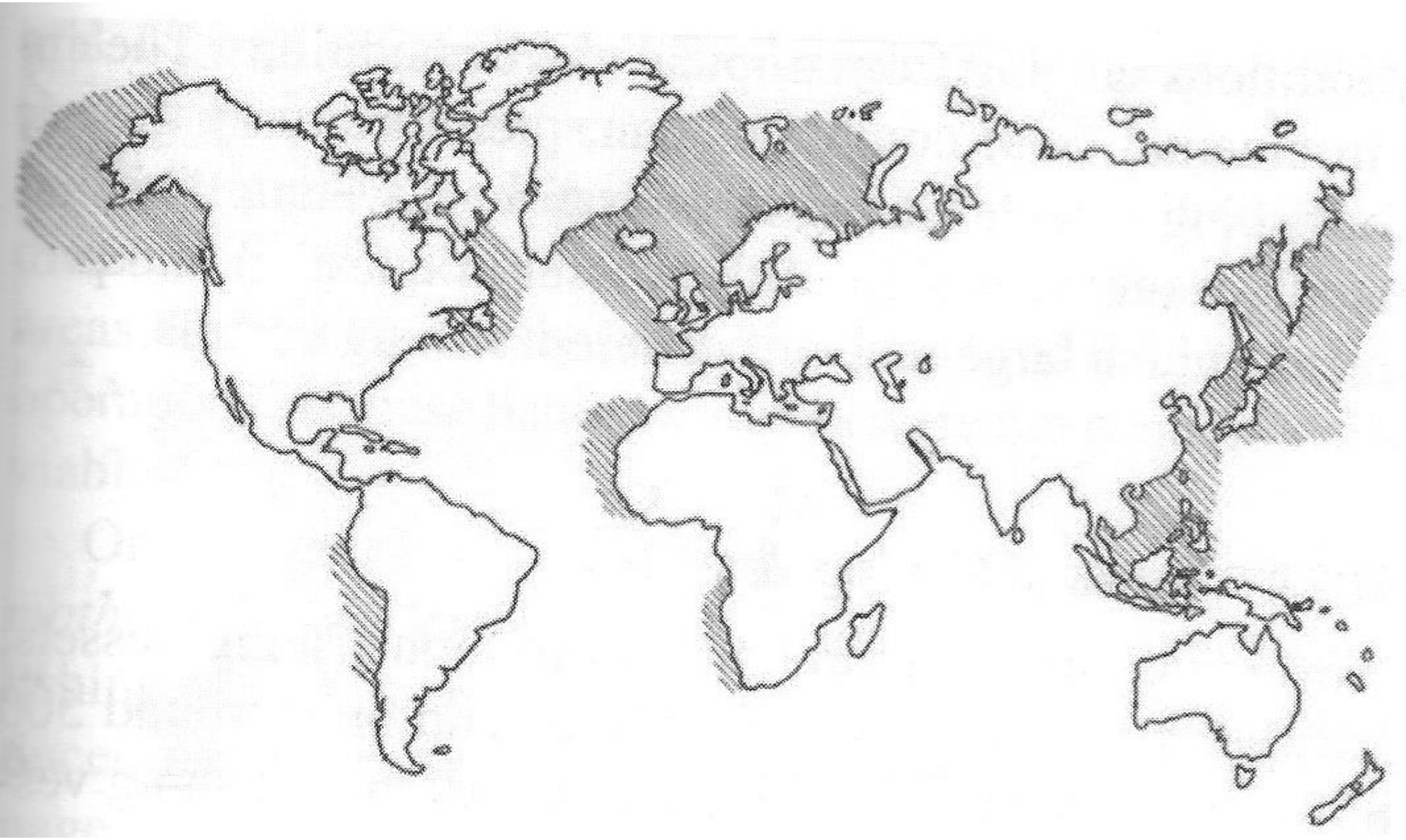
A DESIGN SYNTHESIS FOR STEEL-HULLED TRAWLERS

ACD. REYNALDO B. VEA

ESTD-NAST

REGIONAL SCIENTIFIC MEETING
NATIONAL ACADEMY OF SCIENCE AND TECHNOLOGY
DAVAO CITY, MARCH 2017

MAIN FISHING GROUNDS IN THE WORLD



SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

WORLDWIDE :

