total annual costs can be conveniently divided into two sections:

Annual Fixed Costs and Variable Costs

(1) Annual Fixed Costs include:

(a) Depreciation
(b) Insurance
(c) Fleet Management
(d) Vessel Maintenance and Repair (fixed component)
(e) Crew Share (fixed salary component)

(2) Variable Costs are made up of:

(f) Fuel
(g) Lubricants
(h) Catch Preservation Expenditures
(i) Vessel Repair (variable component)
(j) Gear Repair
(k) Miscellaneous (minor replacement items, freight charges for spares, equipment, etc.)

Estimates of costs under each individual heading, sufficiently accurate for preliminary costings for the purpose of choice of vessel, can be obtained as follows:

(a) Depreciation: estimated at 10 per cent of total investment cost of vessel plus gear. This assumes that the economic life time of the vessel is ten years. Any residual value at the end of this period must be allowed for in the calculations.

(b) Insurance: rates can vary widely according to whether there is an established rate for marine risks of this type and local quotations should be obtained if possible. In an area where this type of insurance is readily available 5 per cent of vessel cost can be assumed a reasonable figure.

(c) Fleet Management: appropriate where from four to five vessels up to a large fleet are to be managed by one group, this item is difficult to generalize and should be estimated on the basis of salaries paid at the upper level of the skill demanded for this most important function. The item should include the salary of an experienced engineer/skipper with the administrative capability needed to keep vessels operating, plus mechanics, parts storekeeper and office staff on a scale according to the number of vessels and the complexity of the operation. Where no data are available 10 per cent of vessel cost could be used as an annual operating figure with a minimum of ten vessels in the fleet - costs being correspondingly higher for a smaller and lower for a larger fleet.

(d) Vessel Maintenance and Repair: the fixed component of vessel maintenance refers to regularly recurring maintenance and repair costs, e.g., periodic slipping of vessel for hull cleaning and painting, regular engine overhaul at fixed periods, classification costs for larger vessels, etc. If figures are not available from similar operations

5 - 6 per cent of vessel cost could be used. Here again exceptional local costs such as high slippage fees due to restricted availability of suitable equipment, or the need to travel considerable distances for such facilities, should be taken into account, as should the need for major engine overhauls.

(e) Crew Share: the fixed component of crew share, i.e. direct salary payments, should be established according to local practice. It is strongly recommended that some form of incentive bonus should be paid as an addition to a fixed salary component, and this can be calculated as an addition to the price per ton of fish caught. Local practice should be followed where possible; alternatively incentive payments in other countries could be studied and a bonus system appropriate to local conditions established.

(f) Fuel: fuel consumption per trip must be estimated on the basis of the hp of the main engine, the trip time which is itself dependent on the chosen operation radius and the division into steaming, fishing and rest periods. Local fuel prices in combination with fuel consumption (which can be calculated as 180 g/hp/hour) and number of trips or operational days/year will provide an estimate of cost.

(g) Lubrication: operational data from other vessels will give an accurate figure. If not available 10 per cent of fuel costs will provide an approximate figure for estimating.

(h) Catch Preservation: in small vessels of the type discussed here operating in a short-range coastal fishery in tropical or semi-tropical waters the most common method will be cooling with ice in an insulated hold. Section 5.2 gives further details, but as an approximation an ice to fish ratio of 1:2 can be used.

(i) Vessel Repair: variable components of vessel repair due to mechanical failure etc. are difficult to estimate but a competent fleet manager backed by an engineering section should keep this item to within reasonable limits. Complexity of electronics and mechanical installations has a considerable bearing on the final figure. In the case of the smaller vessels we are considering, without sophisticated electronics, the figure could average around 6 per cent of initial vessel cost.

(j) Gear Repair: annual repair and replacement of gear can be estimated as 33 1/3% of value of gear carried.

(k) Miscellaneous Costs: these will include minor replacement items, shipping costs for spare parts and equipment and can include crew food if this is not estimated separately. Management costs and overheads are sometimes included in this total if detailed costs of item (c) are not available. In this case a figure of 10% of total costs can be used, plus daily expenditure on crew food if included at this point.

With the above calculations completed the net profit is found by subtracting annual operating costs plus depreciation from the annual revenue; this is then expressed as a percentage of investment cost and is a measure of the profits expected to result from a new investment. Care should be taken when comparing the percentage profit figure arrived at in this way with the cost of borrowing the necessary capital to finance the project, as this method does not take into account the value of money and its earning capacity over a period of time. The subject will be discussed in more detail when comparing earning capacities of different technical alternatives in Section 7.

## 4. THE FISHING OPERATION AND ITS EFFECT ON VESSEL SIZE AND ARRANGEMENT

The designs illustrated in this series are chosen to show a range of vessel choices according to the size of trawl gear and type of operation appropriate to different trawl fisheries.

Vessel size is restricted to small bottom trawlers intended for coastal fisheries and trawling method is limited to an investigation of possible stern trawling arrangements.

Side and beam trawling although applicable in certain circumstances are not covered in the designs shown.

One boat mid water trawling, in which large wide opening nets are towed in mid water at a pre-determined depth, to be successful usually requires larger vessels and more sophisticated fish finding net control and handling gear than that in the small coastal fishing trawlers illustrated. Smaller boats can be successfully used in mid water pair trawling and certain of the vessles shown here could be used for this method.

Consideration is also given to possible combination operations where the appropriate catching method varies due to a seasonal or diurnal change in fishing conditions.

Deck arrangements can, where appropriate, be transferred from one hull size to another where catch rate, weather conditions or range of operations dictate a smaller or larger vessel. The Fisheries Technology Service will be pleased to provide advice on suitable modifications on request.

### 4.1 Hand Hauled Stern Trawls

Hand hauling of small otter trawls of 9-12 m (30-40 ft) headline length with a net opening of 7.5-9 m (25-30 ft) can be a profitable low cost operation, and the small boat illustrated in drawings numbers 1 and 10 is designed to tow a net similar to that illustrated in the FAO Catalogue of Small-Scale Fishing Gear, page 70.

Both shrimp and bottom fish can be caught with an engine of 15-25 hp. The arrangement shown is based on two stout towing bitts sited 1 m from the stern to permit sufficient manoeuvrability while towing, with a raised after-deck section used for net stowage. Trawl boards of 1100 mm x 610 mm (3 ft 6 in x 2 ft) are light enough to be lifted aboard by hand and trawl warp stowage is provided in removable boxes aft of the fixed thwart. Space is allowed for an insulated fish/ice box forward of the engine and boxes for stowing are stacked on the port side opposite the hauling position when handling the cod end. The lower right hand illustration in drawing number 1 shows the addition of a simple sprit sail rig principally for fuel conservation while sailing to and from the fishing ground, and as an auxiliary to the engine when wind conditions are favourable for combined sail/motor trawling. Simple bent pipe demountable davits are shown as an alternative means of handling the trawl boards.

### 4.2 Small Pair Trawlers

A similar size of boat to that shown in drawing number 1 has been successfully used for pair trawling in inland waters in Africa. In the arrangement shown in drawing number 2 the raised after-deck is extended to stow the larger net, cleats are provided fore and aft to facilitate handling of the trawl and warps during transfer, while manoevrability is obtained by towing from a central towing bitt sited forward of the central thwart. An optional headline between the boats is designed to maintain the correct net opening, although this is frequently dispensed with by experienced crews. A short mast and boom are shown in this arrangement from which the cod end can be handled if catches are large enough to warrant this modification. Alternatively, the auxiliary sail arrangement of drawing number 1 can be used for increased fuel economy.

## 4.3 Shallow Water Mechanized Trawl

Trawler deck arrangements are, to any experienced skipper, very much a matter of personal preference, conditioned by his own operational experience.

The following arrangements are chosen to illustrate a range of possible layouts designed to fit most trawl conditions which are likely to be required by simple coastal fishing vessels. As has already been mentioned in the Introduction, the arrangements chosen have a priority requirement of simplicity, low cost and ease of maintenance in order that they be suitable for adoption by developing fisheries where well equipped workshop facilities and experience of fitting and maintaining sophisticated equipment may not be available.

The design shown in drawings numbers 3 and 11 illustrates an arrangement in which the warps are lead directly from the winch to overhead blocks on the mast and from there to davit blocks on the quarters. The advantage of this arrangement is in the overhead run of trawl warp which is thus kept clear of the working deck. The method is most suitable to trawling in comparatively shallow waters, as, due to the necessarily short distance from the overhead block to the winch drums, the latter must be kept relatively narrow to permit adequate spooling and the quantity of warp which can be stored on each drum is therefore limited (assuming mechanical spooling as a pre-condition dictated by the low cost and simplicity requirement of the design). Other features of the design include a stern roller with guide rollers which can be shifted to control the hauling width on the stern roller and a davit arrangement chosen for simplicity and low cost (details of suitable sizes for the various shaft horsepowers for trawling are listed in drawing number 18). The towing position in relation to the rudder is important in order to assure adequate manoeuvrability when turning while towing. For this size of vessel, the davit position is fixed at 1 m forward of the rudder post.

An other arrangement using the same principle is shown in drawings numbers 5 and 15, where the mast is sited aft of the fish hold hatch and the warps are led from the mast to fixed gallows or, as in the arrangement shown, the gallows can be pivoted to swing inboard to clear the vessel sides in port. The advantage of this method is in the extra length of warp between winch and first block which makes mechanical spooling of the warps easier and allows a wider barrel winch and greater warp capacity. This arrangement is found in many southern Mediterranean trawlers, frequently in combination with an aft engine room which, while taking up valuable space on the working deck, is an acceptable solution where the catches per haul are not large and the space requirements for handling the trawl and its cod end are not so critical.

## 4.4 Alternative Warp Lead Arrangements

The simplest solution to the problem of winch location and warp leads on deck is to site the winch well forward and lead the warps directly to pipe gallows on the quarters. This solution requires a minimum of 4-5 metres between winch and gallows and a linked spooling arrangement to allow the warps to be distributed evenly on the drums. While at first sight the angle of lead of warp from winch barrel to davit would appear to make spooling difficult, a linked arrangement, such as that shown in drawing number 4, will permit the pull of the starboard warp to be balanced by the counter pull of its partner to port (or vice versa) permitting the warps to be hand or mechanically spooled without excessive force being required.

In smaller vessels, in order to raise the warps to permit passage along the working deck, a winch with deep barrels sited on a raised foundation can be used to bring the warp up to a sufficient height to allow crew to duck under the warp where it crosses the working deck.

Other possible warp arrangements are given in drawing number 5. The upper method has been discussed on the previous page, while the lower illustration shows a fairly frequently used method on older trawlers which does not find much favour with FAO fishing technologists, due to the reduction of working deck space caused by the running of warps across the deck and the siting of the blocks necessary for correct lead of the warps. Another disadvantage is the lead of warps across the fish hold reducing the free space available for loading the catch from one tow into the hold after sorting and while a second tow is in progress. The warps in position below knee height are also liable to trip up crew members moving around the working deck, particularly if motion is irregular due to wave action.

## 4.5 Arrangements for the Handling of Heavier Catches

Where catch rates are high or large amounts of mud and rubbish are caught in the net and weights are considerable, lifting by means of a single mast and boom can be a time-consuming process. In these cases there is an advantage in a permanent lifting structure (or gantry) on the after deck. One fairly simple example of this type is shown in drawings numbers 6 and 12. Towing davits are built into the gantry structure and in the example shown they are pivotable to allow inboard stowage, which avoids risk of fouling other boats' hulls or gear when several boats are rafted up together in port. Three strong lifting points should be arranged with the possibility of direct leads to the warping heads of the winch. The height of the lifting point should be sufficient to allow a good proportion, if not all, of the bag to be lifted over the rail in one pull. Any strengthening cross members should be sufficiently high up or far enough forward to allow the bag to be swung well inboard to deposit the catch on deck.

## 4.6 Double Rig Trawling

This trawling arrangement is used where the species to be caught do not rise far from the bottom as the catch effectiveness depends on the width of the area covered. The widest possible spread of the net is therefore more important than the height of the head rope. The towing resistance of the net and hence the hp required depends, to a large part, on the total quantity of mesh in the trawl. Therefore the same power used to tow one large net can be used for two small trawls with less vertical opening and approximately one third more spread. Alternatively, the same spread of net can be achieved with two trawls which are considerably smaller and hence have less towing resistance.

The most widespread use of this method is in vessels designed to catch shrimps as a major part of the catch, as shrimps do not rise far from the bottom.

The vessel layout shown in drawings numbers 8 and 14 illustrate the method with two otter-board trawls being towed from the outrigger booms which are used to maintain separation of the trawls, as shown in the smaller illustration in the upper right hand corner of drawing number 8. The warps are led from a two-drum winch (with the barrel axes parallel to the longitudinal axis of the vessel) to towing blocks at the boom ends and so to the bridle attached to the otter-boards. Hauling the small trawls is relatively simple. As can be seen in drawing number 8 the otter-boards are hauled up to the outrigger booms and the cod end brought aboard by means of an inhaul with the rest of the net remaining in the water. A small try net, which can be easily hauled, is used to check on the presence of shrimps in the area swept and this is towed from the transom, as shown in the upper illustration in drawing number 8.

The booms used in the standard double rig shrimp trawler are heavy and require extensive staying. Smaller boats can use the simpler rig, shown in drawings numbers 7 and 13, which is suitable both for double rig trawling where the catch is to be primarily shrimps and a single higher opening trawl where the catch is to be principally for fish not staying so close to the bottom. In this case the outrigger booms are pivoted on a strong fitting at bulwark height (which means shorter and lighter booms can be used) and the warps lead from a conventional athwartships trawl winch to the single rig towing davits aft, and from there to the end of the outrigger boom. A safety device is incorporated, in that the towing block is held at the boom end by an outhaul through a revolving boom end fitting. Should one of the nets become caught on the bottom with the risk of a large loading on the end of one outrigger boom and possible capsize of the vessel, the outhaul will break and the load will be taken at a lower point on the towing davit.

With the outriggers stowed upright in the boom rests a normal high opening bottom trawl can be used for fish, with the warps led through the trawl davits in the normal way.

This arrangement will permit the use of both methods in one trip and where appropriate double rig trawling could be used for shrimps at night and a single rig trawl for bottom fish in the daytime.

4.7 Combination Trawler/Purse Seiners

Due to seasonal variations in species distribution, vessels which spend part of their time trawling for bottom fish may practise other methods for a part of the fishing year. While some fishing methods can be used on almost any trawler without major modifications the most common combination requiring a specific deck arrangement is that of a trawler/purse seiner.

As purse seiners frequently achieve larger catch volumes than an equivalent sized small trawler this must be taken into account in the planning of hull volume and fish hold capacity. This is further discussed in Section 5.

In changing from one method to another the following considerations are important:

(1) Is it possible to carry the subsidiary gear on board without affecting the principal fishing method ?

(2) Can the fishing gear and fittings previously in use be easily removed from the deck areas required by the replacement gear, and is the presence of any remaining gear unimportant, or a relatively minor inconvenience ?

(3) Are fittings required by replacement gear already in position, or can principal gear fittings be used even if at reduced efficiency ?

(4) Can the fish hold accept the fish to be caught by the subsidiary method ?

If the answer to all those questions is yes then the vessel should be able to operate efficiently as a combination vessel.

Deck arrangements for combination vessels of this type are shown in drawings numbers 9, 15 and 16.

The arrangement in drawings 9 and 16 shows a typical layout using a combination trawl/purse seine winch with drums parallel to the longitudinal axis of the vessel. On small vessels the distance from the drum to the warp lead blocks on the rail is, of necessity, small and if simple spooling arrangements such as that shown in drawing number 9 are used the drums need to be narrow to enable the warps to be correctly guided on. Consequently, such an arrangement is used for trawling in relatively shallow water where warp lengths are not long. This arrangement has the advantage that the working deck is completely free, so that bringing aboard the cod end and discharging and sorting the fish for transfer into the hold, are not impeded by warps on lead blocks.

For purse seining from the starboard side, the starboard warp lead block on the bulwark and the trawl gallows are removed and a retractable purse davit set in place in line with the winch. This arrangement is the simplest system for purse seining for a combination vessel of this type, and if purse seining is the most important method, with trawling as secondary, this is the arrangement to be adopted.

A boom for a power block for hauling the purse seine net is shown and an optional smaller boom for brailing of the catch or lifting the cod end aboard, if this is to be done over the side.

The alternative arrangement in drawing number 15 shows a conventional athwartships trawl winch with trawl warp leads to an aft mast and thence to the trawl gallows. Depending on the size of vessel the warp leads from the winch to the first lead block are longer, the winch drums can be wider and more warp can be accommodated for deeper trawling. The aft mast and boom allow the cod end to be lifted either over the stern or the side and deck space is adequate for handling the fish from either position.

For purse seining the drawing shows the use of a rope purse line from the winch warping heads to snatch blocks aft of the wheel house and thence to the purse davit. Alternatively a wire purse line can be used and the warps led from the bottom of the winch drums to repositioned snatch blocks in line with the drums and thence to the purse davit. In this latter case a winch should be chosen in which the brakes and winch controls can be operated from either side.

Note that in this case the wheel house and fish hold hatch are sited off centre in order to leave a larger clear working deck space for handling the purse seine. A power block can be hung from the aft mast for hauling and stacking the net if so desired. The mast is supported by pipe stays from the port side only. This is done in order to leave the starboard side free for purse seine operations and is an acceptable solution because the load on the boom will come from the starboard side, and the pipe stays will be in tension when the mast is loaded. For trawling additional support is added by way of pipe stays from the trawl davit to the mast.

The arrangements shown on these two small trawler/purse seiners can be modified to suit the hulls of the larger vessels, provided fish hold volumes and weight distributions are appropriate to the designs. For further information and advice contact the Fisheries Technology Service.

## 5. GENERAL VESSEL REQUIREMENTS

It is not the intention to provide in this section all the information necessary to design a trawler as this is more correctly the province of the designer but rather to show how the use of graphical information will allow an approximation to be made of engine hp and fish hold capacity for a given size of vessel and indicate how these and other space requirements have been incorporated in the designs shown in drawings numbers 10 to 16. In these drawings will be found recommended hp ranges together with accommodation possibilities and deck layouts and an indication of the fish hold capacity. In drawings numbers 17 to 19 dimensions of mast, rigging and deck gear for various sizes of boat are given so that correct sizes of materials can be used for the loadings expected.

Before commencing a preliminary calculation of appropriate vessel size, it is helpful to consider just what a trawler is required to do in order to make a profit for its owners. Such a vessel has three main functions:

(1) to catch fish by the towing through the water of a trawl net of a size and design appropriate to the power installed in the vessel, the depth of water on the trawl grounds and the size or species distribution of fish expected to be caught;

(2) to transport the fish from the catching area to the port or anchorage where it is to be unloaded;

(3) to preserve the fish while on board and land it in good condition to fetch the highest possible market price.

In order to carry out these functions the deck area must be sufficient for the catching and handling equipment to be laid out for safe and easy operation of the gear and the bringing aboard of the fish, as discussed in Section 4. Not only must we allow sufficient area on deck but also provide a hull of sufficient volume to accommodate the fish hold, propulsion machinery and its fuel tankage, and cooking, eating and sleeping quarters for the crew. Space must also be found for the storage of fishing and other gear and food and water for the maximum length of fishing trip which is planned. The correct balancing of the various volumes and the weights to be put into them is a task for the designer but some idea of the volumes required and the ways they can be laid out in the design are necessary to proceed with a simple calculation of approximate vessel size.

There are six theoretical special arrangements of the main below-deck areas, fish hold, engine room and accommodation/gear stowage, but practical considerations of their relationship to suitable working deck arrangements and considerations of vessel trim under different loading conditions limit the choice to two or three possibilities in the range of small stern trawlers being considered here. The most usual arrangement, because free working deck space aft is a prime consideration, is with fish room aft, a central engine room and accommodation forward. Where the crew is small and/or daily operation makes accommodation below decks unnecessary, a central fish hold, engine forward and gear space aft can provide a satisfactory solution, provided engine and fuel weights forward can be compensated by aft fuel or ballast water tanks when the vessel is running light. Forward engine position is however limited by the need to mount the engine low enough in the hull to avoid excess space loss with a large shaft tunnel through the fish hold.

An aft engine room, central fish hold and forward accommodation would at first sight appear an ideal arrangement, with major weight changes during loading sited on or near the centre of buoyancy. In the small vessels under consideration, however, the need for a deck structure and access to the engine room from the after deck can be a serious handicap to the free working space needed. Practical considerations may dictate this solution in countries where installation, alignment and maintenance of long shaft runs to forward engines could create mechanical problems, particularly in wooden boats.

## 5.1 Choice of Vessel Size

In order to have some basic dimensions from which to begin an analysis of appropriate vessel size it is helpful to find some convenient relationship between vessel length, volume and carrying capacity. For the small trawlers which we are considering, a decision on minimum size of vessel to carry out a particular operation depends principally on engine HP and fish hold capacity. As the vessel dimension most familiar to the layman is length overall (LOA) it will be helpful to use this measure as a departure point. However, the best method of comparing the vessel sizes needed to contain differing fish hold capacities, accommodation and gear spaces and the hp needed to propel the hull through the water is by comparing volume measures.

A convenient measure for comparison purposes is the volume of a rectangular box defined by the length overall of the boat multiplied by the maximum beam and the depth (see Figure 1). This volume expressed in cubic metres is called the cubic number (which is abbreviated to CUNO). For purposes of comparison boats having the same CUNO will have approximately the same size.

Now, as small trawlers up to a length of about 18 m (60 ft) often have similar beam to depth relationships, it is possible as a first approximation to plot a series of LOAs of typical small trawlers and relate this to the cubic number, as shown in Figure 2. It should be emphasized that the approximate relationship shown is only relevant for small vessels with a cubic number less than 250 and is valid for vessels with a typical trawler hull in the low to medium power range. Vessels specially designed with wide beam, exceptionally deep draft, large load capacity and/or high installed HP will fall well outside the plot as will very narrow boats such as those adapted to trawling from traditional hulls designed or built for other types of fishing.