100 MILLION FISHING VESSELS MOSTLY ONE-MAN FISHING BOATS

500 LARGE FISHING FREEZER TRAWLERS

VESSEL LENGTH (m)	VOYAGE DURATION (days)	REFRIGERATION		FISH PROCESSING ONBOARD
		ICE	FREEZER HOLDS	
<11	1	with or none	none	none
10 TO 50	1 TO 5	with	with	with
50 TO 100	5 TO 30+	none	with	with

TYPES OF FISHING

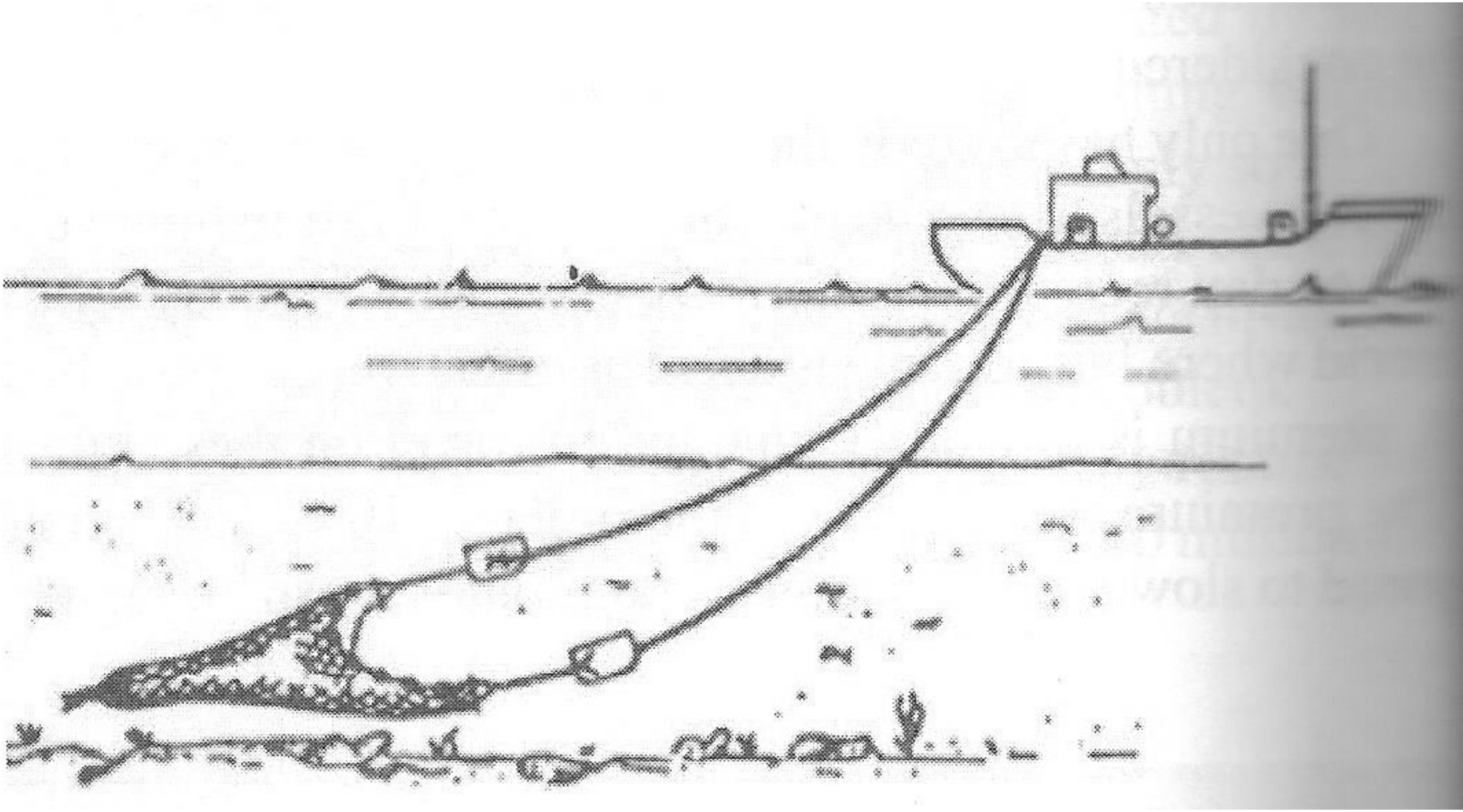
BOTTOM

- SIDE TRAWLING
- BEAM TRAWLING
- STERN TRAWLING

SURFACE

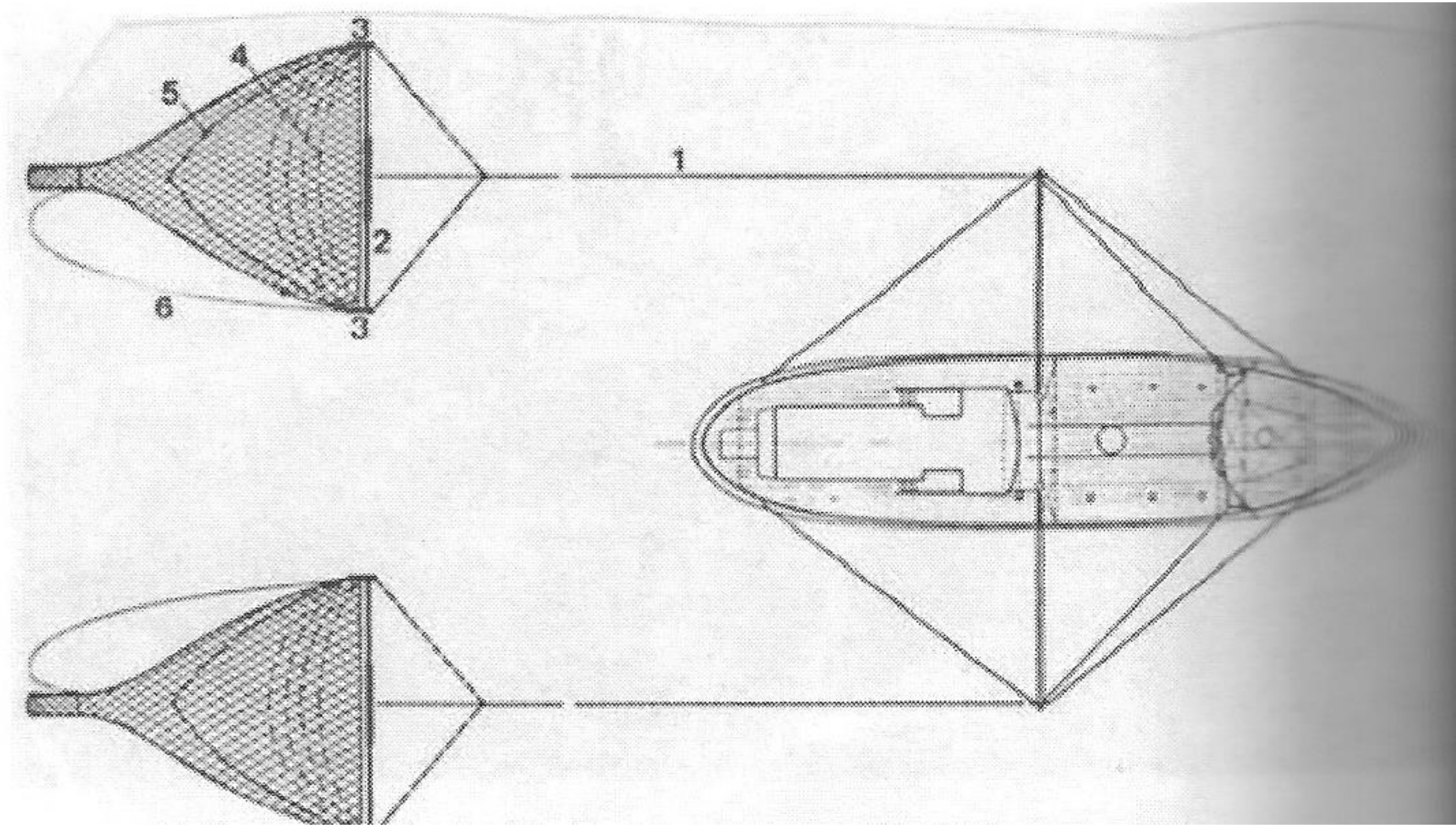
- PURSE SEINING
- GILL NETTING
- LONG LINING
- HAND LINING
- ROD (POLE) LINING
- MIDWATER TRAWLING

TYPICAL SIDE TRAWLING NET CONFIGURATION



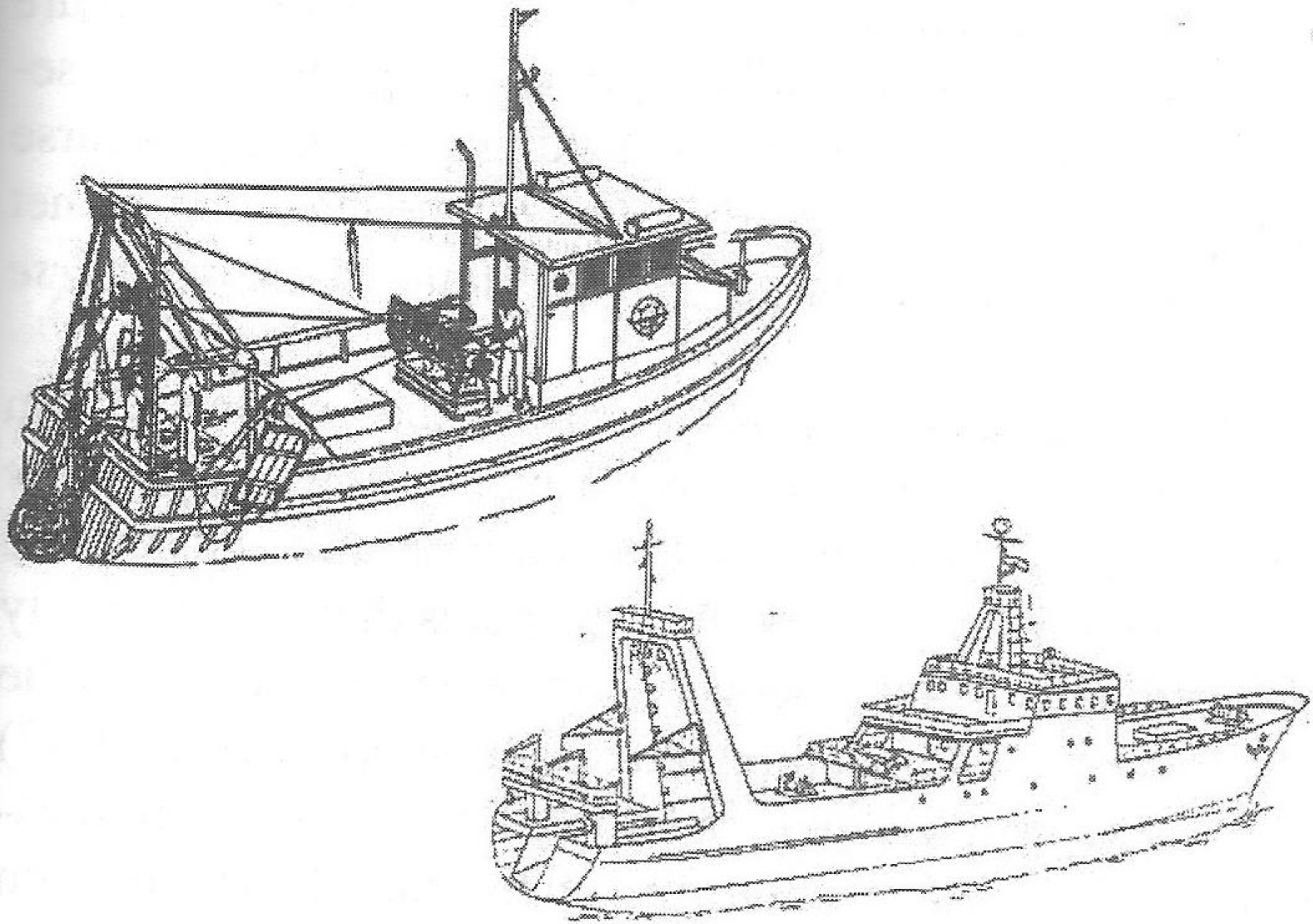
SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