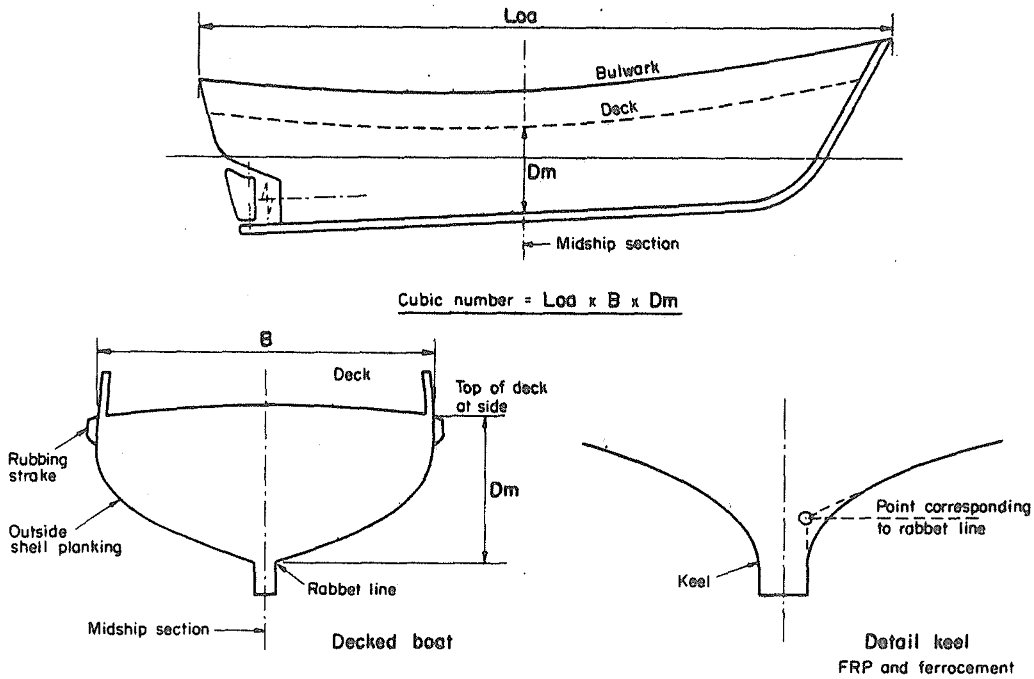


Fig. 1 DEFINITION OF CUBIC NUMBER

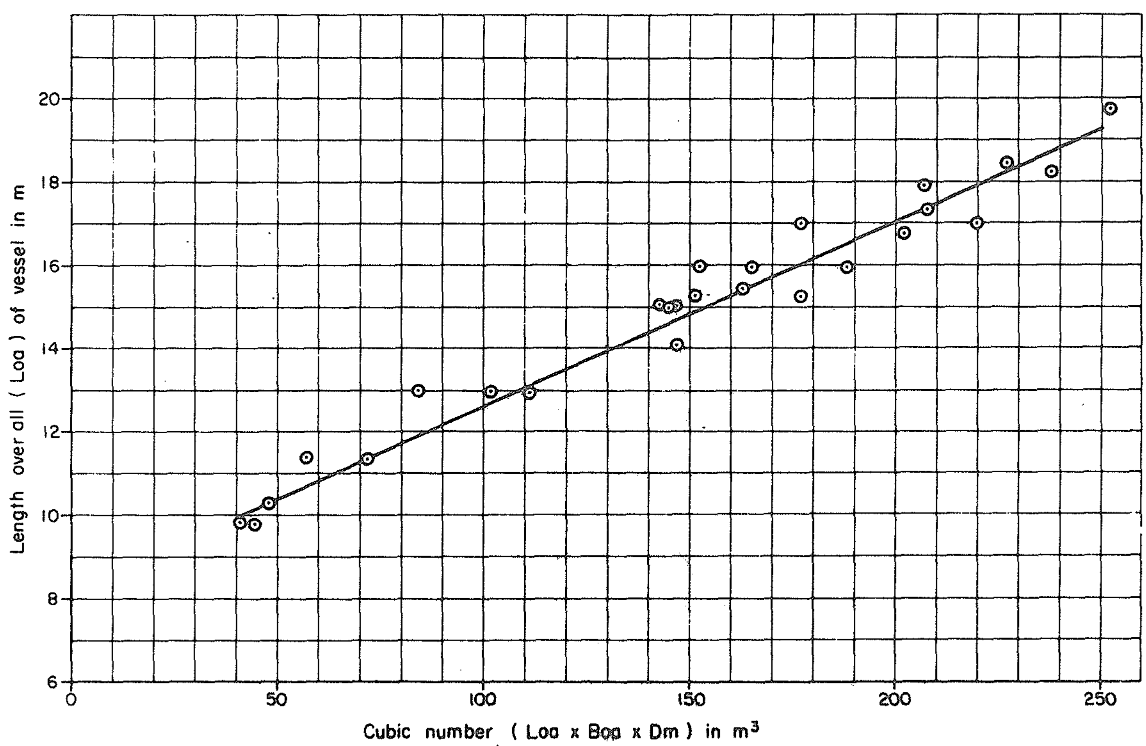


Fig. 2 COMPARISON OF LENGTH OVER ALL OF VESSEL (LOA) AND CUBIC NUMBER (CUNO) FOR SMALL TRAWLERS AND COMBINATION VESSELS

Figure 3 gives a relationship between CUNO and continuous shaft horsepower (i.e., the horsepower available at the output shaft coupling for continuous 24 hour operation) while Figure 4 relates CUNO to a likely fish hold capacity. In both these figures it can be seen that a range of plus or minus 10 percent of the median will cover a large number of the examples plotted (which have been chosen as average trawlers in the required size range).

Looking at Figure 3 will show several valves which are well above the average line. These illustrate a tendency in some countries to increase installed hp to a figure well above the real requirement for the vessel size in question. Given the recent rapid increase in fuel prices this is a tendency which should be resisted especially in countries without abundant fuel resources. The figures given by the use of the tables will be perfectly adequate to tow the nets shown in Fisheries Technical Paper No. 189 referred to on page 21.

With respect to the fish hold capacity, while the graph in Figure 4 gives an average figure for a likely capacity, it should be appreciated that the volume available for the fish hold is also dependent on the amount of crew accommodation required below decks, the operational range and hence the quantity of fuel to be carried, etc. Rather wider variations than given by the graph will be found in certain designs but for an average figure for an initial calculation Figure 4 is sufficient.

Let us now use these graphs to calculate the size of a hypothetical vessel.

We can consider two possible starting points. First, let us say that we require a vessel for an existing fishery and discussion with fishermen and owners has indicated that a suitable boat might be around 13 m (43 ft) in length. What then will be an appropriate shp for the main engine and what will be the probable capacity of the fish hold[1/] which we can accommodate?

From Figure 2 a line drawn parallel to the base line from the 13 m LOA value on the left hand side will intersect the graph line at a point we can call A. From this point a vertical line to meet the base scale will give us a figure for CUNO, in this case 108.

This value can be entered in the CUNO scale on the base lines of Figures 3 and 4, extended in the vertical direction to intersect the line of the graph and then in the horizontal direction to give (1) an shp figure of 104 from the left hand scale in the case of Figure 3, and (2) a fish hold capacity of 15 cubic metres in Figure 4.

In order to provide a range of values from which to choose, plus or minus 10 percent of the median can be taken and this range should include most requirements likely to be met in an estimation of the type we are attempting.

In the case of shp however there is an exception for the smallest vessels in the range, i.e., with CUNOs from 40-50 where values should be somewhat higher than shown in the straight line graph due to higher allowances needed for weather effects, etc. In those cases, an increase of 20 percent can be added to the value given by the graph.

The second point of departure is when an estimate of average catch weight per trip has been made as proposed in Section 3.4.2. Given such an estimate, stowage rates according to the stowage method used (see Table I), can be applied to calculate the average catch volume. An allowance of 30 percent for larger than average catches should be added to this figure to give the total volume required in the fish hold. This volume can be entered in Figure 4 to give an approximate value of CUNO for a suitable vessel. Returning to Figures 2 and 3 will give an estimate of LOA and shp required.

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1/ In all discussion of fish hold capacity the quantity given refers to the total volume inside the insulation

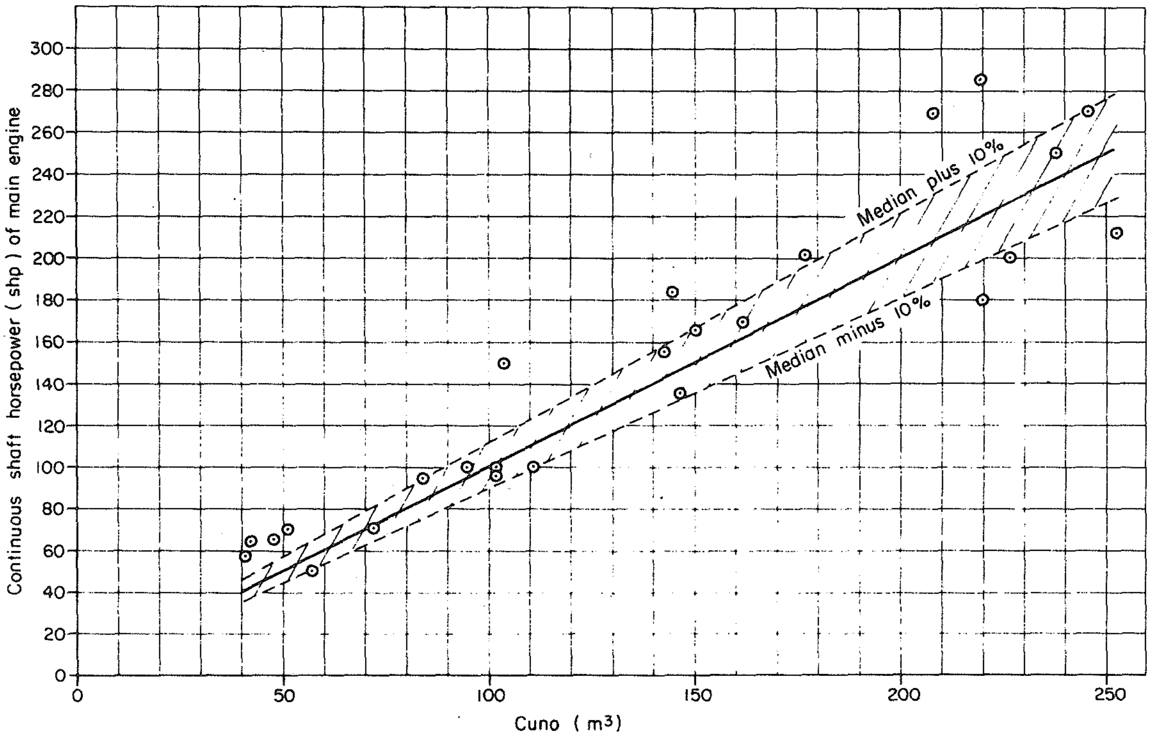



Fig. 3 SELECTION OF CONTINUOUS SHAFT HORSEPOWER OF SMALL TRAWLERS ACCORDING TO CUBIC NUMBER

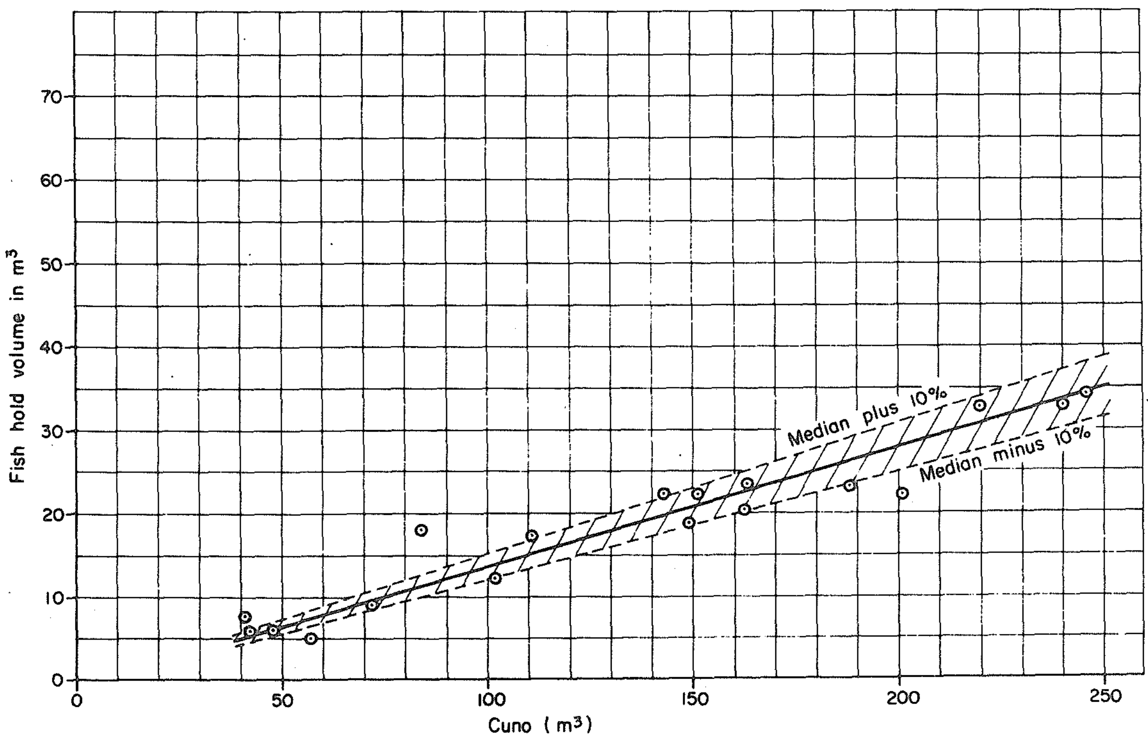



Fig. 4 VOLUME OF FISH HOLD IN M3 ACCORDING TO CUBIC NUMBER OF SMALL TRAWLERS

Table I

Fish hold stowage rates (kg/m$^3$)

| Raw Material | Method of Stowage | Stowage Rate kg/m$^3$ |
|---|---|---|
| Ice | Crushed | 550 |
| Ice | Flake | 420 |
| Small fish (e.g., sardine) | No ice | 800-900 |
| Small fish (e.g., sardine) | Bulk fish with ice | 650 |
| Small fish (e.g., sardine) | In chilled sea water | 700 |
| Medium to large fish | Bulk fish with ice | 500 |
| Medium to large fish | Boxed fish with ice | 350 |
| Medium to large fish | Whole frozen | 500 |

## 5.2 Choice of Power and its Relationship to the Fishing Gear

The horsepower required by a small trawler to tow her gear is largely dependent on the resistance of the trawl and rigging at the required towing speed. Resistance of the hull to forward motion makes up only a small proportion of the total resistance at the towing speeds required by small vessels. The resistance of the trawl boards can be readily calculated and to this must be added the resistance of the trawl net itself. This resistance depends on the geometry of the net and the area of the solid mesh components and may be calculated by formulae. Both the trawl design to be adopted and the towing speed through the water are related to the species which it is expected will be caught. The design is also dependent on the bottom conditions which are to be found in the chosen trawling area.

Our preliminary formulae make allowance for these factors in a general way for the average trawler.

Choice of the most appropriate trawl and gear should be left to a fishing technologist if local experience has not already proved the suitability of a particular design. As a basis for preliminary investigation once a size of vessel and shp have been decided (e.g., from Figures 2, 3 and 4), a choice can be made from a selection of high opening bottom trawls given in Fisheries Technical Paper No. 189, Bottom Trawls for Artisanal Fisheries. Three trawl designs are shown (according to the species to be caught) for each of three horsepower ranges: 50-75, 100-120 and 150-180.

## 5.3 Masts, Rigging and Deck Gear for Fishing Operations

### 5.3.1 Masts and Booms

Masts, booms and their supporting rigging have two main purposes, to lift loads and to set sails which can be used for auxiliary propulsion or as riding sails in certain fishing methods. In the case of a small stern trawler, the most viable use of sail is as an auxiliary source of power to conserve fuel during travelling to and from the fishing grounds. Design and installation of an efficient sailing rig suitable for a fishing vessel requires a good knowledge of sail and its practical uses and if auxiliary sail is required on a planned vessel it is suggested that the Fisheries Technology Service be consulted for proposals. Sailing rig apart, the principal use of masts and booms on small trawlers is for the lifting of loads such as the bringing aboard of the cod end of the trawl at the end of a tow and the transferring of the catch from the fish hold to the quayside at the end of a voyage.

A description of the basic principles of mast and boom design calculation are included here but it should be emphasized that due to the load-carrying requirement of masts and booms, often under difficult conditions at sea and with a crew working on deck, a complete strength calculation should be made by an experienced designer so that safe operation is ensured.

Four types of masts are used in fishing vessels, wooden masts with wire stays and shrouds, steel pipe masts with pipe stays, steel bipod masts or wooden unstayed (stump) masts where loading capacities are not high. For the purposes of the vessels illustrated in this publication, a standard design of pipe mast and boom with pipe stays has been provided in drawing number 17. The maximum safe working load at the boom end in each case is 1 t. Two boom lengths are shown, the longer for hauling of cod ends over the stern and for other lifting requirements in the same area while the second is a shorter boom for loading and unloading purposes, either when the cod end is brought round to the side of the vessel and a shorter boom length can be used, or where the cod end is handled by other methods and the short boom is used mainly for unloading of the catch.

The drawing gives dimensions and all the necessary details for construction of masts by any experienced metal working shop.

The correct navigation light fittings and the regulation distances at which they should be mounted are also included.

For wooden stayed masts or steel bipod masts ask the Fisheries Technology Service for further details.

In order to understand the basic loading requirements of masts and booms, an indication of the forces which will occur in the various components are shown in the design with tables of loads to be expected at two different boom angles for both the 3.0 m and 6.0 m booms. Looking at the mast and boom design in the upper left hand side of the drawing, one can see that the maximum safe working load on the runner is 1 t. A load on the runner at this point produces a force Q in the topping lift which prevents the boom moving down under the load, while the resultant forces acting on the topping lift and runner blocks and their direction are shown as R and S. There will also be a compression loading T on the boom together with a compression loading on the mast and tension in the fore stay. These last two are not shown in the table in the drawing. All of these forces can be calculated using the parallelogram of forces method. Mast, boom and stays are then designed to accommodate them with suitable safety factor allowances. Results for two different boom angles are shown. The magnitude of the forces is dependent on the ratio of the mast length to boom length and to the angle of the boom. As can be seen, with the boom at an increased angle, forces Q and R and the compression loading on the mast are decreased. The ideal boom angle is around 30 degrees although the reach of the boom is then somewhat reduced.

5.3.2 Winches

Due to the loads involved and the hauling force required, it is convenient or, in the case of larger vessels, essential, to have some form of mechanical assistance to haul the trawl and fish catch on board.

For all except the smallest 7.5 m trawlers shown in our examples, a mechanical winch is included in the design.

Winches for small trawlers are usually of the two-drum, two-warping head variety in which the trawl warps are hauled on the drums with the warping heads used for auxiliary hauling requirements such as hauling sweeplines, the wings of the trawl net, hoisting the cod end inboard using the boom, etc.

As has been explained in Section 4, winches are located with the shaft line of the winch drums either transversely or in the longitudinal axis of the vessel according to the fishing requirement.

In order to specify the correct size of winch for a particular vessel size, engine hp and trawl fishery, a knowledge of the hauling power of the winch, the capacity of trawl warp (and hence diameter of the trawl drums) and the hauling speed are needed.

The hauling power of the winch can be estimated by assuming that the pull in the winch will be approximately equal to the bollard pull which can be exerted by the vessel at the shp available at trawling rev/min. This pull is conservatively estimated for our approximate calculations at 12 kg/shp. The shp at trawling speeds for various engine horsepowers are shown in Table II and using the figure of 12 kg/shp, we can calculate the pull of the winch at an average value.

When the trawl warps are being hauled in and the warps are spooled on to the winch drums, the effective diameter of the drum increases. This means that the lever arm from the outside layer of warp to the centre of the drum is increasing and therefore the force required to exert the same pull on the trawl also increases. For this reason it is usual to specify the maximum pull of the winch at half drum as this represents an average value. Figures for the pull at half drum are given in Table II. Speed of revolution of the winch drums and hence the hauling speed of the warps also influences the power requirement of the winch. Power = force x velocity or in this case = force x hauling speed.

Let us assume that a warp drum has a diameter of 32 cm (= 0.32 m), then the amount of warp hauled in one revolution equals $\pi$ x diameter of the drum, i.e., 1.005 m. If the drum is revolving at 30 rev/min then it will be turning at 0.5 rotations per second and the hauling speed of the winch is 1.005 x 0.5 = 0.5 m/s. If the winch is hauling a trawl which has a resistance of 1 t, then the hauling force will be 1 000 kg and the power required = 1 000 kg x 0.5 m/s = 500 kg m/s. As 1 hp is equal to a force of 75 kg at a velocity of 1 m/s, then 1 HP = 75 kg m/s and dividing our result by this figure we can find the hp requirement of the winch at that hauling speed, which in this case is 6.7 hp. Doubling the number of rotations per minute of the winch (without changing the drum diameter) will double the hauling speed to 1 m/s and as the resistance of the trawl and hence the force required remains the same the power requirement will be:

1 000 kg x 1 m/s = 1 000 kg m/s, i.e., 1 000/75 = 13.4 hp

As an approximation for our purposes, we can assume that, under normal conditions of operation of our small trawlers, the maximum hauling speed at half drum will be 0.75 m/s and the maximum power requirement at full drum will be the pull of the winch times the hauling speed at full drum, i.e., 1.5 m/s. Assuming an efficiency of 80 percent for mechanical transmission, we must add a further 20 percent to the figure arrived at and in this case the power requirement for the winches at different engine powers will be as shown in Table II.

In order to relate ratings of marine engines furnished by the engine maker to the actual power available to propel the vessel, it is necessary to make allowances for the various losses in power which occur between the manufacturer's figures and the actual installation in the vessel.

The most common rating given by the manufacturer is brake horsepower and this usually refers to the power measured at the flywheel. There are various ratings which are used for other purposes but the only rating suitable for fishing vessels is the continuous rating for heavy duty 24-hour-a-day use. In order to estimate power at the output shaft which is available to the propeller, allowance must be made for losses in the shafting and bearings together with the driving of any auxiliary equipment fitted directly to the main engine.

These losses can be estimated as 5 percent of the continuous bhp. In addition, in tropical conditions there should be a further allowance of losses for high temperature and humidity. If we assume as an approximation that this will amount to a further 5 percent we can conservatively estimate the actual shp available as 10 percent less than the manufacturer's continuous bhp. A further reduction of 20 percent should be made for trawling conditions in order not to overload the engine.

These figures are given in Table II for a range of engine horsepowers suitable for small trawlers.

Table II

Power requirements for trawl winches

| Manufacturer's continuous bhp | Max. cont. shp | shp at trawling rev/min | Pull of winch at $\frac{1}{2}$ drum | Power required hp |
|---|---|---|---|---|
| 60 | 54 | 43 | 520 | 13 |
| 80 | 72 | 58 | 700 | 17 |
| 100 | 90 | 72 | 860 | 21 |
| 120 | 108 | 86 | 1 030 | 25 |
| 140 | 126 | 100 | 1 200 | 29 |
| 160 | 144 | 115 | 1 380 | 33 |
| 180 | 162 | 130 | 1 560 | 37 |
| 200 | 180 | 144 | 1 730 | 42 |

5.3.3 Trawl Davits

An examination of fishing vessel designs and operational vessels will show a wide variety of different designs of trawl gallows and davits which act as warp leads and towing points for the trawl.

For the small trawlers under consideration the simplest form of towing point is a pipe davit of the form shown in drawing number 18. The davit revolves in a deck fitting both to assist in swinging the trawl boards inboard and also to stow the davits when in port to avoid damage against quaysides and other vessels.

The davits are held in position for towing by chains fastened to chain plates in the bulwarks and tightened by means of a rigging screw.

Scantlings for various sizes of trawl davit according to the shp of the vessel are listed in the table at the top right hand corner of the drawing.

Dimensions A and B are calculated to allow trawl boards of the sizes shown in drawings numbers 10, 11 and 12 in Fisheries Technical Paper No. 189 to be correctly handled and swung inboard.

5.3.4 Gantries

As mentioned on page 11 it is often convenient for handling of heavier catches to have a permanent lifting structure on the after deck. Drawing number 19 shows such a structure for loadings likely to be hauled with vessels powered to 100 shp. The forces involved and dimensions required for the various components are calculated in a similar manner to those used for masts and booms. For larger structures and engine horsepowers over 100 consult the Fisheries Technology Service.

## 6. CONSTRUCTION COST ESTIMATION FOR SMALL TRAWLERS

In the field of small fishing vessels where the major part of a construction programme is directed toward local markets, there can be a wide divergence in price from one country to another depending purely on local cost structures for materials, import taxes on items such as marine engines, variations in local labour costs, etc. When preparing an estimate of cost of construction of a small trawler there may be a considerable error in the estimation if constructions costs from another country are used. It is therefore suggested that the standard method described below be used for preliminary cost calculations unless local shipyards are already building similar vessels and can furnish an accurate estimate.

A calculation of this type is based on a measure of vessel size. Once costs are known for one particular vessel, then, using the standard measure, costs can be estimated with reasonable accuracy for other vessels <u>of similar shape</u>.

Size is best calculated for cost purposes on a volume measure and the method proposed uses cubic number (CUNO) arrived at by multiplying the length of the boat over all (LOA) by the maximum beam (B) by the depth at midships from the top of the deck at the side to the point where bottom and keel meet as described on page 14 and in Figure 1. If hull and deck constructions costs are known for one size of vessel, then a direct comparison of CUNOs for this and other vessels of different size but similar shape will give a reasonably accurate costing, provided the basic cost structures and building scantlings are similar in the areas where the vessels have been built.

The calculation does not, of course, stop there - the hull and deck making up only some 30-45 percent of the total costs of a fully equipped vessel, depending on the complexity of the equipment installed.

For purposes of estimating, the vessel is divided into seven component divisions. The weights of materials used in these divisions are calculated and estimates of cost derived by applying material and man-hour costs per ton derived from local cost figures (see Table III for a breakdown of how this may be done).

In Section 1, Hull Structure, the area of hull and deck for weight estimation may not be readily available, so approximations of areas and weights/$m^2$ based on cubic number are included in Figures 5 and 6.

Material costs for hull structure are then estimated by applying a basic cost per ton, calculated from the cost/$m^3$ of sawn planks x specific gravity of timber used; 30-40 percent is added for wastage (this figure can be more closely approximated by obtaining more accurate estimates from local yards), plus 20 percent for fastenings, paints, etc. Labour in man-hours/ton is then added. The number of man-hours/ton can vary considerably, depending on the degree of skill and efficiency of the yard - from 300-500 hours/ton - local information will assist in establishing the correct figure.

Estimates for the other divisions are applied according to the information obtained from Table III and manufacturers' leaflets and quotations.

In order that the method can be easily understood, two worked examples are given in Sections 6.1 and 6.2. The first is a comparative costing of an identical sized vessel in wood and steel while the hull estimation method for a different hull material, ferro-cement, is shown in Section 6.2. As costs can change rapidly, no attempt has been made to bring the costings up-to-date. They are shown in the currency of calculation (with the current dollar conversion) in the year in which they were carried out and are intended to serve as an example of the working of the method. Totals arrived at bear no relation to present-day costs.

## Table III

Itemization of vessel weights, material and labour costs

| Division | Items Included | Weight | Material Costs | Labour Costs |
|---|---|---|---|---|
| 1 Hull Shell | Skin and frames | Area of shell ($m^2$) x weight/$m^2$ (from Figs. 5 and 6) | Cost $m^3$ and wastage 30%, fastenings 20% | Weight x man-hours/ton (man-hours/ton estimated 300-500) |
| 1a Hull Strength Members | Keel, deadwood, bulkheads, engine bearers, stringers etc. | 40% of shell weight | | Weight x man-hours/ton (man-hours/ton estimated 350-400) |
| 1b Deck | Deck, deckbeams | Area of deck ($m^2$) x weight/$m^2$ (from Figs. 5 and 6) | | |
| 2 Deckhouse | Wheelhouse and deckhouse | Based on cubic No. CUNO x 6-10 kg/$m^3$ for wooden deckhouse | Weight x material cost/ton | Weight x man-hours/ton (man-hours/ton estimated 350-400) |
| 3 Outfit | Joiner work, fish hold lining and insulation, masts rigging, fuel tanks, anchors, chain life-saving equipment, galley equipment, navigation equipment | Based on cubic No. CUNO x 30-40 kg/$m^3$ for decked boats | Weight x cost/ton | Weight x man-hours/ton (man-hours/ton estimated 500-600) |
| 4 Machinery | Main engine, shafting and propeller | From manufacturers' leaflets | Manufacturers' quotation | Weight x man-hours/ton (man-hours/ton estimated 300-400) |
| 5 Auxiliaries | Generators, pumps rudder and steering gear, refrigeration machinery | From manufacturers' leaflets | Manufacturers' quotation | Included in 4 |
| 6 Electrical | Batteries, wiring, deck lights and interior lights, electronic equipment | From manufacturers' leaflets | Manufacturers' quotation | Quotation from company experienced in marine electrical installation |
| 7 Deck Equipment | Fishing winches, power blocks, anchor winches, etc. | From manufacturers' leaflets | Manufacturers' quotation | Included in 3 and 4 |

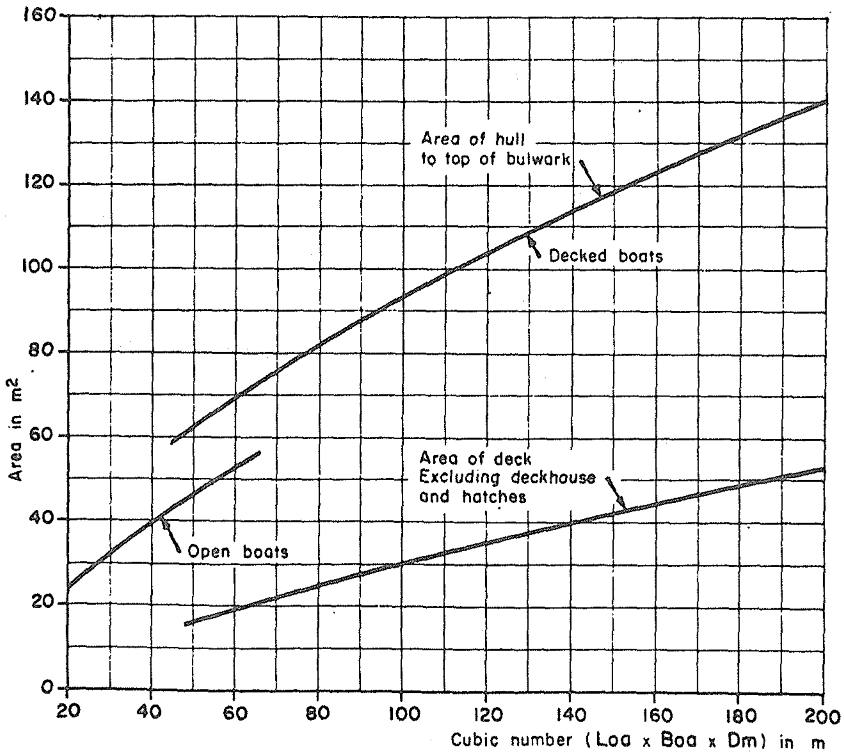



Fig. 5 AREA OF HULL AND DECK

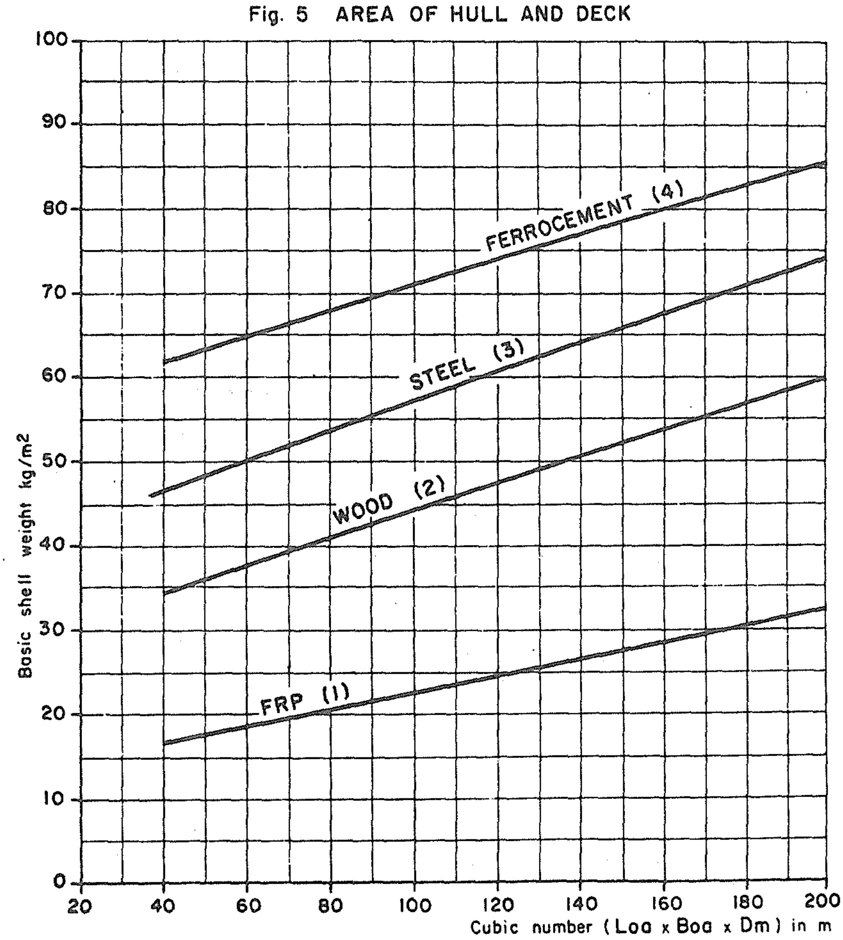



Fig. 6 WEIGHT PER SQUARE METER OF HULL AND DECK. (EXCLUDING KEEL, DEADWOOD, BULKHEADS, STRINGERS AND LOCAL STIFFERING).

## 6.1 Cost Estimates for Vessel Construction in Wood/Steel

Structural hull cost of a 13 m trawler/purse seiner

(all prices in Dalasi at December 1976. Dal. 1 = U.S.$ 0.47)

### Division 1 - Hull and Deck

Cubic number = 13 x 4.34 x 1.96
= 110.6 $m^3$

(i) Basic material costs

| | Dal. |
|---|---|
| Local mahogany (*Khaya senegalensis*) | 530/$m^3$ |
| Imported mahogany (*Khaya ivorensis*) | 740/$m^3$ |
| Imported iroko (*Chlorophora excelsa*) | 880/$m^3$ |
| Mild steel plate | 826/t |
| Average price for plate and profiles | 880/t |

(ii) Weight of hull structures

Area of hull: Shell: 100 $m^2$
Area of deck: 32 $m^2$

| | Wood | Steel |
|---|---|---|
| Weight | 46 kg/$m^2$ | 58 kg/$m^3$ |
| Hull weight | 4 600 | 5 800 kg |
| Deck weight | 1 472 | 1 856 kg |
| Keel, deadwood, bulkheads, etc. 40% of shell weight | 1 840 | 2 320 kg |
| Total bare hull structural weight | 7 912 | 9 976 kg |

(iii) Material cost/t

(a) Wood

| | Dal. |
|---|---|
| (Average specific weight = 0.75) = $\frac{720}{0.75}$ | 960/t |
| Average cost | 720/$m^3$ |
| Wastage 30% of Dal. 960 | 288 |
| Fastenings, paint, etc., 20% of Dal. 960 | 192 |
| Total material cost/t | 1 440 |

(b) Steel/t

| | |
|---|---|
| Wastage 20% of Dal. 880 | 176 |
| Paint, welding electrodes, etc., 20% | 176 |
| Total material cost/t | 1 232 |

(iv) Hull cost in wood and steel

| | Wood | Steel |
|---|---|---|
| Material cost/t | 1 440 | 1 188 |
| Estimated manhours/t | 500 | 350 |
| Labour cost/h, including overheads | 1.80 | 2.40 |
| Labour cost/t | 900 | 840 |
| Hull weight | 7.9/t | 10/t |
| Material costs | 11 376 | 11 880 |
| Labour cost, including overheads | 7 110 | 8 400 |
| Total hull cost Dal. | 18 486 | 20 280 |

Division 2 - Deckhouse in Wood or Steel

| | Material and equipment | Labour |
|---|---|---|
| Deckhouse in wood | 80 kg/m$^3$ x 5.8 m$^3$ x 1 440 Dal./t = Dal. 668 | .464 x 500 x 1.8 = Dal. 418 |
| Deckhouse in steel | 140 kg/m$^3$ x 5.8 m$^3$ x 1 232 Dal./t = Dal. 1 000 | .812 x 350 x 2.4 = Dal. 682 |

Division 3 - Outfit

Material and equipment
Weight/cost = 35 kg/m$^3$ x 100 m$^3$ = 3.5 t x Dal. 2 000/t = Dal. 7 000

Labour for installation
3.5 t x 800 manhours/t = 2 800 x Dal. 2.0/h = Dal. 5 600

Total outfit = Dal. 12 600

Division 4 - Machinery (main engine, propeller, shafting, etc.)

Equipment - 80 to 90 hp, landed cost (estimated) = Dal. 22 000

Labour for installation - 0.7 t x 600 manhours/t = 420 x Dal. 2.4/h = Dal. 1 008

Total machinery = Dal. 23 000

Division 5 - Auxiliaries

Equipment (bilge pump and piping) = Dal. 350

Labour for installation included in Division 4

Total auxiliaries = Dal. 350

Division 6 - Electrical (batteries, electrical installation, deck and navigation lights and electronics)

Equipment = Dal. 4 800

Labour for installation included in Division 3

Total electrical = Dal. 4 800

Division 7 - Deck Equipment (trawl/purse seine winch, purse davits and trawl gallows, etc.)

Equipment = Dal. 8 500

Labour for installation included in Divisions 3 and 4

Total deck equipment = Dal. 8 500

Total Divisions 1 to 7

| | | Wood | Steel |
|---|---|---|---|
| Including overheads on materials and direct labour costs. | | 68 826 | 70 496 |
| | Say | 69 000 | 70 500 |
| Profit and contingencies 20% | | 13 800 | 14 100 |
| Total cost | | 82 800 | 84 600 |
| | Say | 83 000 | 85 000 |

## 6.2 Estimate of Structural Hull Cost of a 15.85-m (52-ft) Ferro-Cement Trawler

(All prices quoted are in Malaysian dollars at January 1975. 1 U.S.$ = M.$ 2.22)

(i) CUNO of vessel (in metres) = 15.85 x 4.42 x 2.05 = 144
(See Fig. 1)

| | | |
|---|---|---|
| (ii) | **Basic material costs** | **M.$** |
| | Galvanized wire mesh 19/20 g ½ in x ½ in | 2.50/m |
| | Reinforcing rods 6 g hard drawn | 0.25/m |
| | Reinforcing rods 6 mm mild steel | 0.17/m |
| | Cement, Portland type I | 7.50/50 kg |
| | Sand | 2.00/$m^3$ |
| | Tie wire 18 g | 35.00/9-kg coil |
| (iii) | **Weight of hull structures** | |
| | Area of hull (See Fig. 2) | 117 $m^2$ |
| | Area of deck | 41 $m^2$ |
| | Weight/$m^2$ (See Fig. 3) | 75 kg |
| | Hull weight = 117 x 75 | 8 775 kg |
| | Deck weight = 41 x 75 | 3 075 kg |
| | Keel, bulkheads, etc., estimated at 30 per cent of hull weight | 2 632 kg |
| | Total hull structural weight | 14 482 kg |
| (iv) | **Material cost/ton** | |
| | For 1 $m^2$, mesh 8 layers at M.$ 2.50 | 20.00 |
| | For 1 $m^2$, rods 6 g hard drawn M.$ 0.25 x 14 m | 3.50 |
| | For 1 $m^2$, rods 6 mm mild steel M.$ 0.17 x 14 m | 2.38 |
| | Tie wire 0.5 kg/$m^2$ | 1.94 |
| | Cement 38 kg/$m^2$ | 5.70 |
| | Sand and mortar additives | 0.76 |
| | Miscellaneous structural steel and welding costs/$m^2$ | 1.60 |
| | Total cost/$m^2$ | 35.88 |
| | Cost/ton $= \frac{35.88 \times 1\,000}{3.175 \times 24}$ | 470.87 |
| | Wastage/ton estimated at 15 per cent of M.$ 470.87 | 70.63 |
| | Paint and finishing at 5 per cent of M.$ 470.87 | 23.54 |
| | Total material cost/ton | 565.04 |
| (v) | **Total material cost 14.482 x 565.04** | 8 182.96 |
| (vi) | **Direct labour costs** | |
| | Estimated man/days of labour/ton | 35 |
| | Total man/days 35 x 14.482 | 507 |
| | Total direct labour cost at an average wage (including skilled and unskilled workers) of M.$ 10/day | 5 070 |
| (vii) | **Total cost of hull deck and bulkheads** | 13 253 |

As all remaining items of the construction, including deckhouse, outfit, engine installation, fishing gear, overheads and profit are essentially the same for both wooden and ferro-cement boats, it is therefore possible to draw a comparison at this point between wooden and ferro-cement fishing vessels of equivalent size. See Section 6.1.

## 7. COMPARATIVE ECONOMIC EVALUATION OF SMALL TRAWLERS

By using the information in the previous sections, together with local information on resource, type of fishing gear, catch rates, construction materials and labour costs, it should now be possible to arrive at an initial estimate of likely catch rate, catch volume per trip, size of vessel, hp of main engine, fishing gear and deck equipment and a preliminary costing for an appropriate vessel.

By a comparison of annual revenue and annual operating costs as listed on page 8, an indication of expected net profit can be found. This can then be expressed as a percentage of the investment cost of the vessel.

This percentage is known as the accounting rate of return and can be used to measure the profits expected from a new investment such as a fishing vessel.

Let us now use this method for comparison of three different trawlers in a day fishery in which we assume that for a small vessel of 10-15 m (32 ft 6 in to 50 ft) the trawl grounds are approximately 2 hours steaming from a convenient port. This will mean a total of four hours steaming per day. In order to complete the fishing operation and return to port in one day, it will be possible to spend 8 hours trawling, assuming 4 tows of 2 hours each with 30 minutes for hauling and shooting the trawl between tows. A further 10% of towing time should be allowed for defective tows and/or minor net repairs between tows. The total time from departure from port until return will then be 15 hours which is about the limit for a daily operation.

Table IV shows a sample calculation of investment cost, expenditure and revenue for three sizes of trawler:

Vessel 1: 10 m (32 ft 6 in) LOA, CUNO 45, 70 hp with a fish hold capacity of 7 $m^3$ (247 $ft^3$)

Vessel 2: 13 m (42 ft) LOA, CUNO 110, 100 hp, fish hold capacity 16 $m^3$ (565 $ft^3$)

Vessel 3: 15 m (50 ft) LOA, CUNO 151, 150 hp, fish hold capacity 22 $m^3$ (777 $ft^3$).

The cost figures used in the calculation are rounded up to the nearest 100 for simplification and are intended as a guide for the application of the method and do not refer to any particular currency. In following the method for evaluation of vessels for use in a particular area, prices, estimates of catch rates, maintenance and repair charges, should be based on local prices and follow local practice with regard to fishing operation, crew payments and bonuses, etc.

These results should not be used as an accurate evaluation of investment potential but do, however, give an indication of which vessel is likely to be the more profitable under the stated conditions. In this case, in a short-range operation, the smaller vessel with lower investment and operation costs appears to show a marginally better return, although whether this return would be profitable would depend on local interest rates and returns on investment capital in other investment opportunities.

Where distances to the fishing grounds are greater and a day fishery is no longer possible, operating conditions change and a different result may appear. Table V shows a calculation for the same three vessels with a total steaming time of 12 hours from port to fishing grounds and return. A continuous day and night trawl operation is assumed and with a crew of 4, a two-day trip is considered as a probable maximum for the 10 m vessel, with 3 days allowed for the 13 and 15 m vessels.

With a two-day trip and one-day turn-around, up to 100 trips per year are feasible with allowances for vessel maintenance and repair and bad weather.

Table IV

Cost and Earnings Evaluation of Three Vessels in a Daily Fishery

| | | Vessel 1 | Vessel 2 | Vessel 3 |
|---|---|---|---|---|
| I. | INVESTMENT COST | | | |
| | (a) Hull and Equipment | 26 600 | 60 000 | 72 000 |
| | (b) Machinery and Installation | 11 400 | 25 000 | 62 000 a/ |
| | (c) Sub-total, Hull and Machinery | 38 000 | 85 000 | 134 000 |
| | (d) Fishing Gear | 9 000 | 12 000 | 16 000 |
| | (e) Total Investment | 47 000 | 97 000 | 150 000 |
| II. | ANNUAL FIXED COSTS | | | |
| | (a) Depreciation (10% of I (c)) | 3 800 | 8 500 | 13 400 |
| | (b) Insurance (5% of I (c)) | 1 900 | 4 300 | 6 700 |
| | (c) Vessel Hull Maintenance (5% of I (a)) | 1 300 | 3 000 | 3 600 |
| | (d) Crew Basic Salary (Crew No.) | 6 000(4) | 9 000(6) | 12 000(8) |
| | (e) Management costs (5% of I (c)) | 1 900 | 4 300 | 6 700 |
| | (f) Total Fixed Costs | 14 900 | 29 100 | 42 400 |
| III. | ANNUAL VARIABLE COSTS | | | |
| | (a) Fuel (hp x 180 g/hour ÷ 830 g/l x 200 days x 0.25/l) | 11 400 | 16 300 | 26 100 b/ |
| | (b) Lubricants (10% of fuel cost) | 1 100 | 1 600 | 2 600 |
| | (c) Ice (50% of catch at 33/t) | 1 800 | 3 200 | 4 800 |
| | (d) Engine Overhaul and Repair (6% of I (b)) | 700 | 1 500 | 3 700 |
| | (e) Hull Repair (3% of I (a)) | 800 | 1 800 | 2 200 |
| | (f) Gear Repair and Replacement (33% of I (d)) | 3 000 | 4 000 | 5 300 |
| | (g) Miscellaneous Costs (10% of III (c)-(f) + crew food at 2/day) | 2 200 | 3 500 | 4 800 |
| | (h) Crew Bonus (20% of Annual Revenue - Variable Costs III (a)-(g) | 5 200 | 9 700 | 14 400 |
| | (i) Total Variable Costs | 26 200 | 41 600 | 63 900 |
| IV. | TOTAL ANNUAL COSTS | 41 100 | 70 700 | 106 300 |
| V. | ANNUAL REVENUE | | | |
| | (a) Hourly Catch Rate (from page 6) | 70 | 120 | 180 |
| | (b) Average Daily Catch (kg) | 560 | 960 | 1 440 |
| | (c) Annual Catch (t) | 112 | 192 | 288 |
| | (d) Average Ex-Vessel Price of Fish/t | 420 | 420 | 420 |
| | (e) Total Annual Revenue | 47 000 | 80 600 | 121 000 |
| VI. | NET PROFIT (V (e) - IV) | 5 900 | 9 900 | 14 700 |
| VII. | ACCOUNTING RATE OF RETURN (VI ÷ I (e) x 100%) | 12.6% | 10.2% | 9.8% |

a/ Includes 20 hp auxiliary generator

b/ 8-hour operation of auxiliary generator

Table V

Variable Costs and Revenue for 2- and 3-day trips

| III. ANNUAL VARIABLE COSTS | Vessel 1 | Vessel 2 | Vessel 3 |
|---|---|---|---|
| (a) Fuel 4 750 hours/year at 0.25/1 | 18 000 | 25 800 | 43 800[a/] |
| (b) Lubricants | 1 800 | 2 600 | 4 400 |
| (c) Ice at 100% of catch weight | 6 000 | 11 500 | 17 300 |
| (d) Engine overhaul (based on 6% of cost/4 000 hours operation | 800 | 1 800 | 4 400 |
| (e) Hull repair | 800 | 1 800 | 2 200 |
| (f) Gear repair | 3 000 | 4 000 | 5 300 |
| (g) Miscellaneous costs | 2 700 | 4 300 | 6 100 |
| (h) Crew bonus | 5 400 | 12 600 | 17 800 |
| (i) Total variable costs | 38 500 | 64 400 | 101 300 |
| IV. TOTAL ANNUAL COSTS (II from Tables III and IV) | 53 400 | 93 500 | 143 700 |
| V. ANNUAL REVENUE | | | |
| (a) Hourly catch rate (kg) | 70 | 120 | 180 |
| (b) Average trip catch (kg) | 1 820 | 5 280 | 7 920 |
| (c) Annual catch (t) | 182 | 348 | 523 |
| (d) Average ex-vessel price of fish/t | 330 | 330 | 330 |
| (e) Total annual revenue | 60 100 | 114 800 | 172 600 |
| VI. NET PROFIT | 6 700 | 21 300 | 28 900 |
| VII. ACCOUNTING RATE OF RETURN | 14.3% | 22% | 19.3% |

a/ Including auxiliary engine operation

With three-day trips a total of 66/year is used.

For this particular area it is assumed that a higher proportion of smaller fish are caught, changing the catch composition and lowering the average fish price/t to 330.

Investment and fixed annual costs for the three vessels remain the same so only calculations of variable costs and annual revenue are shown in Table V.

In this case the highest return is likely to be achieved by the 13 m vessel with higher catch and annual revenue than the smaller vessel and lower investment and operating costs than the 15 m vessel. Increases in steaming distance to the grounds, longer trip times and variations in catch composition and ex-vessel prices will affect the result and should be investigated in the same way.

In some fisheries catches at night can be affected by fish behaviour, with some species rising toward the surface at night and thus out of the area swept by a bottom trawl. In this case catches may be so reduced as to make night trawling unprofitable. Local custom may be against longer trips or fishing at night. In these circumstances trawling may be limited to daylight hours with vessels returning to port or remaining at anchor, or hove to on the fishing grounds for rest. Maximum trawling times should then be estimated and the calculation carried out as before.

Another way of using the cost figures we have obtained to evaluate alternative vessels is to calculate the minimum catch needed for a given boat to break even or alternatively the minimum price/t of fish to avoid making a loss. A knowledge of local conditions will then show whether the margin between these break even figures and actual or potential catches/prices is sufficient to justify the investment.