TYPICAL BEAM TRAWLING NET CONFIGURATION



SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

TYPICAL STERN TRAWLERS



SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

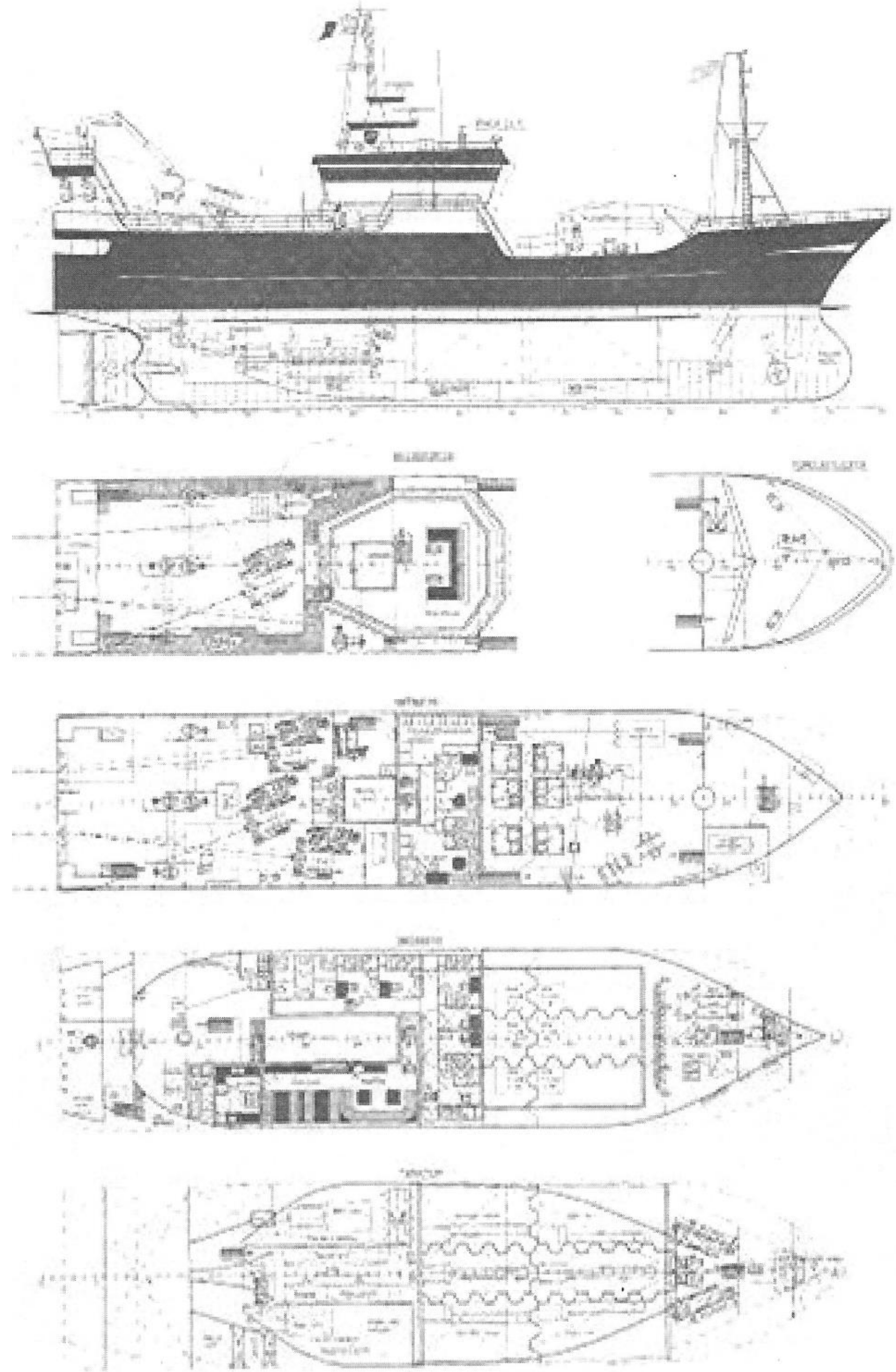