Total annual catch to break even in t (kg) is found by dividing the annual costs by the ex vessel price/t (/kg). Where the minimum price is required the annual costs are divided by the estimated annual catch.

In the simplified calculation of percentage rate of return used above, no allowance has been made for the cost of capital (i.e. the interest to be paid if capital for the original investment must be borrowed).

Annual cost of vessel operation in a break even analysis requires a figure for interest on capital to be added to the annual costs already calculated. A convenient way of applying this is to take the average investment cost as equal to 50% of the total investment and apply an interest rate equivalent to the current local interest rate for a comparable investment.

In this case let us use an interest rate of 10%. Table VI shows a calculation of annual break even catches and minimum prices/t for the three vessels shown in Table V.

Table VI

Calculation of annual catch to break even and minimum price/t of fish

| | | Vessel 1 | Vessel 2 | Vessel 3 |
|---|---|---|---|---|
| I | Annual costs from Table V (excluding crew bonus) | 48,000 | 80,900 | 125,900 |
| II | Interest (10% on average investment cost) | 2,400 | 4,900 | 7,500 |
| III | Total annual costs (excluding crew bonus) | 50,400 | 85,800 | 133,400 |
| IV | Annual catch (t) to break even (at 330/t) | 153 | 260 | 404 |
| V | Minimum ex vessel price/t (using estimated annual catch from Table V) | 277 | 247 | 255 |

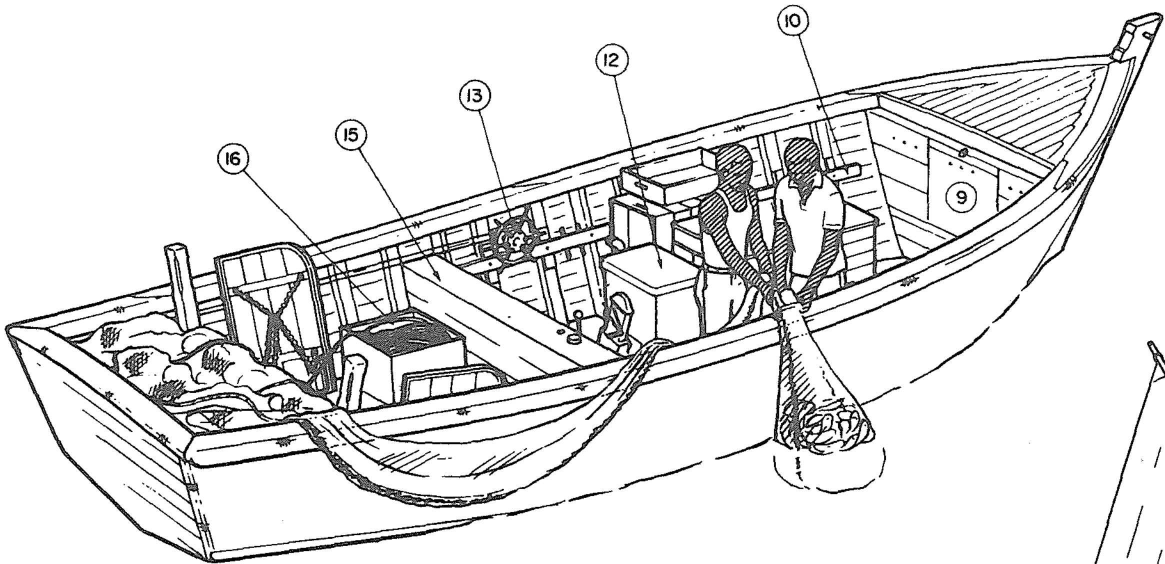
The figures given do not take account of crew bonuses on fish caught. Local practice should be followed in this respect and the cost added to the minimum price/t. In a new fishery, where no standard system of bonuses is available, a percentage of the break even price could be chosen which will provide both an incentive and a reasonable remuneration to the crew.

Where there is no clear indication from an existing fishery of appropriate boat sizes, either of the two methods described can be used to provide a basis for decision on what fishing boats should be employed initially. Provided that reasonable estimates of investment and operating costs can be obtained, and likely ex vessel prices for the fish caught can be established with a fair degree of accuracy, use of these methods for a range of small trawlers taken from the publication should give a useful indication of the most economical size of vessel.

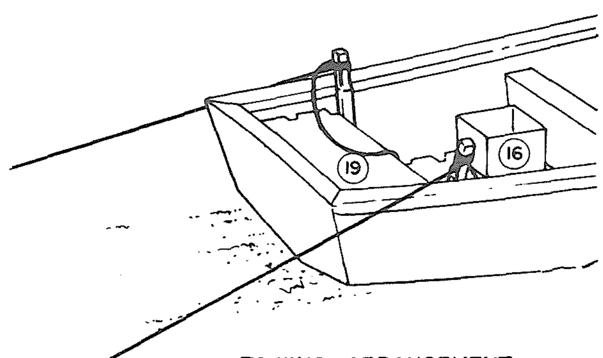
It must be emphasised that such an evaluation while helpful for comparative analysis of different vessels does not show whether an investment will be profitable over the life span of the investment. For this purpose a complete cash flow analysis must be prepared balancing the yearly cash inflows from fish sales against all cash outflows for operating expenses, major repairs, re-engining, etc. and taking account of residual valves at the end of the estimated service life. Discounting these cash flows to present value of future earnings will permit an economic evaluation of the profitability of the investment as a whole.

For those readers who wish to pursue the matter further, the Fisheries Technology Service will be pleased to supply on request additional material describing methods of economic evaluation of fisheries investments projects.

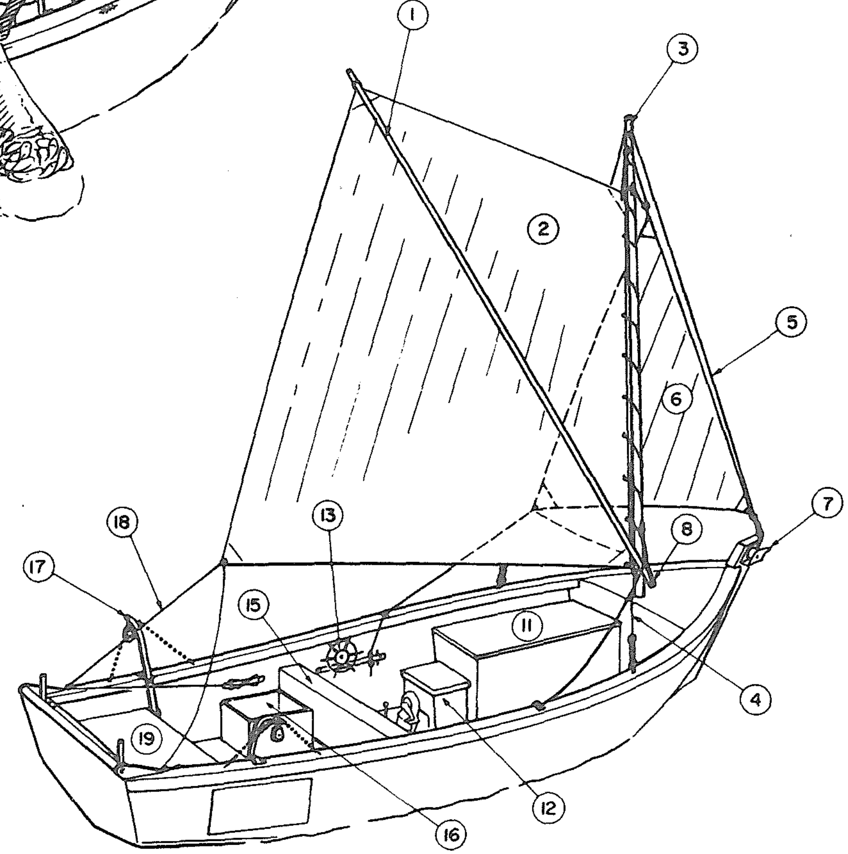
For key to numbers (1) etc. refer to drawing No. 10




HAND HAULING OF OTTER TRAWL

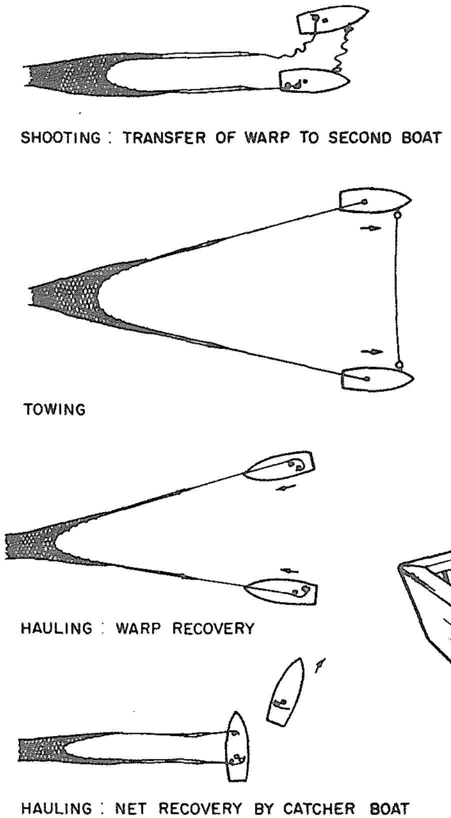


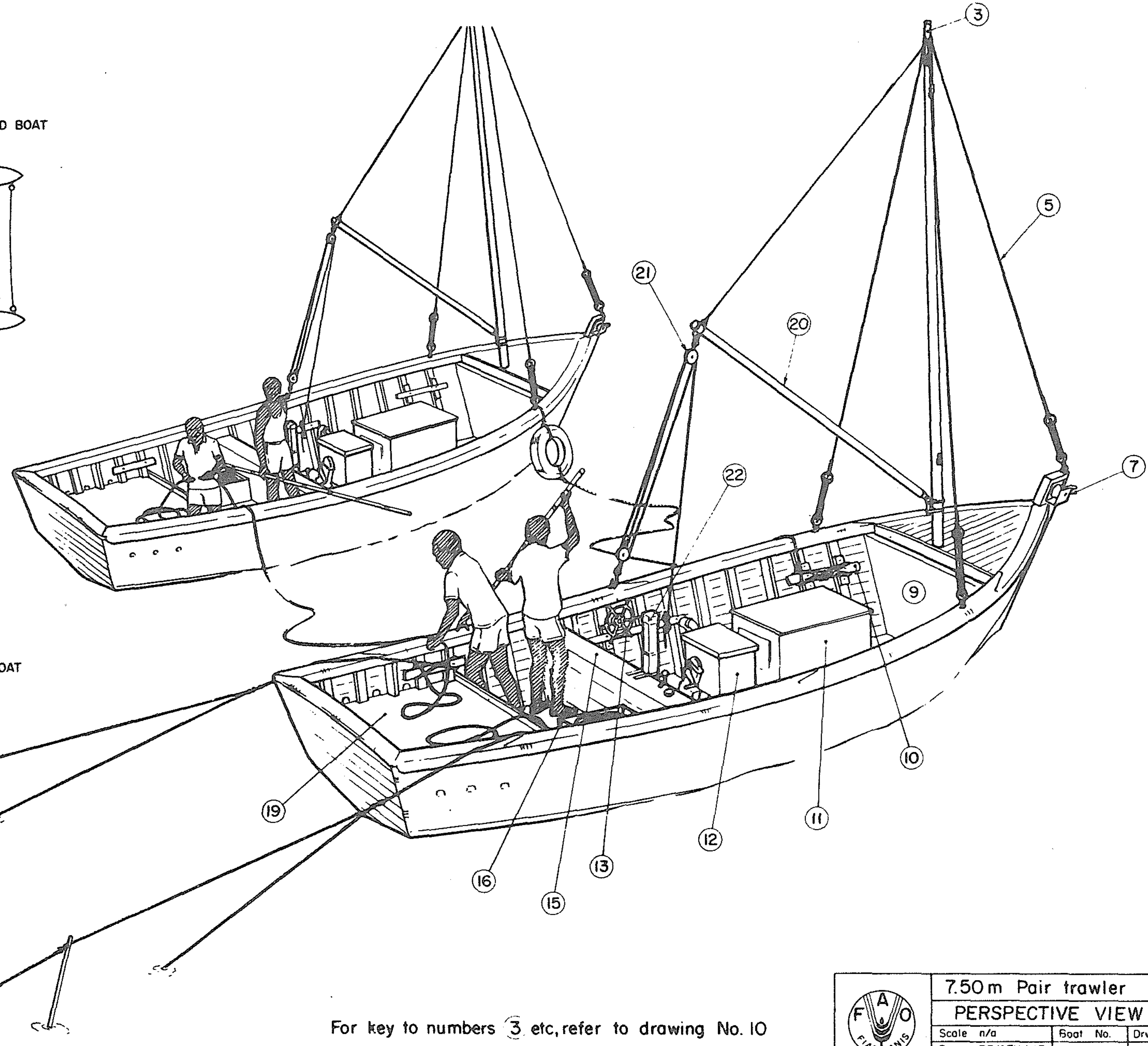

TOWING ARRANGEMENT




OPTIONAL SAIL AND REMOVABLE DAVIT ARRANGEMENT

| | | | |
|---|---|---|---|
| FAO FIAT PANIS | 7.50 m Otter Trawler | | |
| | PERSPECTIVE VIEW | | |
| | Scale n/a | Boat No | Drwg No |
| | Design RP/AFH/JF | ST/MLW-6 | 1 |
| | Rome, Mar/Sept 1979 | | |

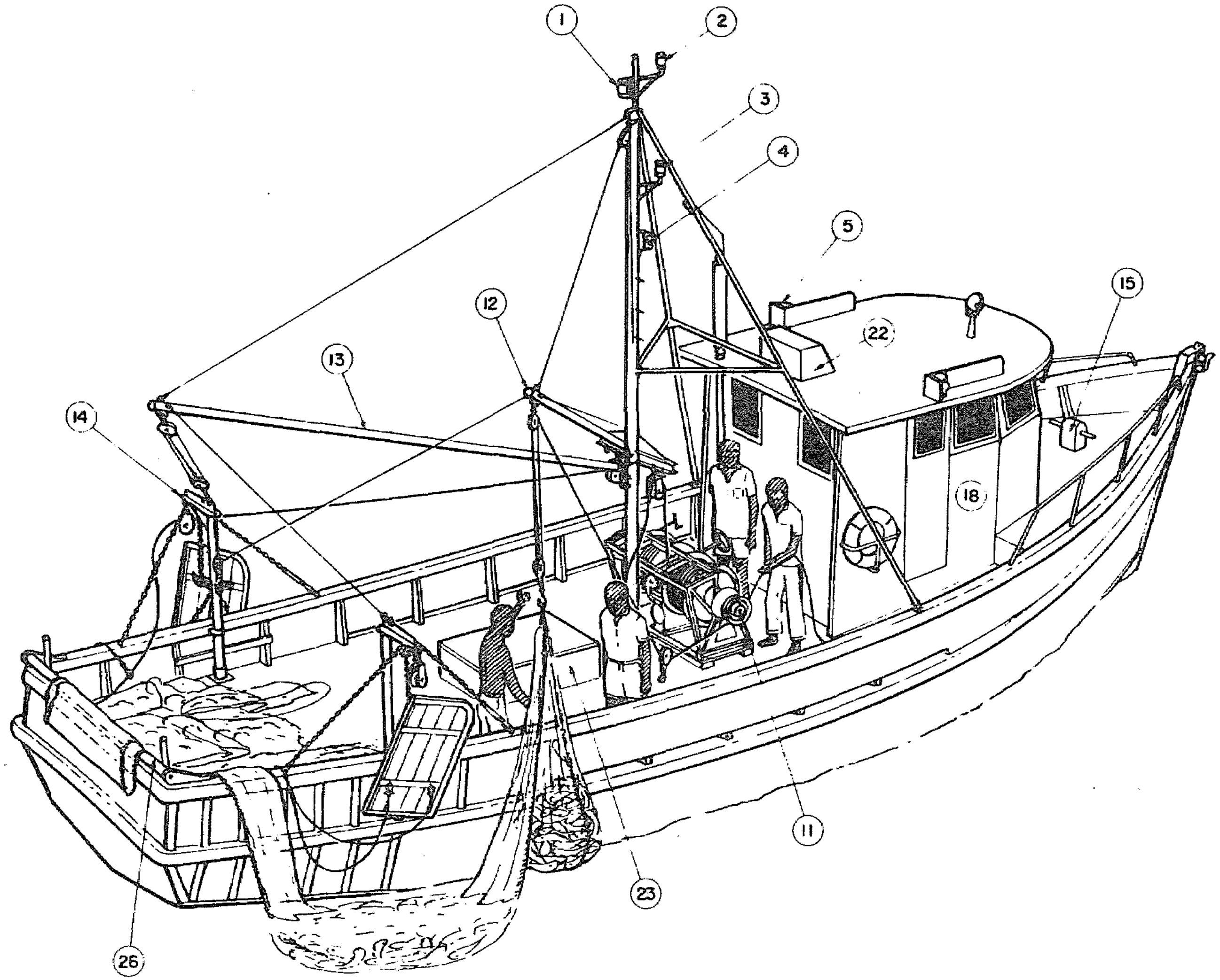



For key to numbers (3) etc, refer to drawing No. 10

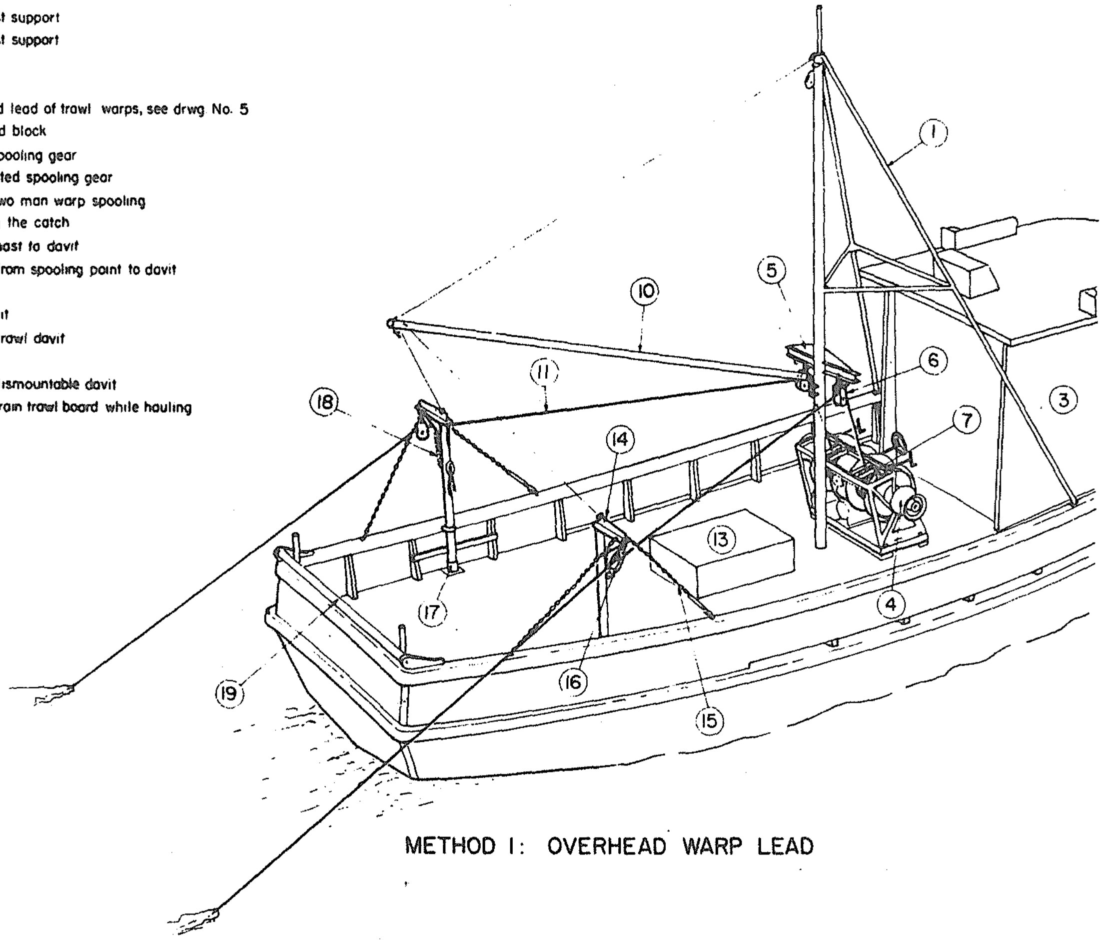
| FAO FIAT PANIS | 7.50 m Pair trawler | | |
|---|---|---|---|
| | PERSPECTIVE VIEW | | |
| | Scale n/a | Boat No. | Drwg No. |
| | Design RP/AFH/JF | ST/MLW-6 | 2 |
| | Rome, Mar/Sept 1979 | | |

For key to numbers (1) etc. refer to drawing No. 11

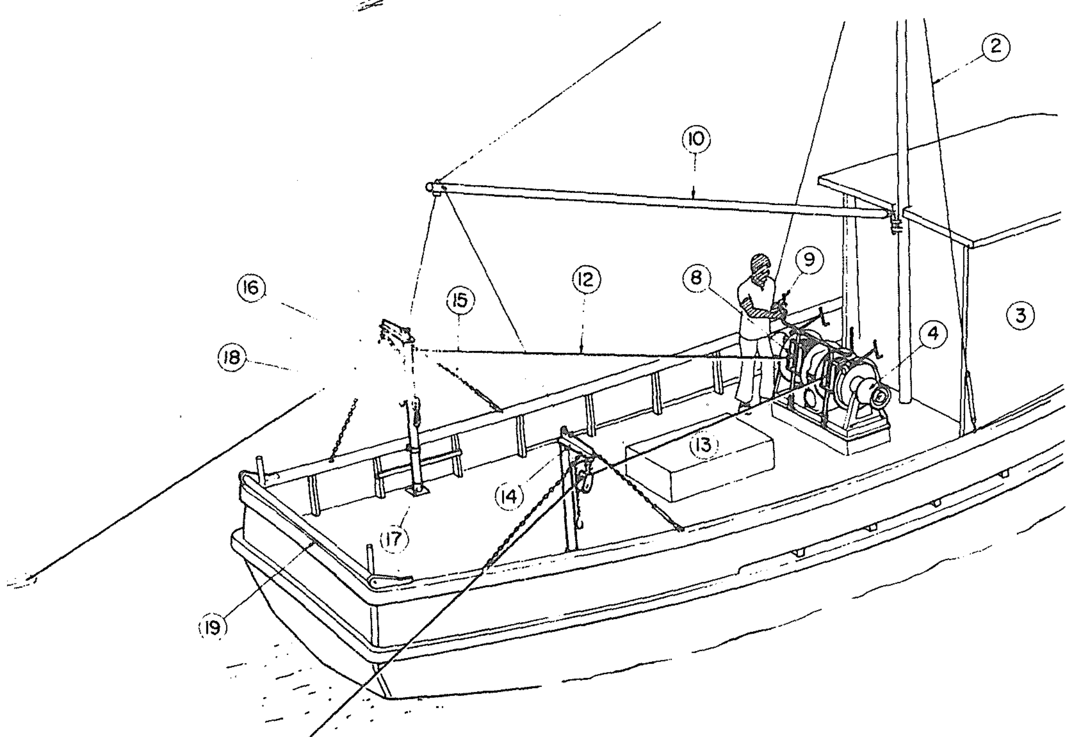



| | | | |
|---|---|---|---|
| FAO FIAT PANIS | 13.00m Trawler | | |
| | PERSPECTIVE VIEW | | |
| | Scale n/a | Boat No | Drwg No |
| | Design RP/AO/JF<br>Rome, Mar/Sept 1979 | ST/GAM-1 | 3 |

1. Pipe stays for mast support
2. Wire stays for mast support
3. Wheelhouse
4. Trawl winch
5. Fitting for overhead lead of trawl warps, see drwg No. 5
6. Overhead warp lead block
7. Mechanical warp spooling gear
8. Linked hand operated spooling gear
9. Handles for one/two man warp spooling
10. Boom for handling the catch
11. Warp lead from mast to davit
12. Warp lead direct from spooling point to davit
13. Hatch to fish hold
14. Movable trawl davit
15. Chain support for trawl davit
16. Trawl block
17. Base support for dismountable davit
18. Chain hook to restrain trawl board while hauling
19. Stern roller



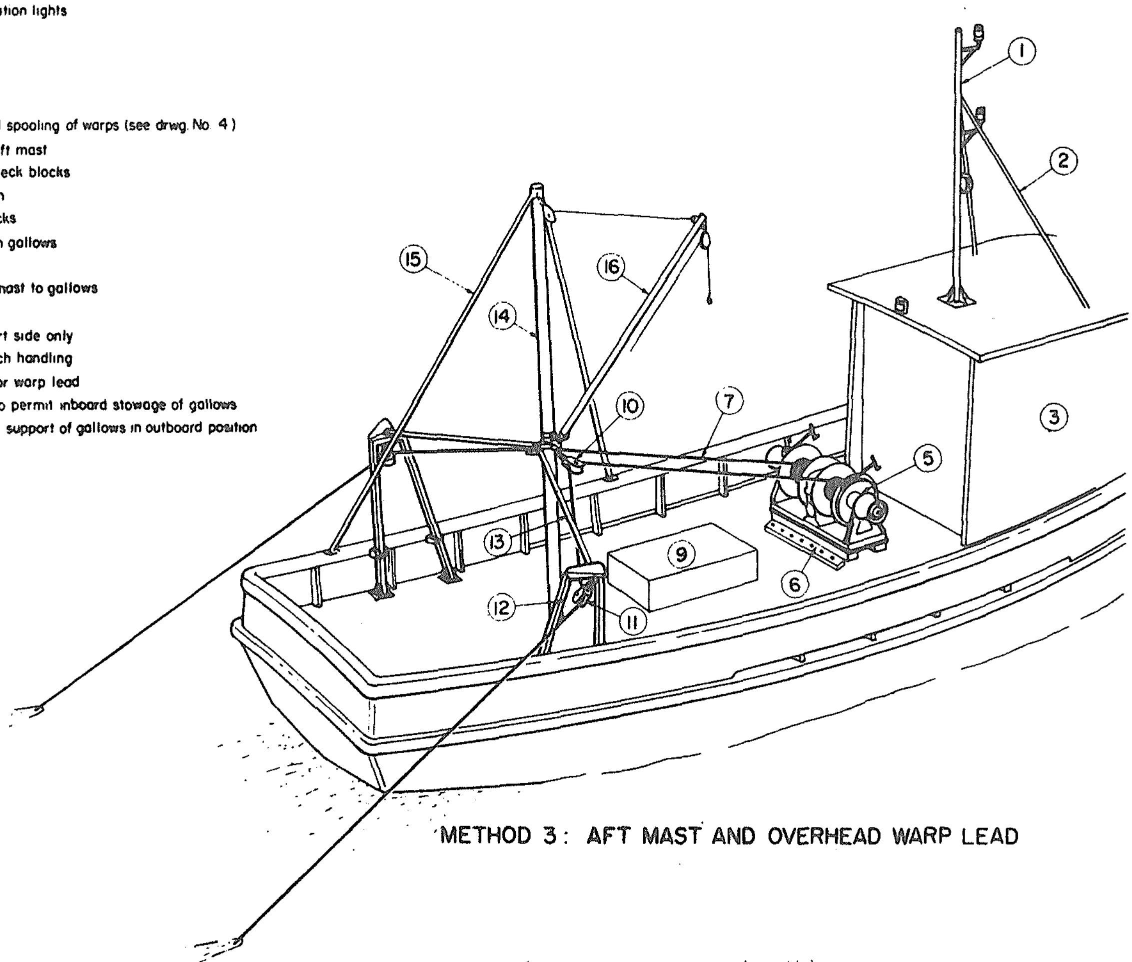

METHOD 1: OVERHEAD WARP LEAD



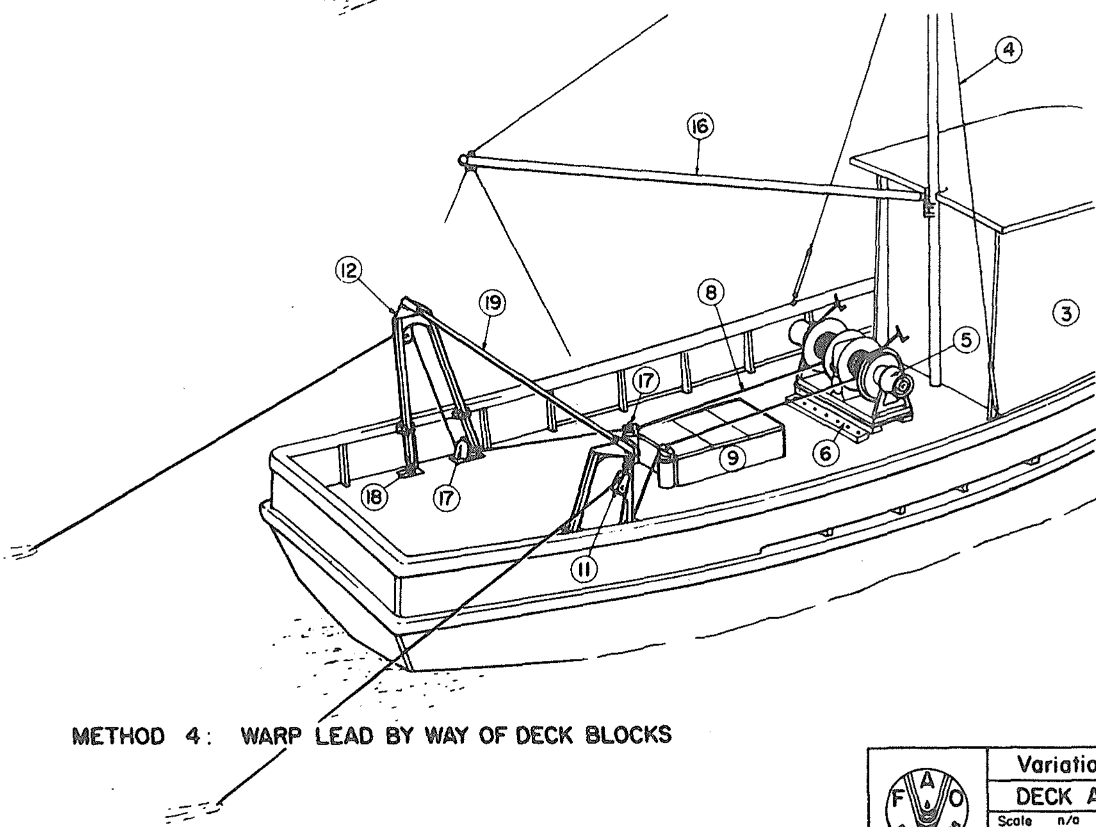

METHOD 2: DIRECT WARP LEAD TO DAVIT

| | | | |
|---|---|---|---|
| FAO FIAT PANIS | Variations in method | | |
| | DECK ARRANGEMENTS | | |
| | Scale n/a | Design No. | Drwg. No. |
| | Design RP/TL/JF<br>Roma, Mar/Sept 1979 | VARIOUS | 4 |

1. Mast for navigation lights
2. Pipe stays
3. Wheelhouse
4. Wire stays
5. Trawl winch
6. Fitting for hand spooling of warps (see drwg. No 4)
7. Warp lead to aft mast
8. Warp lead to deck blocks
9. Fish hold hatch
10. Mast lead blocks
11. Trawl block on gallows
12. Gallows
13. Pipe support mast to gallows
14. Aft mast
15. Pipe stays port side only
16. Boom for catch handling
17. Deck blocks for warp lead
18. Hinge fitting to permit inboard stowage of gallows
19. Cross stay for support of gallows in outboard position



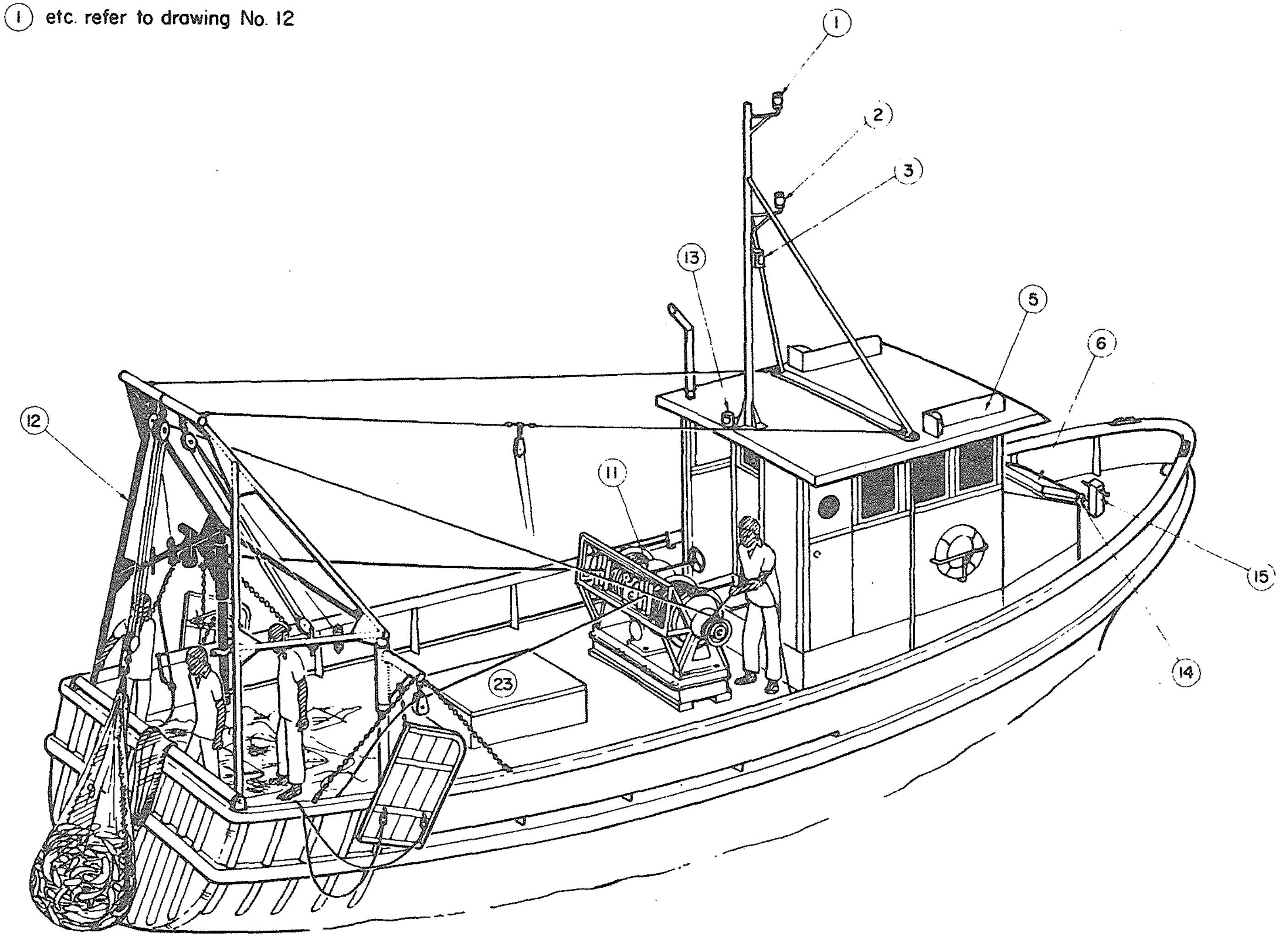

METHOD 3: AFT MAST AND OVERHEAD WARP LEAD




METHOD 4: WARP LEAD BY WAY OF DECK BLOCKS

| | | | |
|---|---|---|---|
| FAO FIAT PANIS | Variations in method | | |
| | DECK ARRANGEMENTS | | |
| | Scale n/a | Boat No. | Drwg No. |
| | Design RP/JF<br>Roma, Mar/Sept 1979 | VARIOUS | 5 |

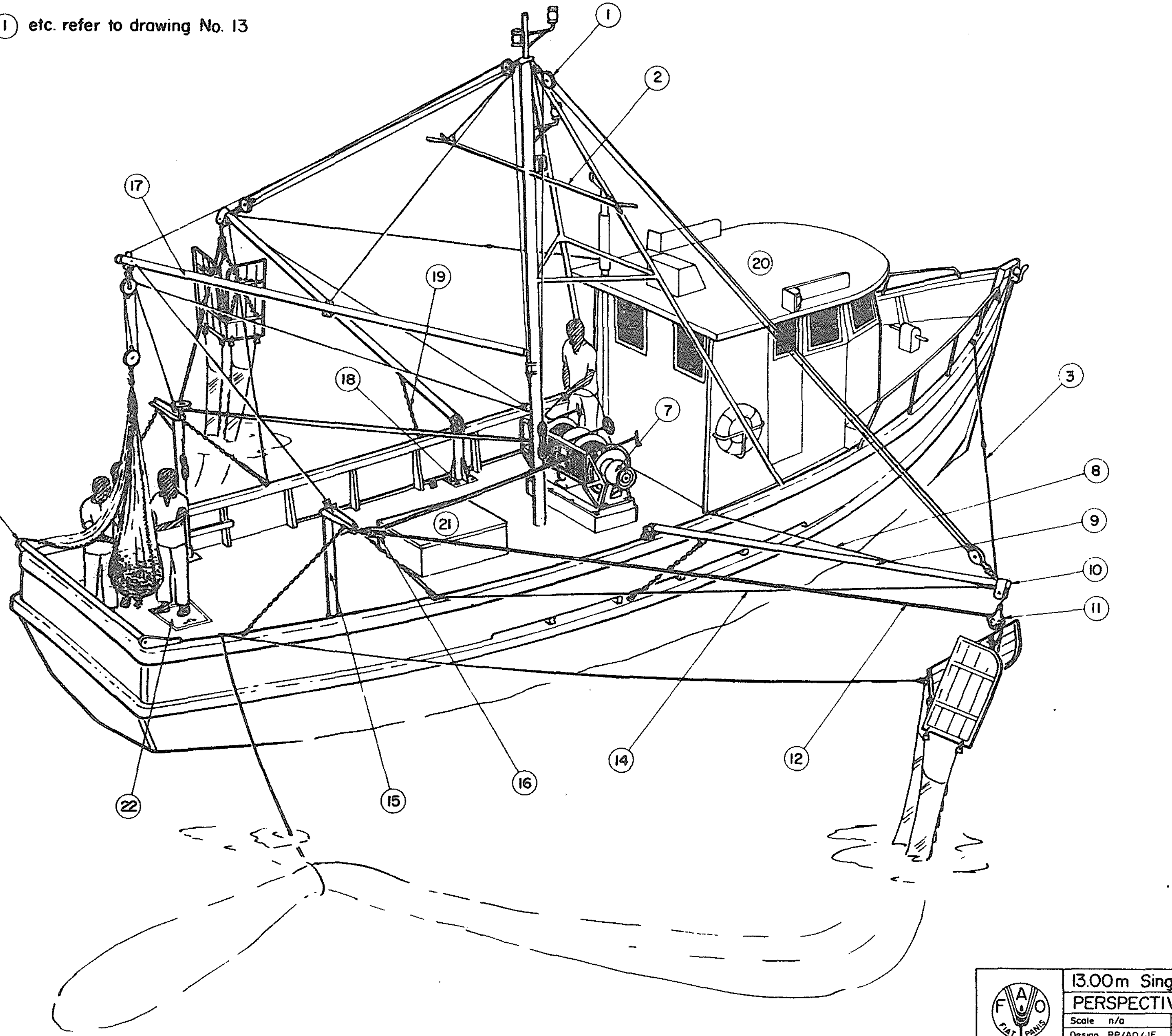
For key to numbers (1) etc. refer to drawing No. 12




| 12.60 m Gantry Trawler | | |
|---|---|---|
| PERSPECTIVE VIEW | | |
| Scale n/a<br>Design RP/ØG/JF<br>Rome, Mar/Sept 1979 | Boat No<br>ST/UGA-2 | Drwg No<br>6 |

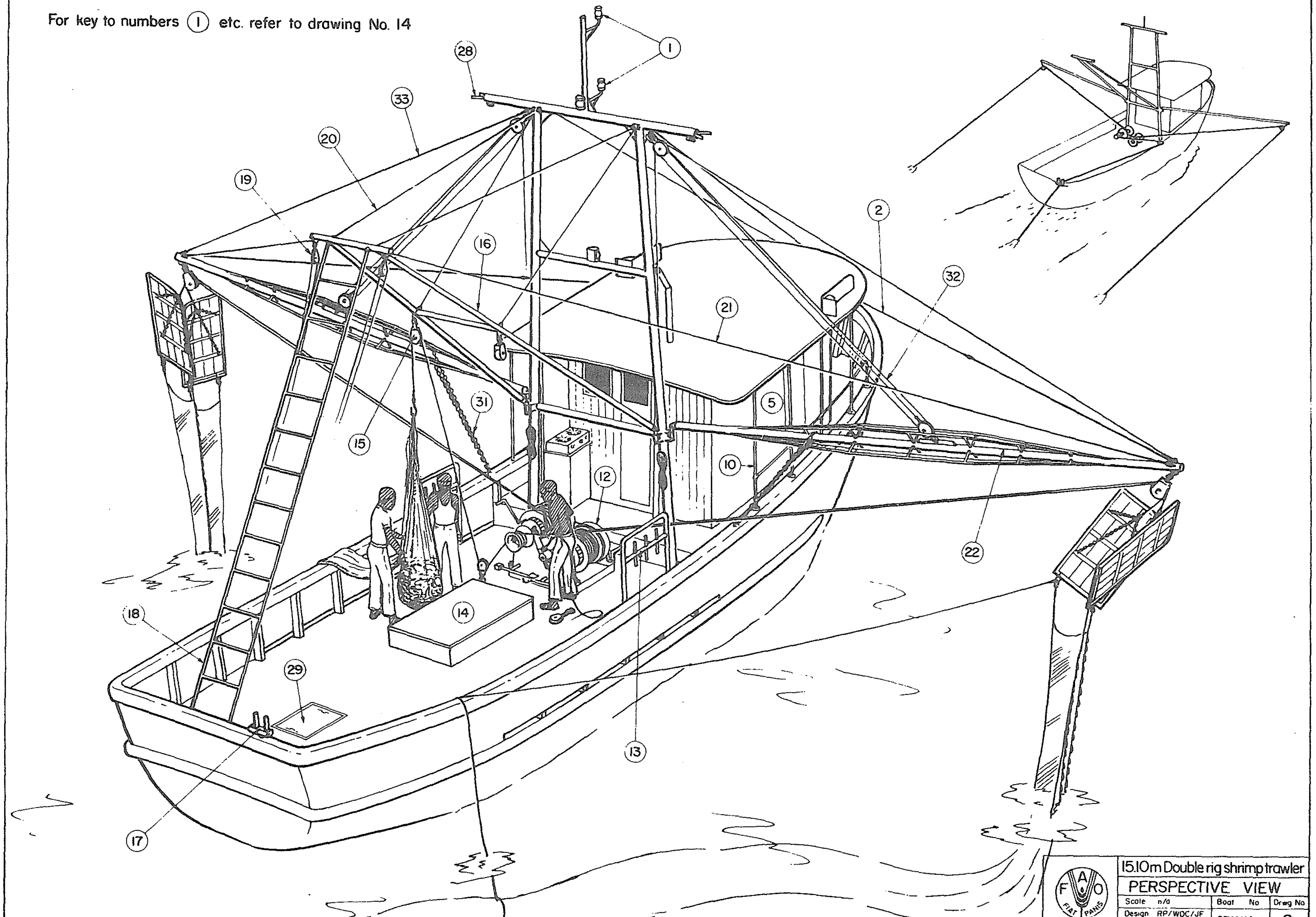
FAO FIAT PANIS

For key to numbers (1) etc. refer to drawing No. 13



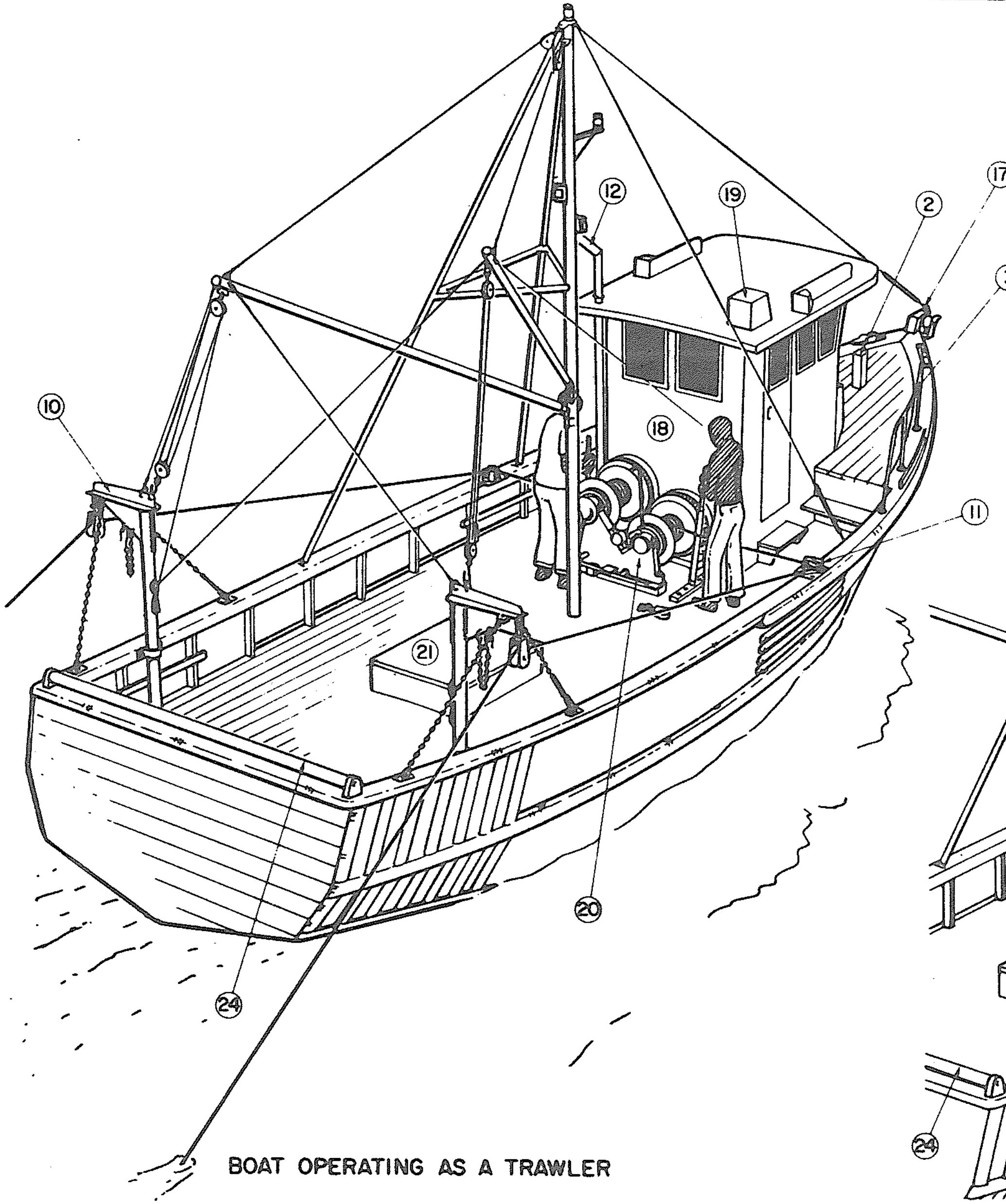

| | | | |
|---|---|---|---|
| FAO FIAT PANIS | 13.00m Single/double rig | | |
| | PERSPECTIVE VIEW | | |
| | Scale n/a | Boat No. | Drwg. No. |
| | Design RP/AO/JF<br>Rome, Mar/Sept 1979 | ST/GAM-1 | 7 |