CONVENTIONAL BEAM TRAWLER

SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

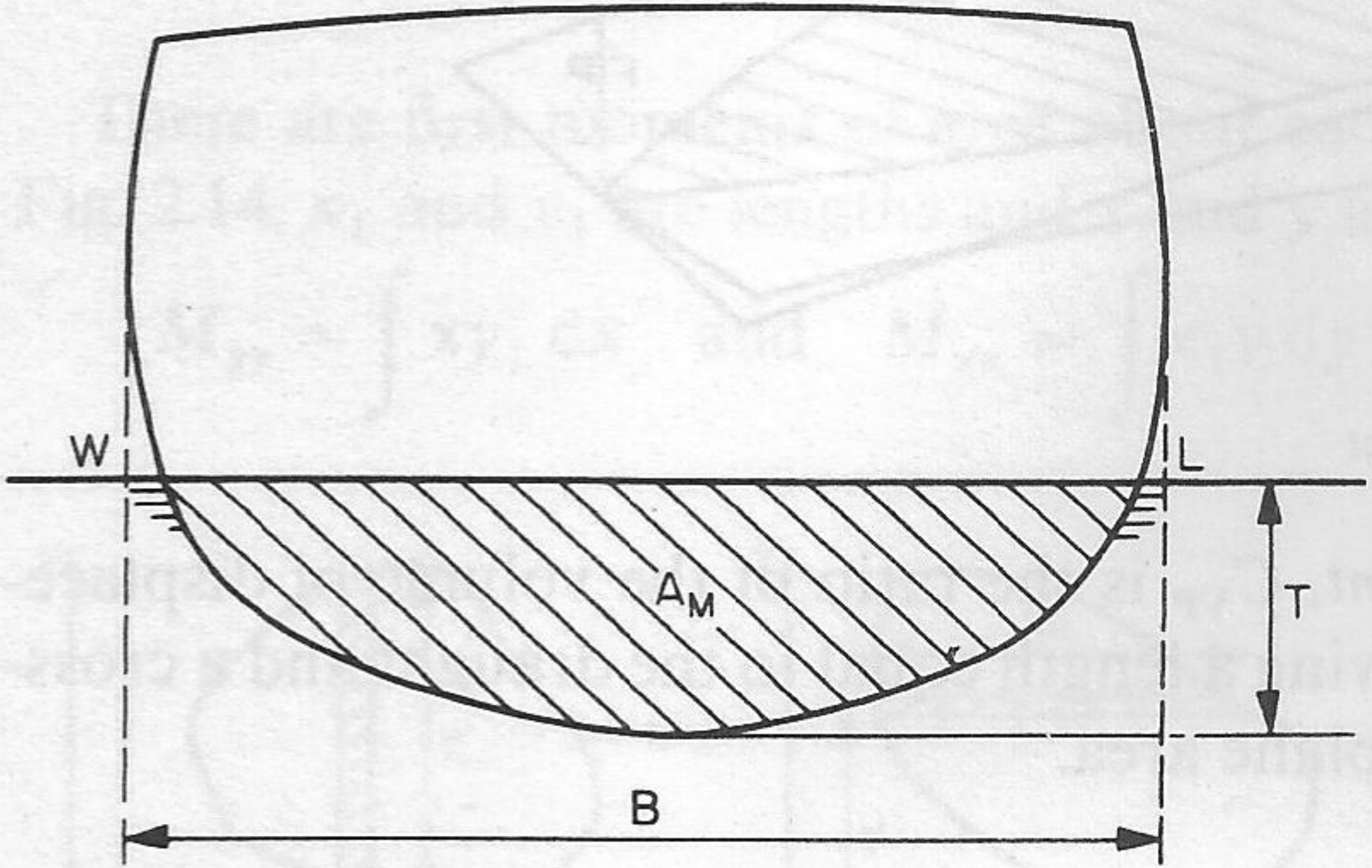
BEAM TRAWLER READY TO SET HER NET

SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.