For key to numbers (1) etc. refer to drawing No. 14

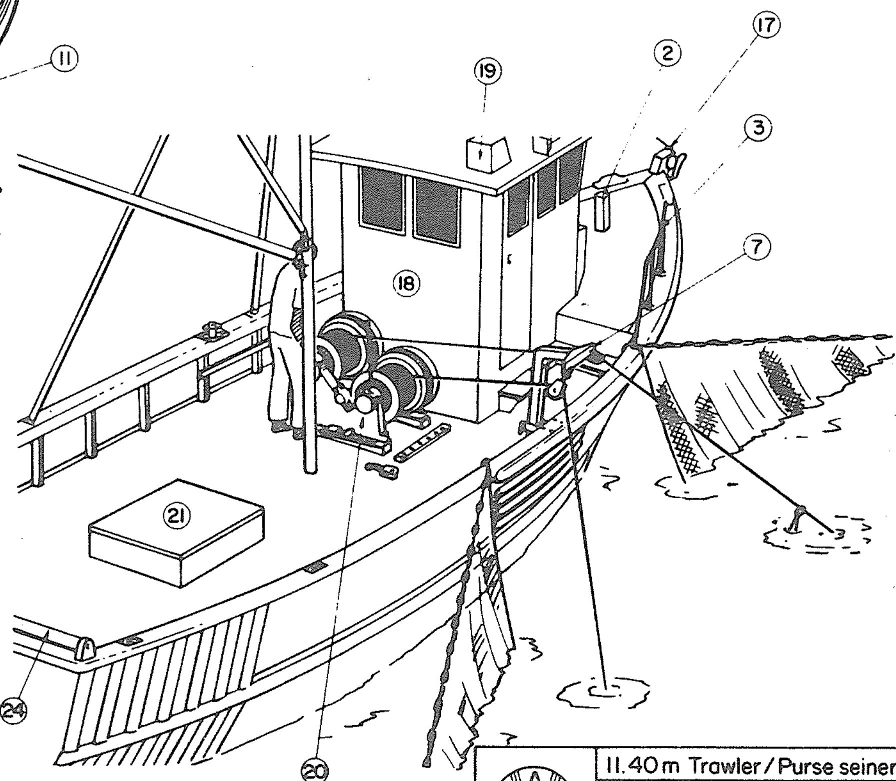



| 15.10m Double rig shrimp trawler | | |
|---|---|---|
| PERSPECTIVE VIEW | | |
| Scale n/a | Boat No | Drwg No |
| Design RP/WDC/JF | ST/GHA-1 | 8 |
| Rome, Mar/Sept 1979 | | |

For key to numbers (1) etc, refer to drawing No. 16




BOAT OPERATING AS A TRAWLER



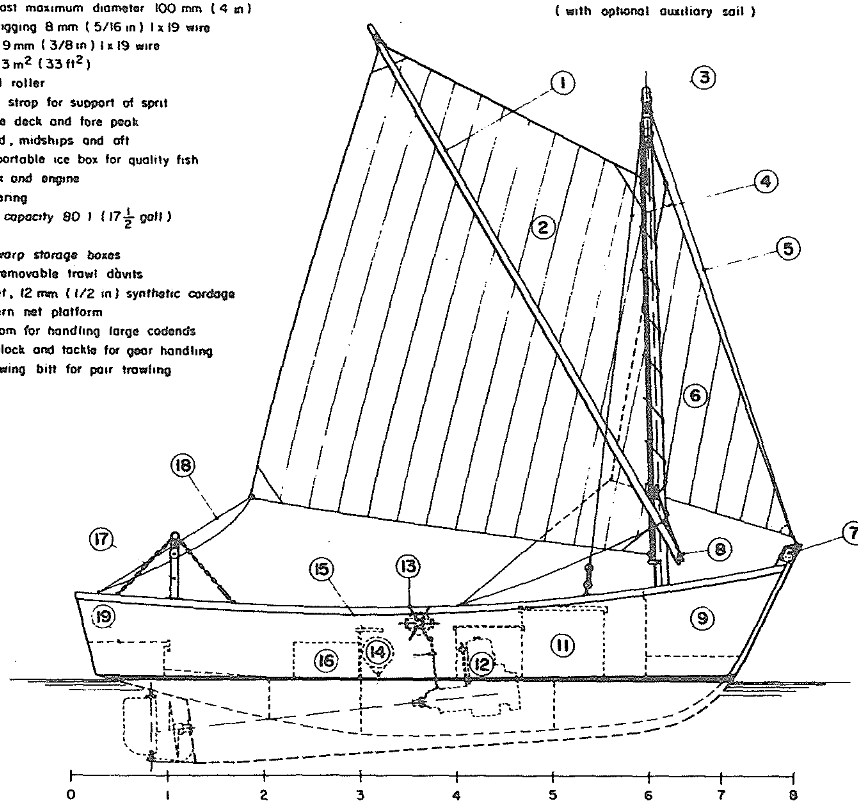

CONVERSION FOR PURSE SEINING

| | | | |
|---|---|---|---|
| FAO FIAT PANIS | 11.40 m Trawler / Purse seiner | | |
| | PERSPECTIVE VIEW | | |
| | Scale n/a | Boat No. | Drwg. No. |
| | Design RP/TL/JF | ST/MLW-4 | 9 |
| | Roma, Mar/Sept 1979 | | |

1. Wooden sprit
2. Main sail, area 15.6 m² (168 ft²)
3. Wooden mast maximum diameter 100 mm (4 in)
4. Standing rigging 8 mm (5/16 in) 1 x 19 wire
5. Fore stay 9 mm (3/8 in) 1 x 19 wire
6. Jib, area 3 m² (33 ft²)
7. Stem head roller
8. Adjustable strop for support of sprit
9. Raised fore deck and fore peak
10. Cleats, fwd, midships and aft
11. Optional portable ice box for quality fish
12. Engine box and engine
13. Wheel steering
14. Fuel tank, capacity 80 l ($17\frac{1}{2}$ gall)
15. Thwart
16. Portable warp storage boxes
17. Optional removable trawl davits
18. Main sheet, 12 mm (1/2 in) synthetic cordage
19. Raised stern net platform
20. Lifting boom for handling large codends
21. Optional block and tackle for gear handling
22. Central towing bitt for pair trawling

## OTTER BOARD TRAWLER

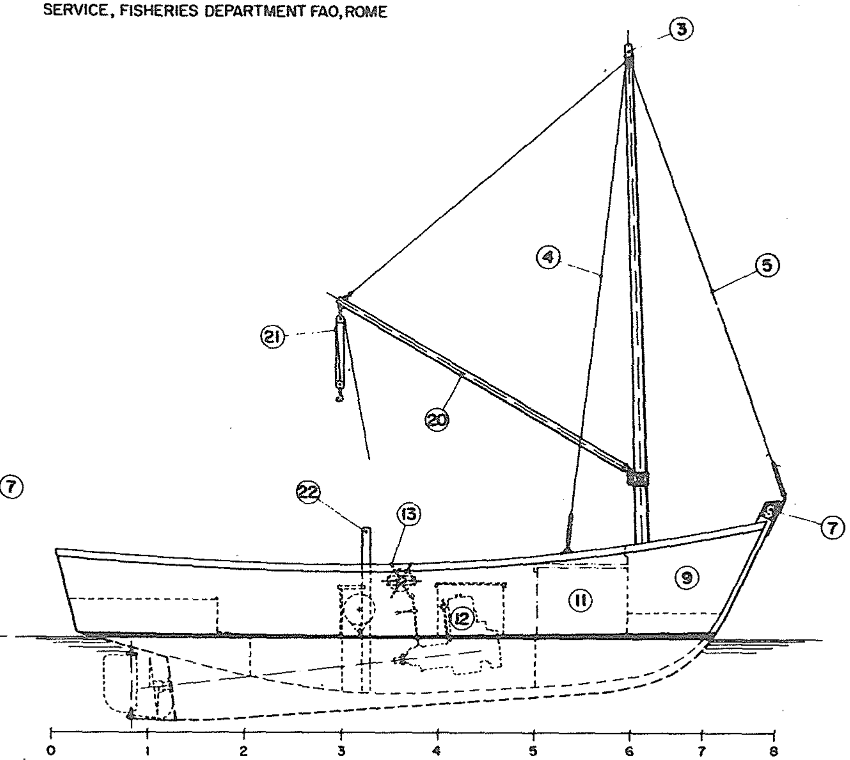
(with optional auxiliary sail)

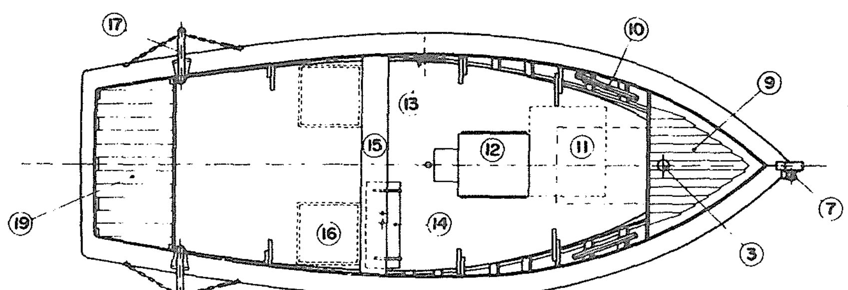


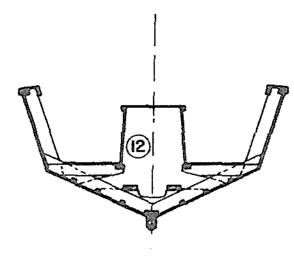

ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME

## PAIR TRAWLER

(with optional rig for gear handling)




SECTION AT STN 4 LOOKING FWD

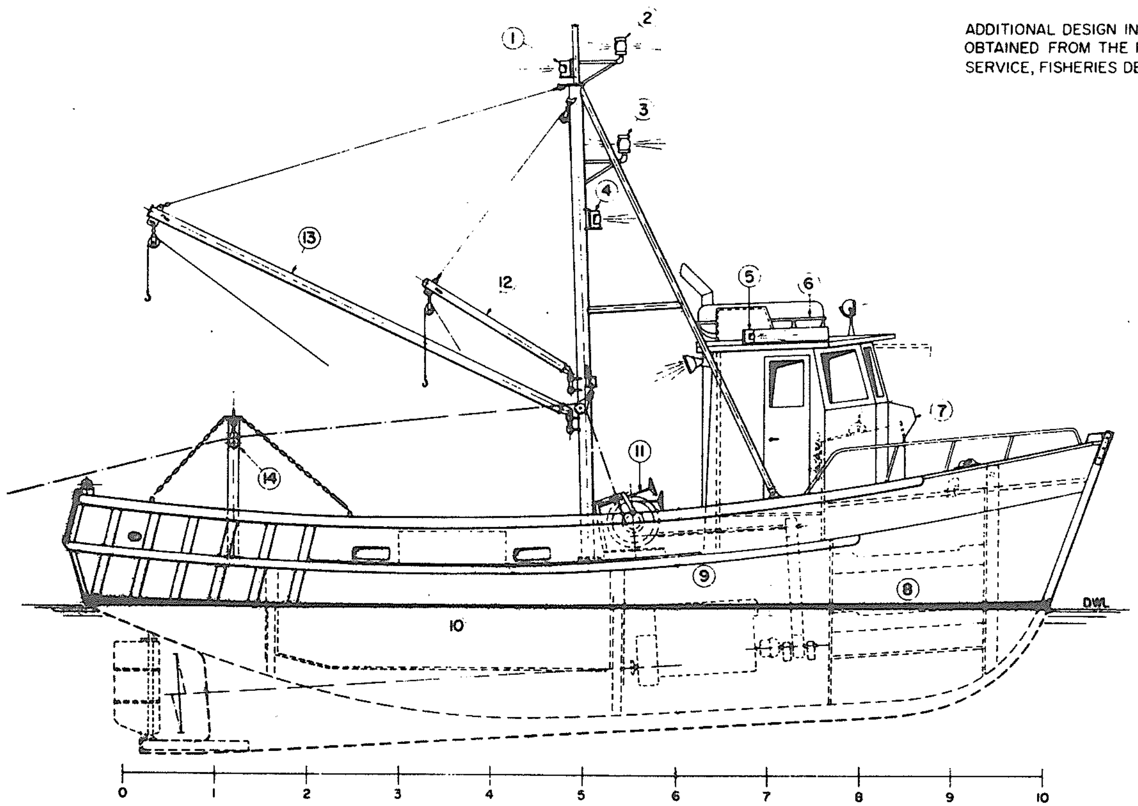
0 0.5 1.0 1.5 2.0 2.5 3.0 Metres

0 1 2 3 4 5 6 7 8 9 10 Feet

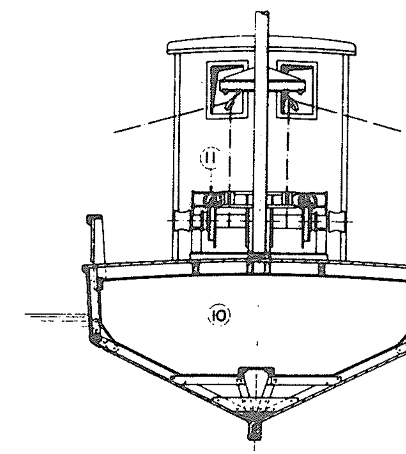
| MAIN PARTICULARS | | |
|---|---|---|
| Length over all | 7.50 m | (24 ft 7 in) |
| Length water line (DWL) | 6.60 m | (21 ft 8 in) |
| Beam water line (DWL) | 2.30 m | (7 ft 6 in) |
| Beam moulded | 2.77 m | (9 ft 1 in) |
| Depth moulded | 1.30 m | (4 ft 3 in) |
| Displacement to DWL | 2.80 m3 | (99 ft³) |
| Engine | 20-30 hp | |

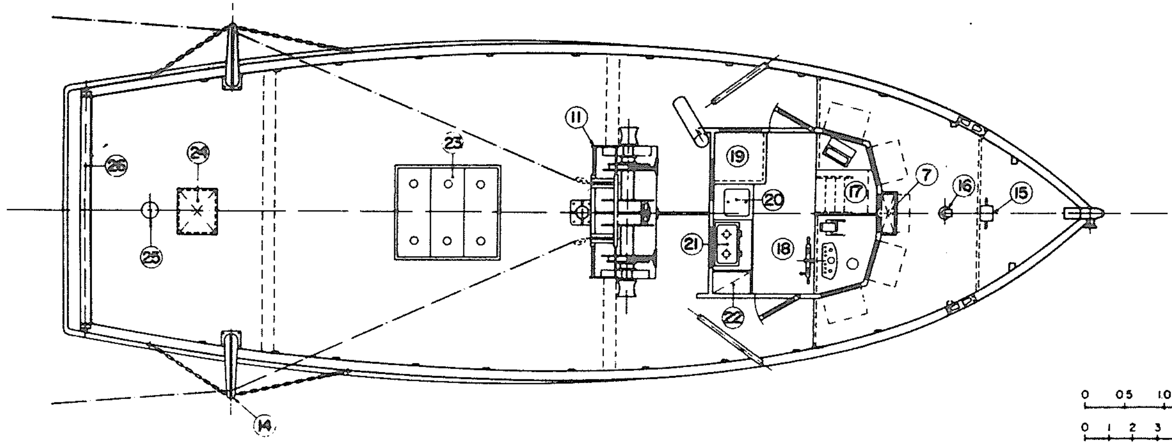
| FAO FIAT PANIS | 7.50 m Single / Pair trawler | | |
|---|---|---|---|
| | GENERAL ARRANGEMENTS | | |
| | Scale as shown | Boat No. | Drwg No. |
| | Design AFH/JF | ST/MLW-6 | 10 |
| | Rome, October 1979 | | |

ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME




1. Stern light white 135°
2. Fishing light green 360°
3. Fishing light white 360°
4. Masthead light white 225°
5. Side lights red/green 112 5°
6. Liferaft
7. Air intake to accommodation
8. Cabin, 4 berths
9. Engine room
10. Fish hold, capacity 17 m³ (600 ft³)
11. Trawl winch
12. Boom for lifting the codend over the side
13. Boom for lifting the codend over the stern
14. Trawl davits, port and starboard
15. Mooring bitt
16. Chain pipe
17. Access to accommodation
18. Wheel house
19. Access to engine room
20. Sink
21. Gas stove
22. Air intake to engine room
23. Hatch to fish hold
24. Hatch to deck store
25. Deck plate over emergency tiller
26. Stern roller




| MAIN PARTICULARS | | |
|---|---|---|
| Length over all | 13 00 m | (42 ft 8 in) |
| Length water line (DWL) | 12 10 m | (39 ft 9 in) |
| Beam water line (DWL) | 4 26 m | (14 ft 0 in) |
| Beam moulded | 4 34 m | (14 ft 3 in) |
| Depth moulded | 1. 96 m | (6 ft 5 in) |
| Displacement to DWL | 25 46 m³ | (899 ft³) |
| Engine | 100 hp | |

0 05 10 15 20 25 30 35 Metres
0 1 2 3 4 5 6 7 8 9 10 11 12 Feet

FAO FIAT PANIS

**13.00 m Trawler**

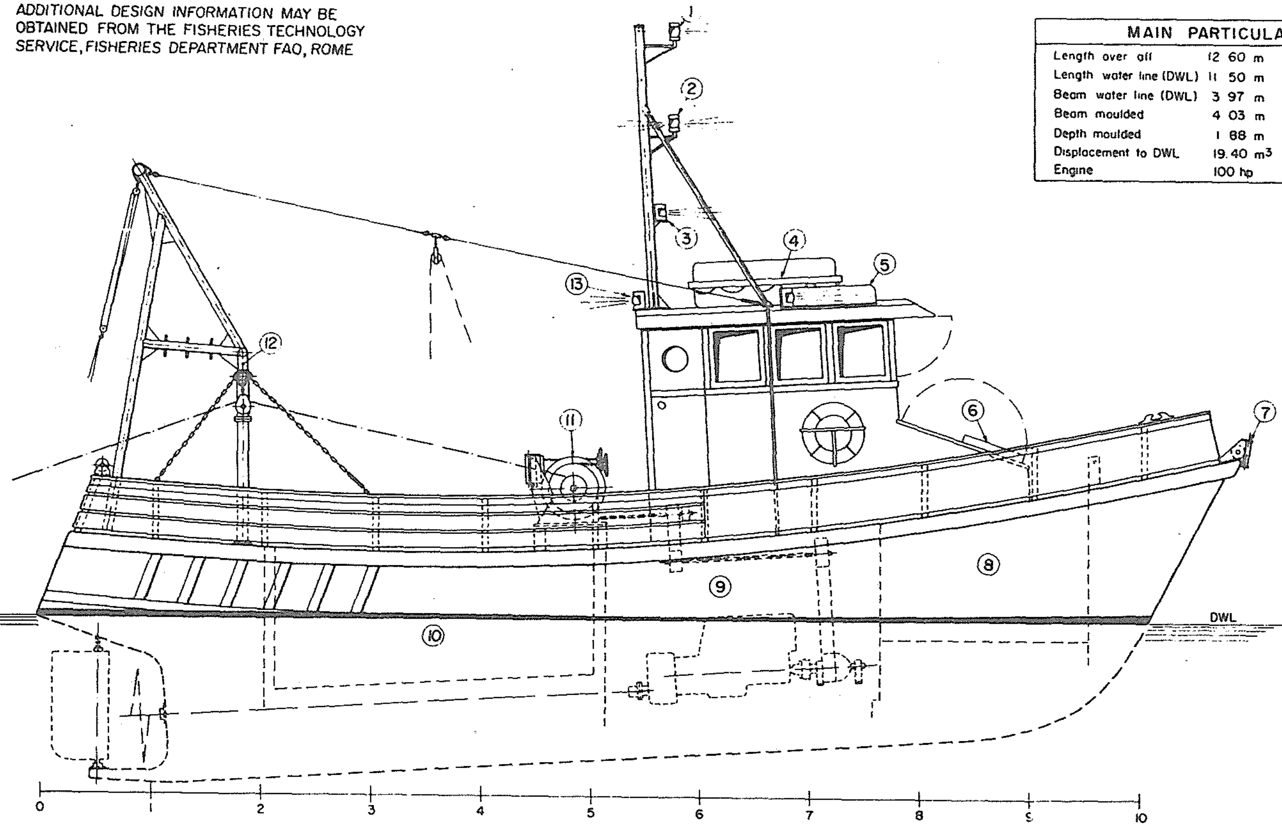
**GENERAL ARRANGEMENT**

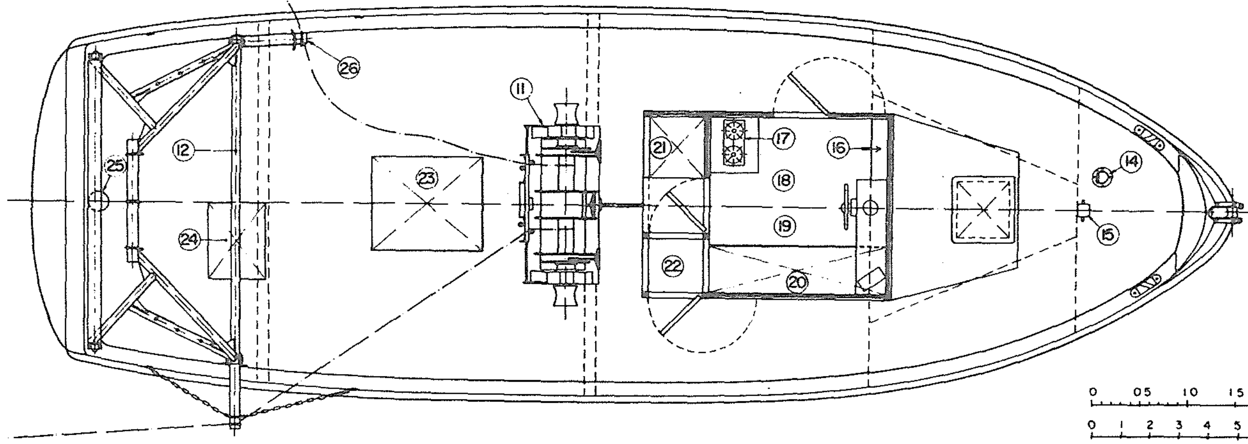
| Scale as shown | Boat No | Drwg No |
|---|---|---|
| Design AO/TL/JF | ST/GAM-1 | 11 |
| Rome, June 1979 | | |

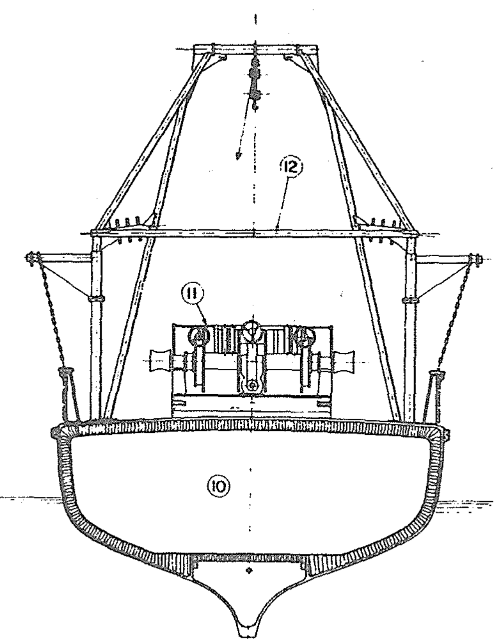
ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME

| MAIN PARTICULARS | | |
|---|---|---|
| Length over all | 12 60 m | (41 ft 1 in) |
| Length water line (DWL) | 11 50 m | (37 ft 9 in) |
| Beam water line (DWL) | 3 97 m | (13 ft 0 in) |
| Beam moulded | 4 03 m | (13 ft 3 in) |
| Depth moulded | 1 88 m | (6 ft 6 in) |
| Displacement to DWL | 19.40 $m^3$ | (685 $ft^3$) |
| Engine | 100 hp | |

1. Fishing light green 360°
2. Fishing light white 360°
3. Masthead light white 225°
4. Liferaft
5. Sidelights red/green 112 ½°
6. Hatch to accommodation
7. Stem roller
8. Cabin with 4 berths
9. Engine room
10. Fish hold 12.0 $m^3$ (423 $ft^3$)
11. Trawl winch
12. Gantry with trawl davits
13. Sternlight white 135°
14. Chain pipe
15. Mooring bitt
16. Down accommodation
17. Gas stove
18. Wheel house
19. Floor removable for access to engine
20. Bunk
21. Entrance engine room
22. Toilet
23. Hatch to fish hold
24. Flush hatch to deck store
25. Deck plate above emergency tiller
26. Trawl davit in retracted position



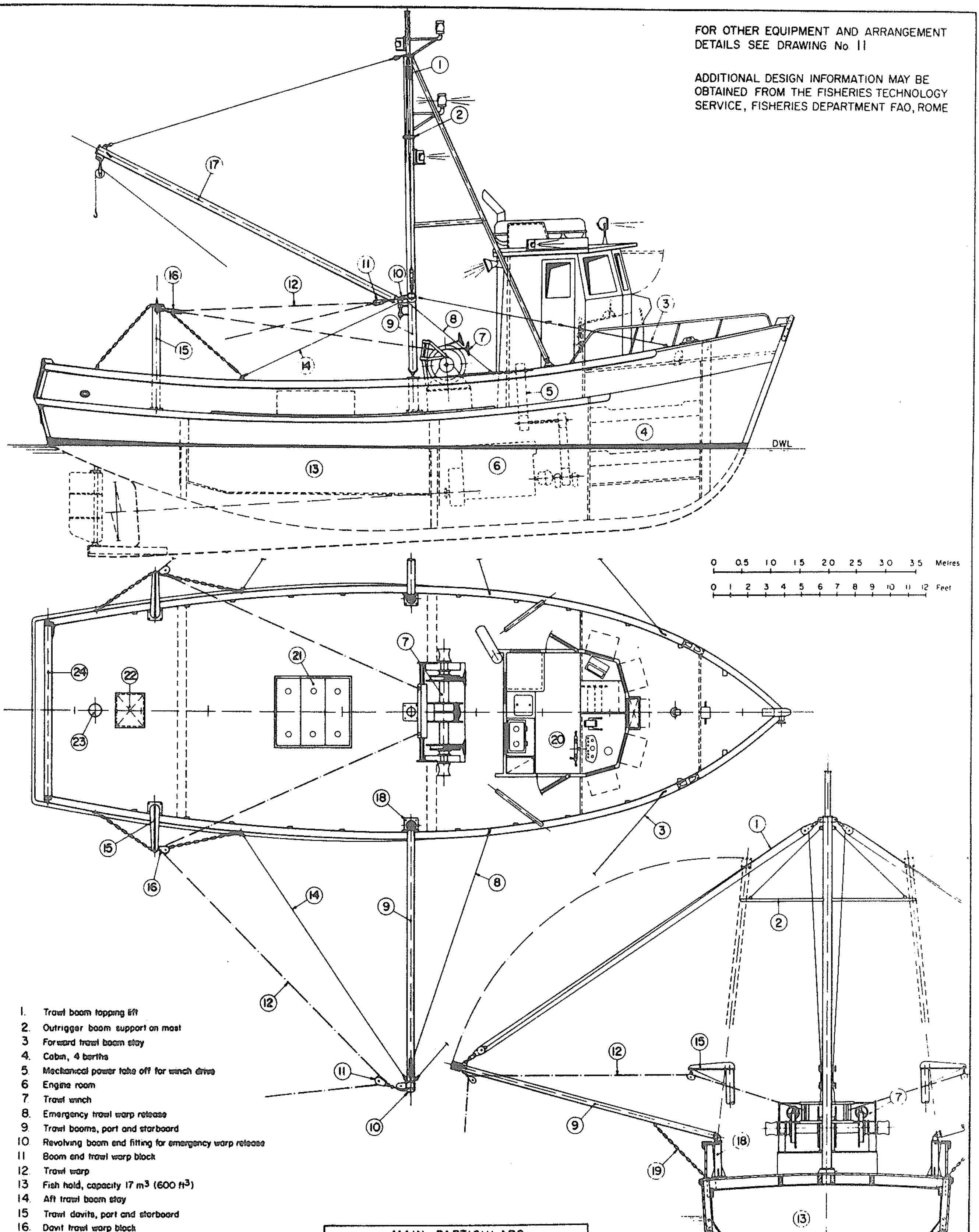




0 0.5 1.0 1.5 2.0 2.5 3.0 Metres
0 1 2 3 4 5 6 7 8 9 10 Feet

| 12.60m Gantry Trawler | | |
|---|---|---|
| GENERAL ARRANGEMENT | | |
| Scale as shown | Boat No | Drwg No |
| Design ØG/TL/JF<br>Rome, June 197 | ST/UGA-2 | 12 |

FOR OTHER EQUIPMENT AND ARRANGEMENT DETAILS SEE DRAWING No 11

ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME




1. Trawl boom topping lift
2. Outrigger boom support on mast
3. Forward trawl boom stay
4. Cabin, 4 berths
5. Mechanical power take off for winch drive
6. Engine room
7. Trawl winch
8. Emergency trawl warp release
9. Trawl booms, port and starboard
10. Revolving boom end fitting for emergency warp release
11. Boom end trawl warp block
12. Trawl warp
13. Fish hold, capacity 17 $m^3$ (600 $ft^3$)
14. Aft trawl boom stay
15. Trawl davits, port and starboard
16. Davit trawl warp block
17. Loading boom
18. Outrigger boom support
19. Holding down chain
20. Wheel house
21. Hatch to fish hold
22. Hatch to deck store
23. Deck plate over emergency tiller
24. Stern roller

| MAIN PARTICULARS | | |
|---|---|---|
| Length over all | 13.00 m | (42 ft 8 in) |
| Length water line (DWL) | 12.10 m | (39 ft 9 in) |
| Beam water line (DWL) | 4.26 m | (14 ft 0 in) |
| Beam moulded | 4.34 m | (14 ft 3 in) |
| Depth moulded | 1.96 m | (6 ft 5 in) |
| Displacement to DWL | 25.46 $m^3$ | (899 $ft^3$) |
| Engine | 100 hp | |

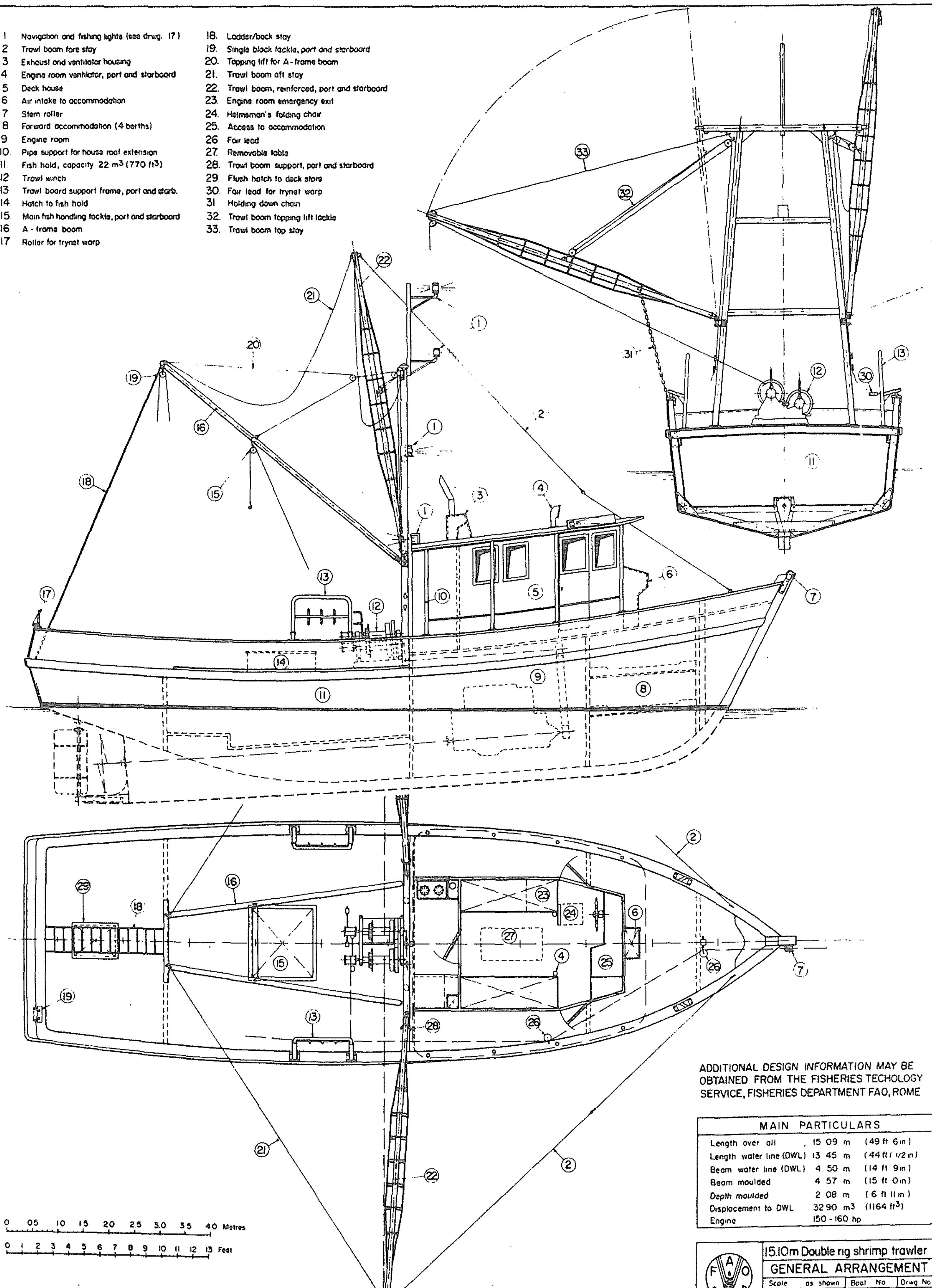
FAO FIAT PANIS

13.00 m Single/double rig

GENERAL ARRANGEMENT

| Scale as shown | Boat No | Drwg No |
|---|---|---|
| Design AO/TL/JF | ST/GAM-1 | 13 |
| Rome, Sept 1979 | | |

1 Navigation and fishing lights (see drwg. 17)
2 Trawl boom fore stay
3 Exhaust and ventilator housing
4 Engine room ventilator, port and starboard
5 Deck house
6 Air intake to accommodation
7 Stem roller
8 Forward accommodation (4 berths)
9 Engine room
10 Pipe support for house roof extension
11 Fish hold, capacity 22 $m^3$ (770 $ft^3$)
12 Trawl winch
13 Trawl board support frame, port and starb.
14 Hatch to fish hold
15 Main fish handling tackle, port and starboard
16 A - frame boom
17 Roller for trynet warp
18. Ladder/back stay
19. Single block tackle, port and starboard
20. Topping lift for A - frame boom
21. Trawl boom aft stay
22. Trawl boom, reinforced, port and starboard
23. Engine room emergency exit
24. Helmsman's folding chair
25. Access to accommodation
26 Fair lead
27. Removable table
28. Trawl boom support, port and starboard
29 Flush hatch to deck store
30. Fair lead for trynet warp
31 Holding down chain
32. Trawl boom topping lift tackle
33. Trawl boom top stay




ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME

| MAIN PARTICULARS | | |
|---|---|---|
| Length over all | 15 09 m | (49 ft 6 in) |
| Length water line (DWL) | 13 45 m | (44 ft 1 1/2 in) |
| Beam water line (DWL) | 4 50 m | (14 ft 9 in) |
| Beam moulded | 4 57 m | (15 ft 0 in) |
| *Depth moulded* | 2 08 m | (6 ft 11 in) |
| Displacement to DWL | 32 90 $m^3$ | (1164 $ft^3$) |
| Engine | 150 - 160 hp | |

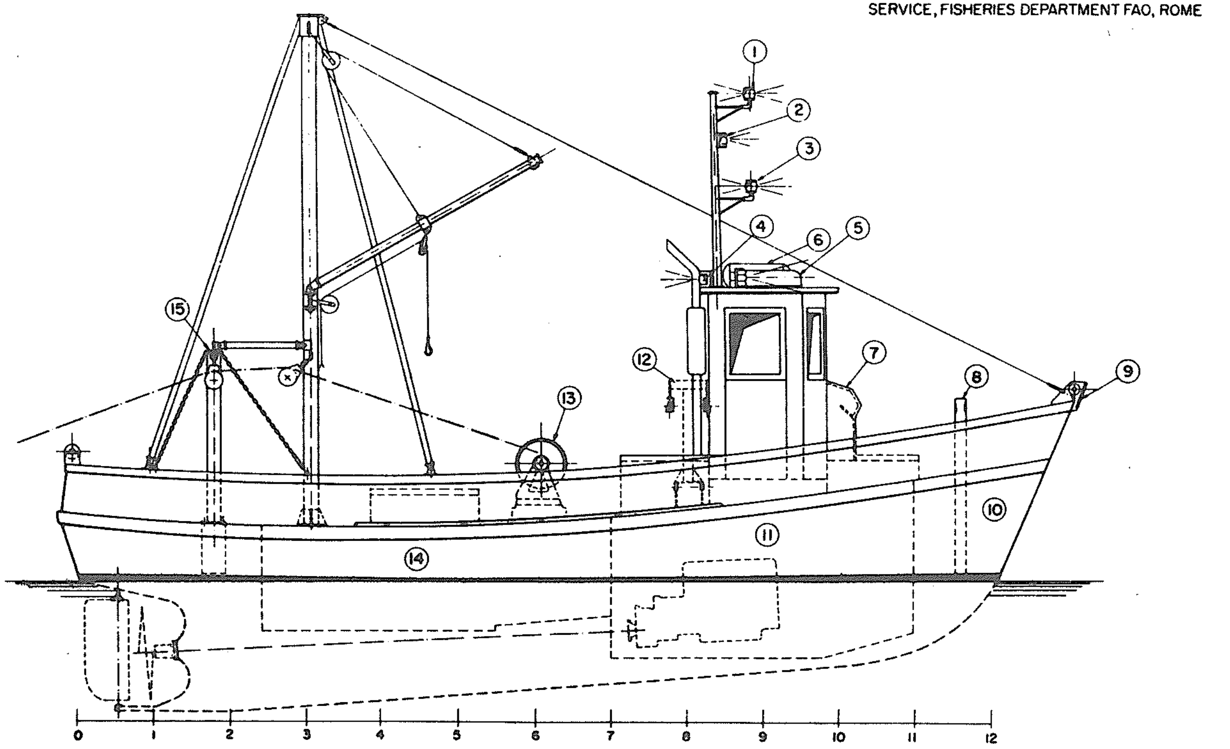
FAO FIAT PANIS

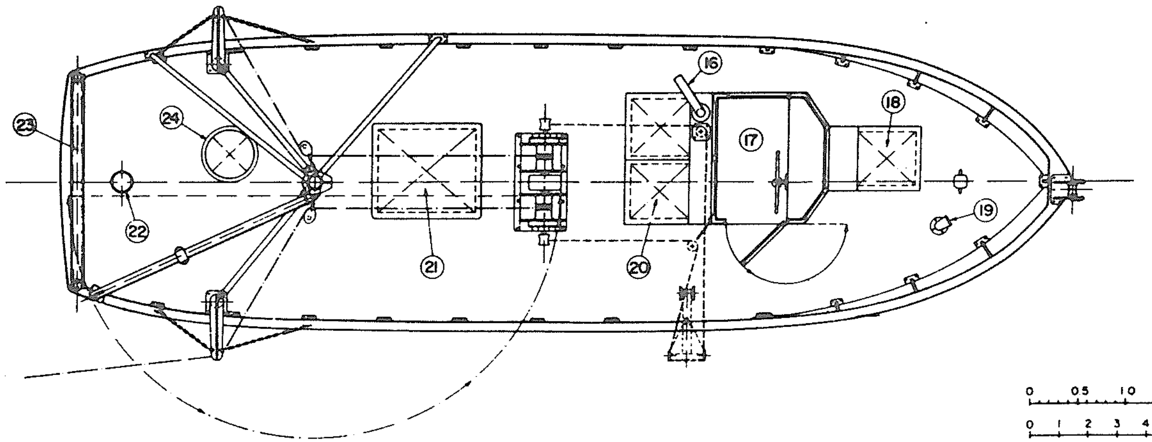
15.10m Double rig shrimp trawler

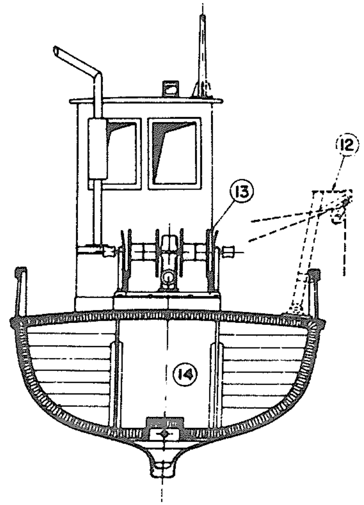
GENERAL ARRANGEMENT

| Scale as shown | Boat No | Drwg No |
|---|---|---|
| Design WDC/TL/JF<br>Rome, September 1979 | ST/GHA-1 | 14 |

ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME







1. Fishing light green 360°
2. Masthead light white 225°
3. Fishing light white 360°
4. Sternlight white 135°
5. Sidelight red/green 112 ½°
6. Liferaft
7. Air intake engine room
8. Mooring bitt
9. Chain roller
10. Chain locker
11. Engine room
12. Removable purse davit
13. Trawl winch
14. Fish hold, capacity 8.5 $m^3$ (300 $ft^3$)
15. Trawl davit, port and starboard
16. Exhaust pipe
17. Wheel house
18. Down engine room
19. Chain pipe
20. Engine remove hatch
21. Hatch to fish hold
22. Deck plate above emergency tiller
23. Stern roller
24. Hatch to deck store

0 0.5 1.0 1.5 2.0 2.5 3.0 Metres

0 1 2 3 4 5 6 7 8 9 10 Feet

**MAIN PARTICULARS**

| | | |
|---|---|---|
| Length over all | 10.50 m | (34 ft 5 in) |
| Length water line (DWL) | 9.50 m | (31 ft 2 in) |
| Beam moulded | 3.25 m | (10 ft 3 in) |
| Beam water line (DWL) | 2.75 m | (9 ft 9 in) |
| Depth moulded | 1.50 m | (4 ft 11 in) |
| Displacement to DWL | 11.30 $m^3$ | (399 $ft^3$) |
| Engine | 60-80 hp | |

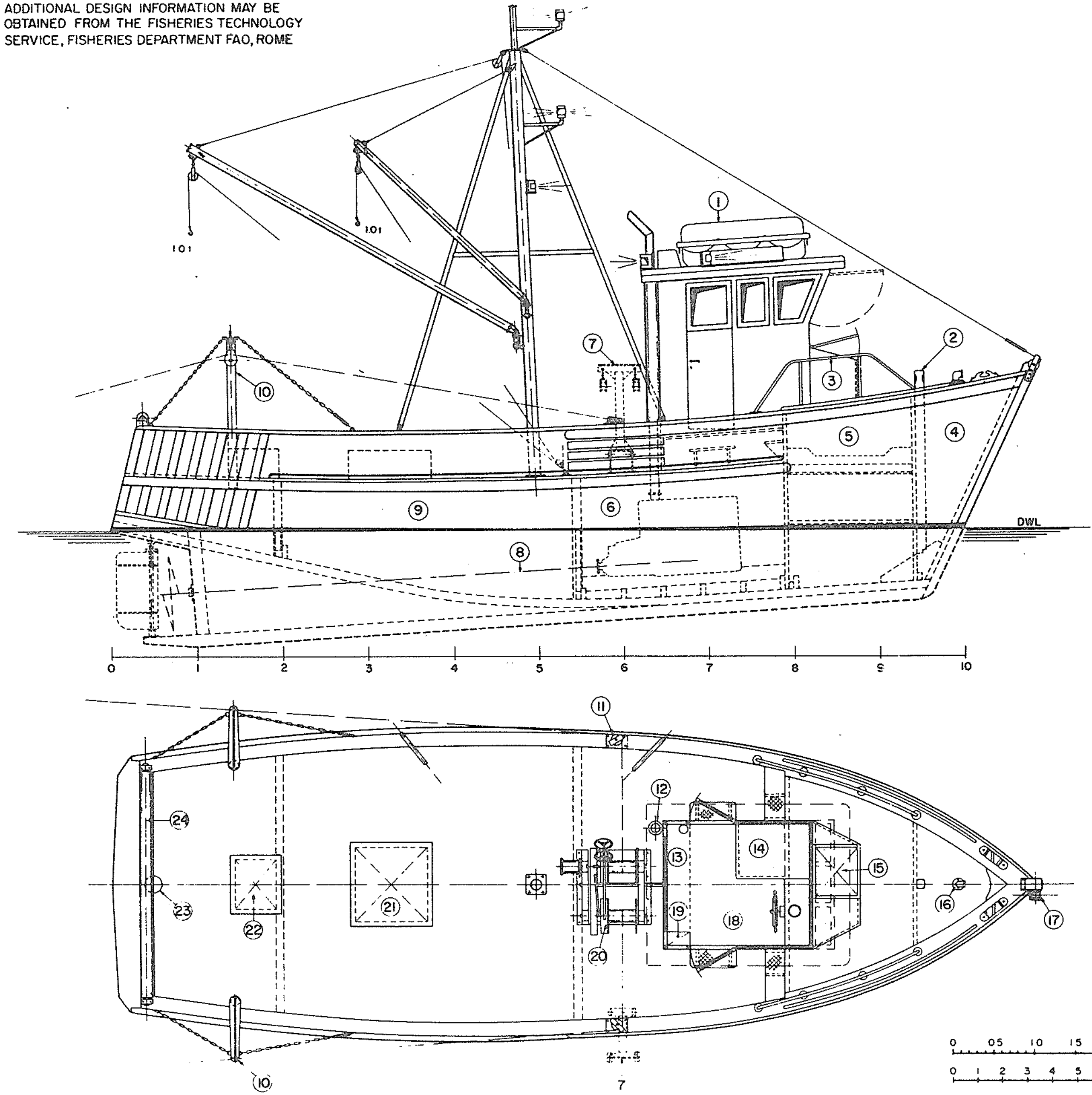
FAO FIAT PAMIS

**10.50 m Trawler / Purse seiner**

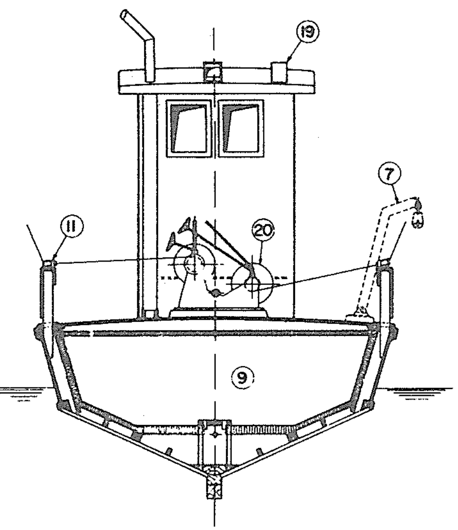
**GENERAL ARRANGEMENT**

| Scale | as shown | Boat No. | Drwg No. |
|---|---|---|---|
| Design | JF / ØG | ST/TUN-2 | 15 |
| Rome, | Nov 1979 | | |

ADDITIONAL DESIGN INFORMATION MAY BE OBTAINED FROM THE FISHERIES TECHNOLOGY SERVICE, FISHERIES DEPARTMENT FAO, ROME

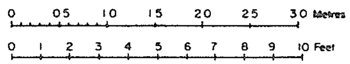



1. Liferaft
2. Mooring bitt
3. Rail
4. Chain locker
5. Cabin with 1 berth
6. Engine room
7. Removable purse davit
8. Average shaft line, adjust according to engine installated
9. Fish hold 9.0 $m^3$ (317 $ft^3$)
10. Removable trawl davit, port and starboard
11. Removable trawl block, port and starboard
12. Exhaust pipe
13. Optional shelf for portable cooker and/or R./T.
14. Down engine room folding chart table over
15. Hatch to accommodation
16. Chain pipe
17. Chain roller bolted through stem
18. Wheel house
19. Air intake to engine room
20. Combined trawl and purse seine winch
21. Hatch to fish hold
22. Hatch to deck store
23. Deck plate above emergency tiller
24. Stern roller



**MAIN PARTICULARS**

| | | |
|---|---|---|
| Length over all | 11 38 m | (37 ft 4 in) |
| Length water line (DWL) | 10.45 m | (34 ft 4 in) |
| Beam water line (DWL) | 3 45 m | (11 ft 4 in) |
| Beam moulded | 3 80 m | (12 ft 6 in) |
| Depth moulded | 1 67 m | (5 ft 5 1/2 in) |
| Displacement to DWL | 12.55 $m^3$ | (443 $ft^3$) |
| Engine | 60-80 hp | |