MODERN MID-SIZED TRAWLER

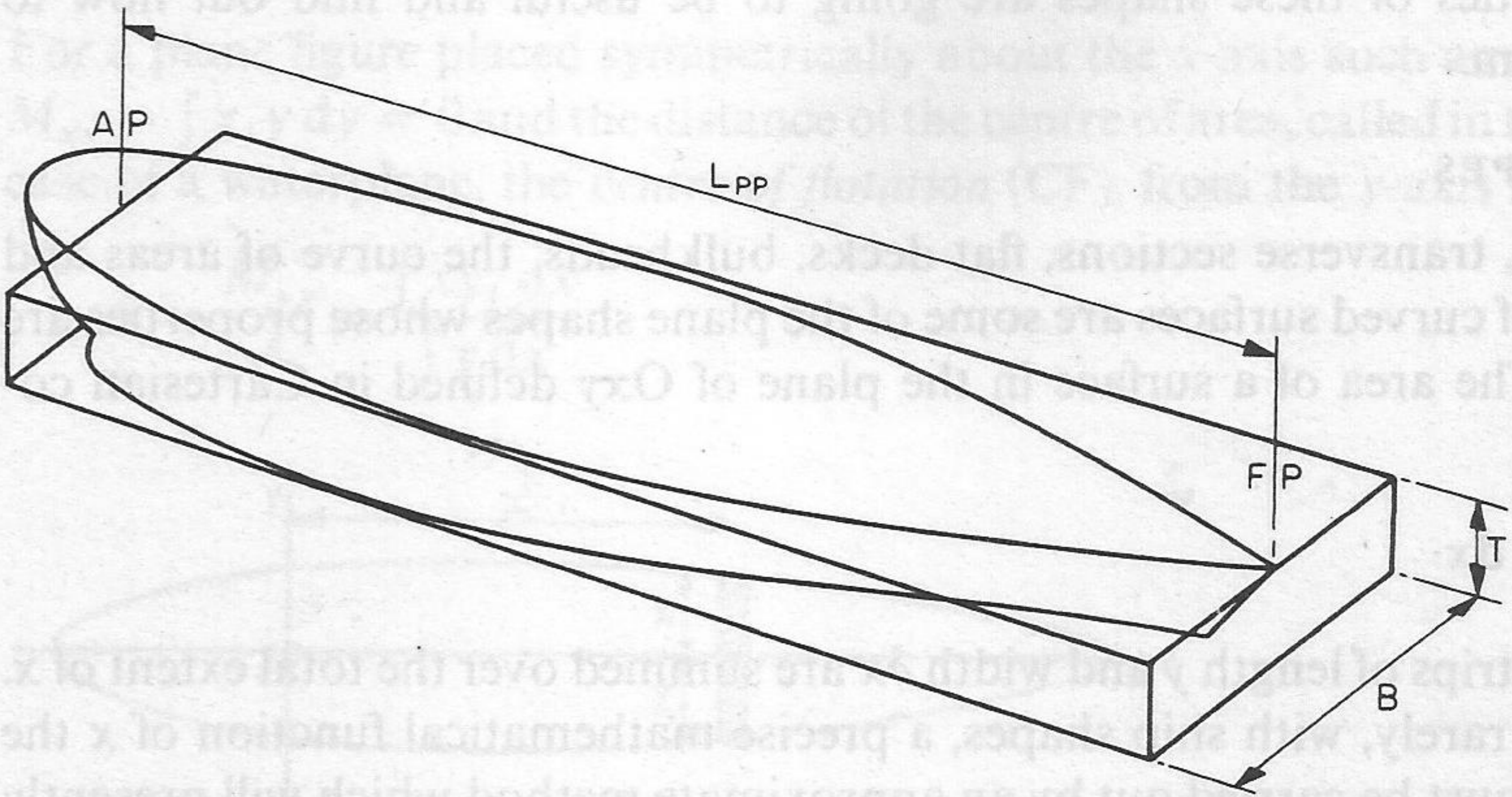


SOURCE: THOMAS LAMB, ED., SHIP DESIGN AND CONSTRUCTION, VOL. II, SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS (SNAME), JERSEY CITY, NJ, USA, 2004.