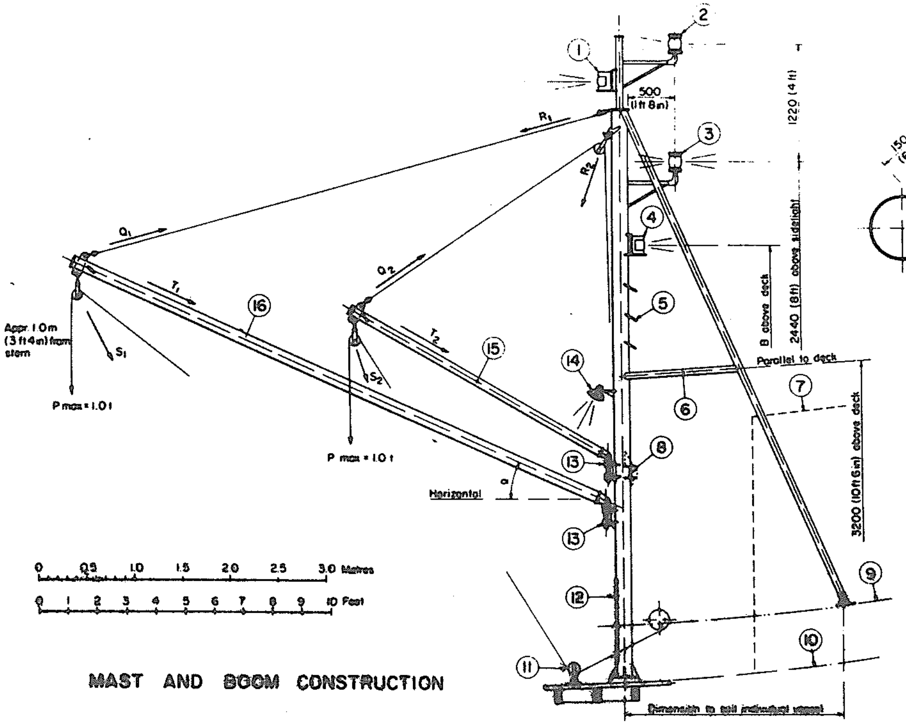



FAO FIAT PANIS

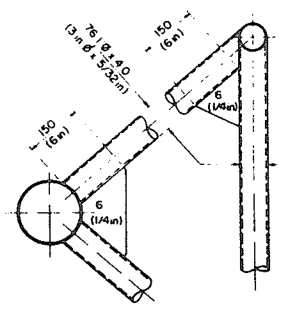
**11.40 m Trawler / Purse seiner**

**GENERAL ARRANGEMENT**

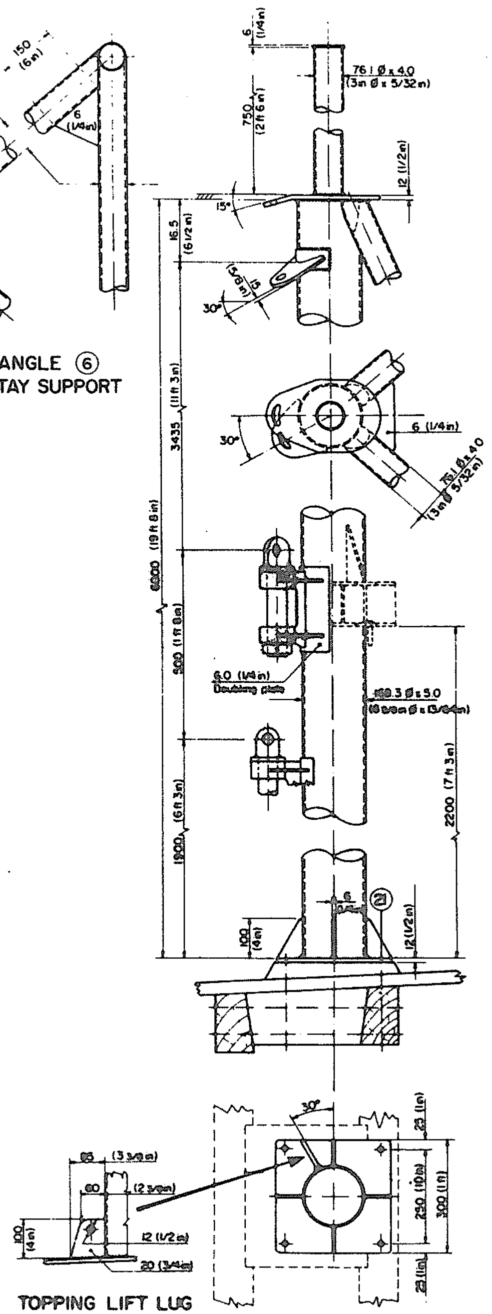
| Scale as shown | Boat No | Drwg No |
|---|---|---|
| Design TL / JF | ST/MLW-4 | 16 |
| Rome, June 1979 | | |




MAST AND BOOM CONSTRUCTION




TRIANGLE ⑥ FOR STAY SUPPORT



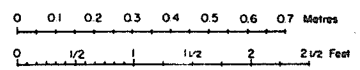

TOPPING LIFT LUG

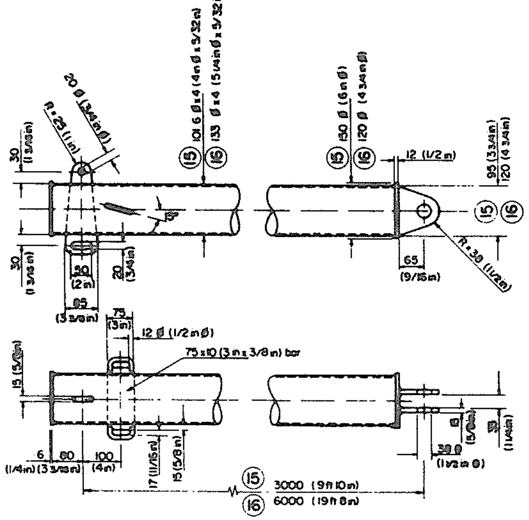
1. Sternlight white 135°
2. Fishing light green 360°
3. Fishing light white 360°
4. Masthead light white 225°
5. Ladder 12 mm (1/2 in) rod
6. Stay support 76.1 Ø x 4.0 (3 in Ø x 5/32 in) steel pipe
7. House
8. Support for trawl wire block
9. Rail
10. Deck line
11. Snatch block for cod end lift
12. Chain fall in topping lift
13. Gooseneck bearing
14. Working deck light
15. Boom length 3.0 m (9 ft 10 in) } between these lengths use intermediate dimensions
16. Boom length 6.0 m (19 ft 8 in) }
17. Galvanized bolt 20 mm Ø (3/4 in Ø)
18. Galvanized bolt 25 mm Ø (1 in Ø)
19. Galvanized bolt 15 mm Ø (5/8 in Ø)
20. Packing each side of bulwark stanchion
21. Galvanized bolt 15 mm Ø (5/8 in Ø)

FOR RAKE OF MAST SEE INDIVIDUAL DESIGNS

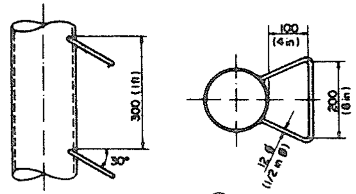
| 3.0 m BOOM | |
|---|---|
| α = 15° | α = 30° |
| $Q_2$ = 1.85 t | $Q_2$ = 1.50 t |
| $R_2$ = 3.40 t | $R_2$ = 2.60 t |
| $S_2$ = 1.90 t | $S_2$ = 1.95 t |
| $T_2$ = 2.15 t | $T_2$ = 2.05 t |

| 6.0 m BOOM | |
|---|---|
| α = 15° | α = 30° |
| $Q_1$ = 2.00 t | $Q_1$ = 1.70 t |
| $R_1$ = 2.00 t | $R_1$ = 1.70 t |
| $S_1$ = 1.75 t | $S_1$ = 1.85 t |
| $T_1$ = 2.80 t | $T_1$ = 2.80 t |

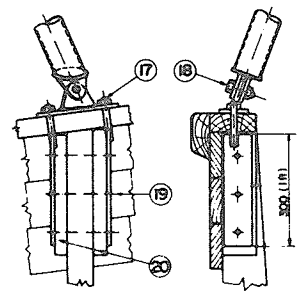



BOOM ⑮ AND ⑯




LADDER ⑤




PIPE STAY / RAIL FITTING

| Small Trawlers | | |
|---|---|---|
| STANDARD RIGGING DETAILS | | |
| Scale as shown | Boat No. | Drwg No. |
| Design TL / JF | VARIOUS | 17 |
| Rome, June 1979 | | |

# DAVIT SCANTLINGS FOR VARIOUS BOATS AND RELATED HORSEPOWERS

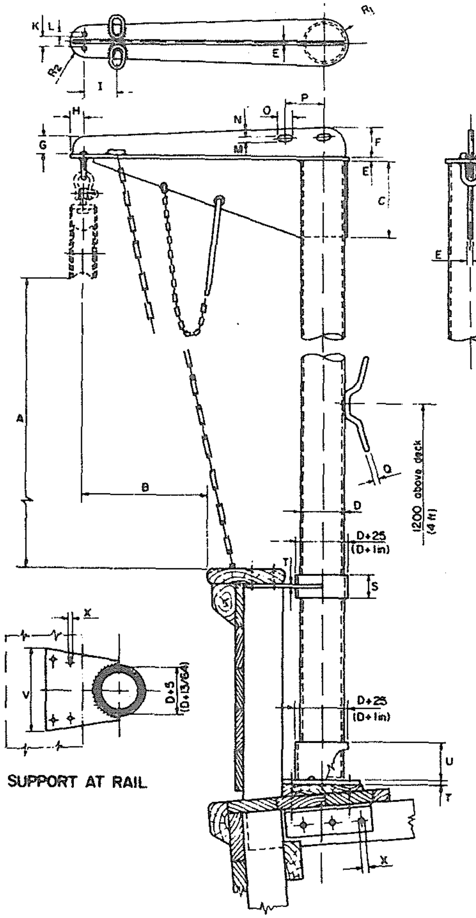
MILLIMETRES

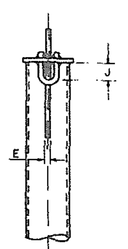
| LOA | SHP[1] | PULL[2] | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | $R_1$ | $R_2$ | S | T | U | V | W | X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.75 m | 60 | 0.60 | 550 | 300 | 200 | 88.9[3] | 10 | 80 | 50 | 35 | 80 | 45 | 25 | 13 | 15 | 15 | 35 | 100 | 13 | 60 | 40 | 60 | 10 | 100 | 200 | 40 | 13 | 300 |
| 11.40 m | 80 | 0.96 | 675 | 375 | 200 | 114.3[3] | 12 | 85 | 55 | 35 | 90 | 45 | 25 | 15 | 17 | 17 | 40 | 100 | 15 | 70 | 45 | 60 | 10 | 100 | 200 | 40 | 13 | 300 |
| 12.60 m | 100 | 1.20 | 755 | 425 | 225 | 133[4] | 12 | 100 | 60 | 40 | 100 | 55 | 30 | 19 | 17 | 17 | 40 | 100 | 15 | 80 | 50 | 60 | 12 | 100 | 250 | 40 | 16 | 300 |
| 13.00 m | 100 | 1.20 | 755 | 425 | 225 | 133[4] | 12 | 100 | 60 | 40 | 100 | 55 | 30 | 19 | 17 | 17 | 40 | 100 | 15 | 80 | 50 | 60 | 12 | 100 | 250 | 40 | 16 | 300 |
| 15.09 m | 160 | 2.08 | 825 | 500 | 250 | 159[5] | 15 | 100 | 65 | 40 | 100 | 60 | 35 | 22 | 20 | 20 | 50 | 100 | 19 | 90 | 60 | 60 | 12 | 100 | 250 | 40 | 16 | 300 |

INCHES

| LOA | SHP[1] | PULL[2] | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | $R_1$ | $R_2$ | S | T | U | V | W | X | Y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 ft | 60 | 0.60 | 18 | 12 | 8 | 3 1/2[3] | 3/8 | 3 1/2 | 2 | 1 3/8 | 3 1/8 | 1 3/4 | 1 | 1/2 | 5/8 | 5/8 | 1 3/8 | 4 | 1/2 | 2 3/8 | 1 5/8 | 2 3/8 | 3/8 | 4 | 8 | 1 5/8 | 1/2 | 12 |
| 37 ft 4 in | 80 | 0.96 | 27 | 15 | 8 | 4 1/2[3] | 1/2 | 3 3/8 | 2 1/8 | 1 3/8 | 3 1/2 | 1 3/4 | 1 | 5/8 | 3/4 | 3/4 | 1 5/8 | 4 | 5/8 | 2 3/4 | 1 3/4 | 2 3/8 | 3/8 | 4 | 8 | 1 5/8 | 1/2 | 12 |
| 41 ft 1 in | 100 | 1.20 | 30 | 17 | 9 | 5 1/4[4] | 1/2 | 4 | 2 3/8 | 1 5/8 | 4 | 2 1/4 | 1 1/4 | 3/4 | 3/4 | 3/4 | 1 5/8 | 4 | 5/8 | 3 1/8 | 2 | 2 3/8 | 1/2 | 4 | 10 | 1 5/8 | 5/8 | 12 |
| 42 ft 8 in | 100 | 1.20 | 30 | 17 | 9 | 5 1/4[4] | 1/2 | 4 | 2 3/8 | 1 5/8 | 4 | 2 1/4 | 1 1/4 | 3/4 | 3/4 | 3/4 | 1 5/8 | 4 | 5/8 | 3 1/8 | 2 | 2 3/8 | 1/2 | 4 | 10 | 1 5/8 | 5/8 | 12 |
| 49 ft 6 in | 160 | 2.01 | 33 | 20 | 10 | 6 1/4[5] | 5/8 | 4 | 2 5/8 | 1 5/8 | 4 | 2 3/8 | 1 3/8 | 7/8 | 3/4 | 3/4 | 2 | 4 | 3/4 | 3 1/2 | 2 3/8 | 2 3/8 | 1/2 | 4 | 10 | 1 5/8 | 5/8 | 12 |

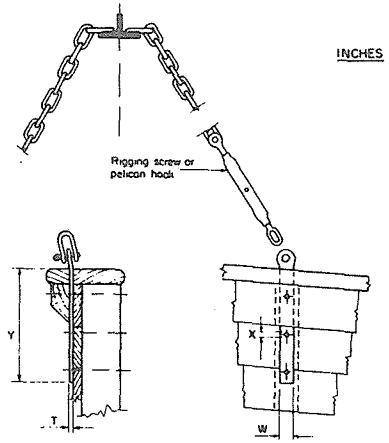
1/ Typical continuous shaft horsepower
2/ Estimated bollard pull in tons
3/ Pipe wall thickness 5 mm (13/64 in)
4/ Pipe wall thickness 5.6 mm (7/32 in)
5/ Pipe wall thickness 7.1 mm (9/32 in)



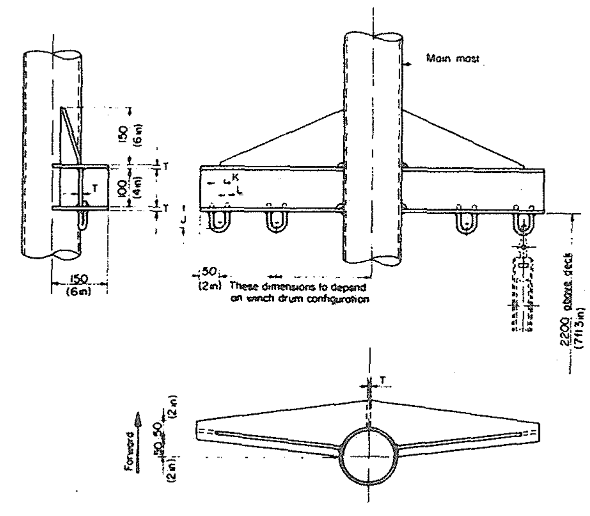



SUPPORT AT RAIL

TRAWL DAVIT

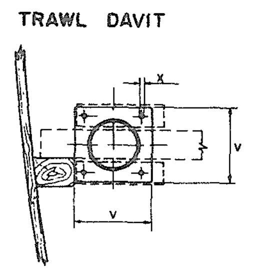



CHAIN SUPPORT TO RAIL

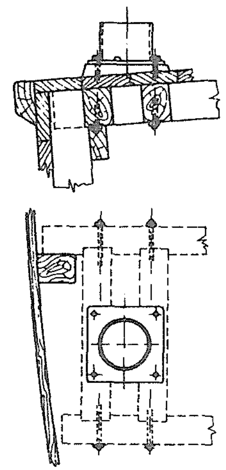



MAST FITTING FOR OVERHEAD LEAD OF TRAWL WARPS

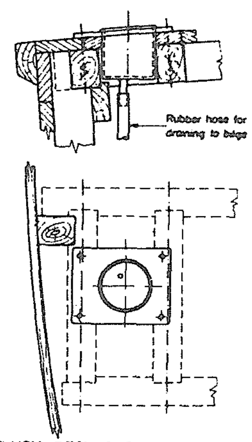
See drawing No. 11 for trawl warp leads



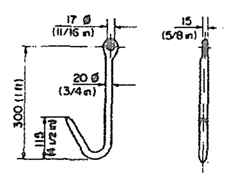
SUPPORTED ON BEAM



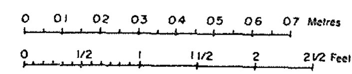
SUPPORTED BETWEEN BEAMS



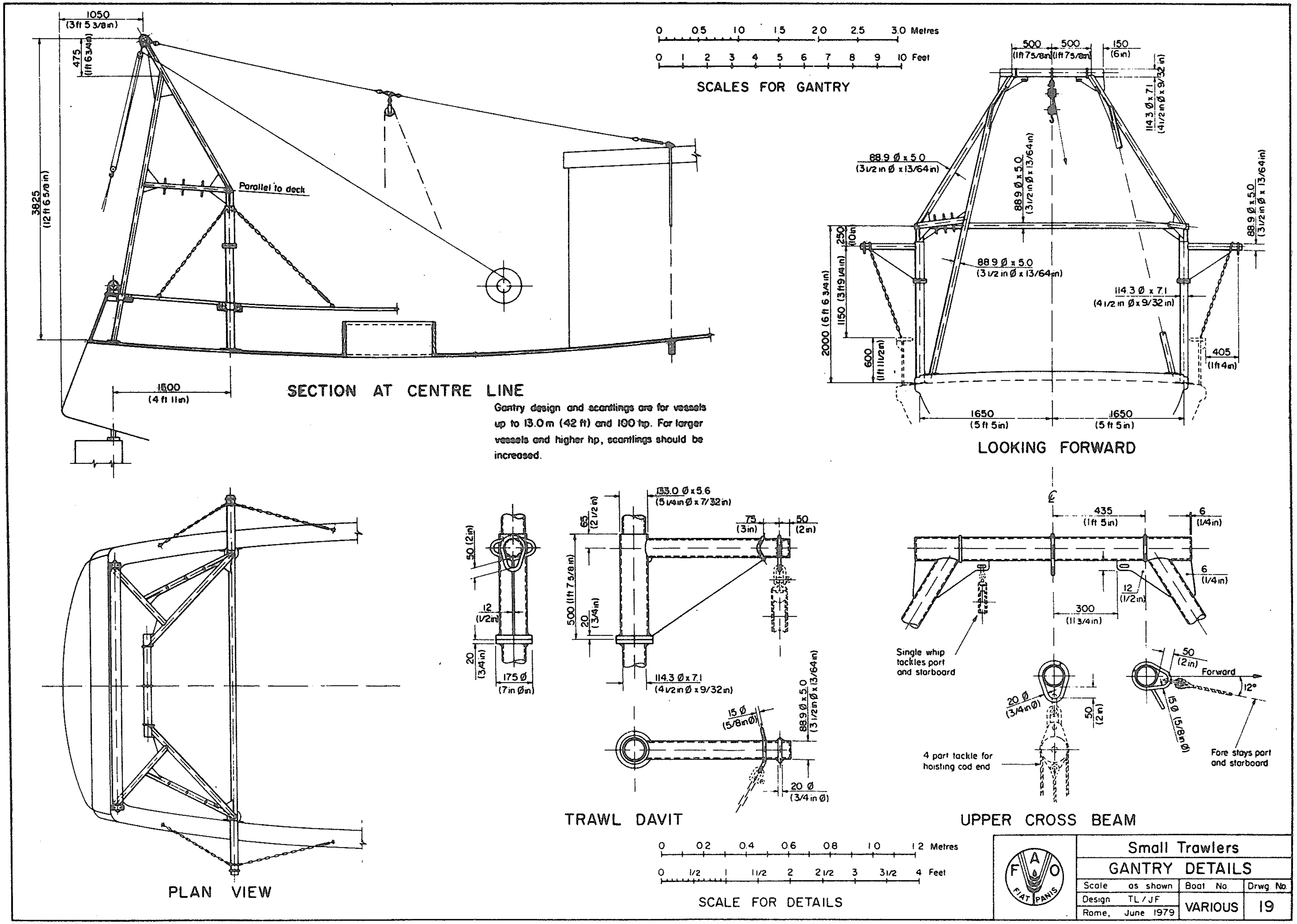

FLUSH DECK SUPPORT FOR COMBINATION VESSEL




TRAWLDOOR CHAIN HOOK




| | | | |
|---|---|---|---|
| FAO FIAT PANIS | Small Trawlers | | |
| | TRAWL DAVIT DETAILS | | |
| | Scale as shown | Boat No | Drwg No |
| | Design TL / JF | VARIOUS | 18 |
| | Rome, June 1979 | | |



SECTION AT CENTRE LINE
Gantry design and scantlings are for vessels up to 13.0 m (42 ft) and 100 hp. For larger vessels and higher hp, scantlings should be increased.
Parallel to deck
1050 (3 ft 5 3/8 in)
475 (1 ft 6 3/4 in)
3825 (12 ft 6 5/8 in)
1500 (4 ft 11 in)
SCALES FOR GANTRY
0 0.5 1.0 1.5 2.0 2.5 3.0 Metres
0 1 2 3 4 5 6 7 8 9 10 Feet
LOOKING FORWARD
500 (1 ft 7 5/8 in)
500 (1 ft 7 5/8 in)
150 (6 in)
114.3 Ø x 7.1 (4 1/2 in Ø x 9/32 in)
88.9 Ø x 5.0 (3 1/2 in Ø x 13/64 in)
250 (10 in)
1150 (3 ft 9 1/4 in)
2000 (6 ft 6 3/4 in)
600 (1 ft 11 1/2 in)
405 (1 ft 4 in)
1650 (5 ft 5 in)
1650 (5 ft 5 in)
PLAN VIEW
TRAWL DAVIT
133.0 Ø x 5.6 (5 1/4 in Ø x 7/32 in)
65 (2 1/2 in)
75 (3 in)
50 (2 in)
500 (1 ft 7 5/8 in)
20 (3/4 in)
114.3 Ø x 7.1 (4 1/2 in Ø x 9/32 in)
50 (2 in)
12 (1/2 in)
20 (3/4 in)
175 Ø (7 in Ø in)
15 Ø (5/8 in Ø)
88.9 Ø x 5.0 (3 1/2 in Ø x 13/64 in)
20 Ø (3/4 in Ø)
UPPER CROSS BEAM
435 (1 ft 5 in)
6 (1/4 in)
6 (1/4 in)
12 (1/2 in)
300 (11 3/4 in)
Single whip tackles port and starboard
20 Ø (3/4 in Ø)
50 (2 in)
4 part tackle for hoisting cod end
50 (2 in)
Forward
12°
15 Ø (5/8 in Ø)
Fore stays port and starboard
SCALE FOR DETAILS
0 0.2 0.4 0.6 0.8 1.0 1.2 Metres
0 1/2 1 1 1/2 2 2 1/2 3 3 1/2 4 Feet
FAO FIAT PANIS
Small Trawlers
GANTRY DETAILS
Scale as shown
Design TL / JF
Rome, June 1979
Boat No. VARIOUS
Drwg No. 19

M-41/T0445E/3/3.91/500
ISBN 92-5-100700-4