MIDSHIP COEFFICIENT

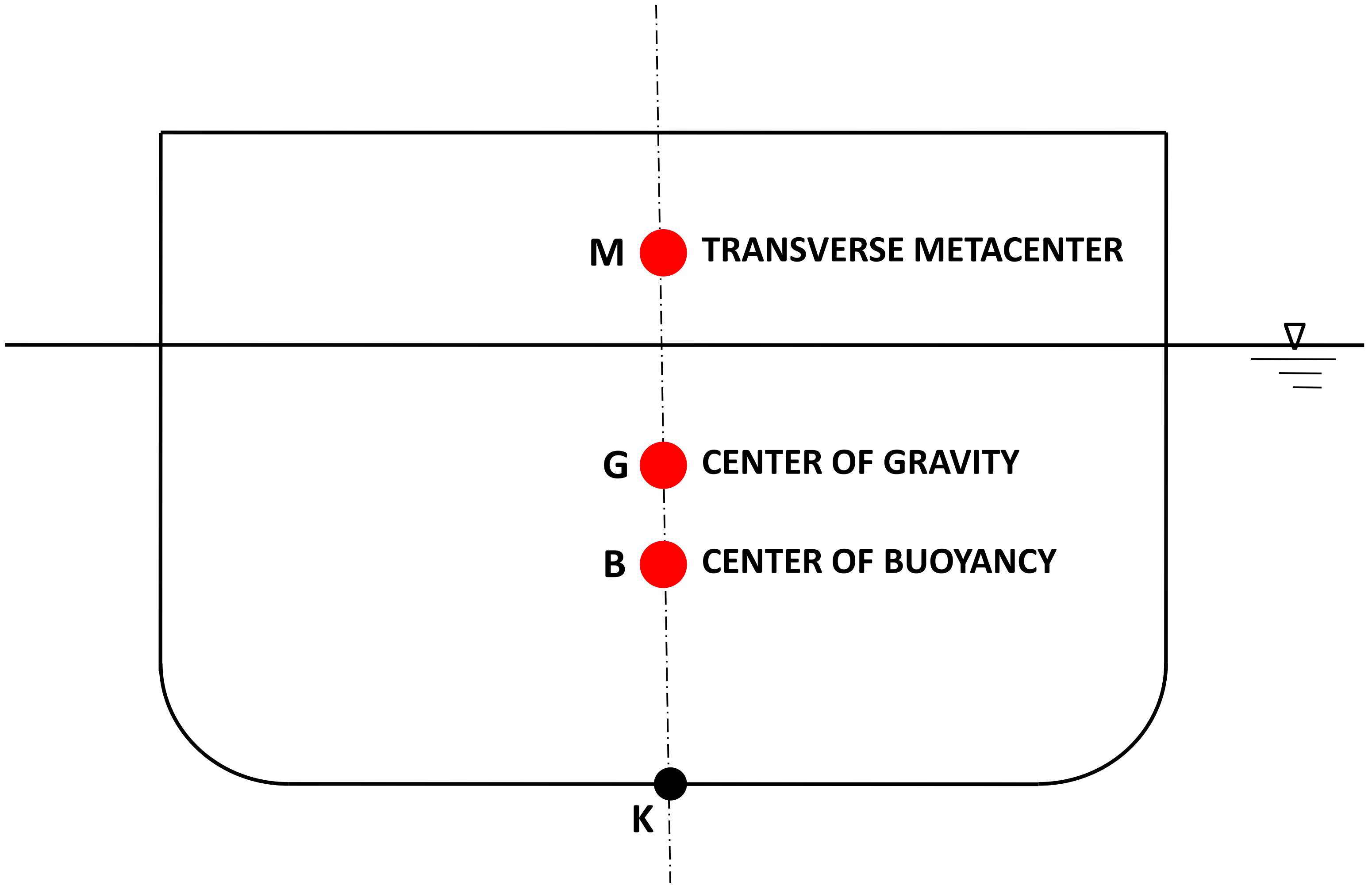
SOURCE: RAWSON, K.J. & TUPPER. E.C., BASIC SHIP THEORY, VOL. I, 2nd Ed., LONGMAN GROUP LIMITED, NY, 1981.



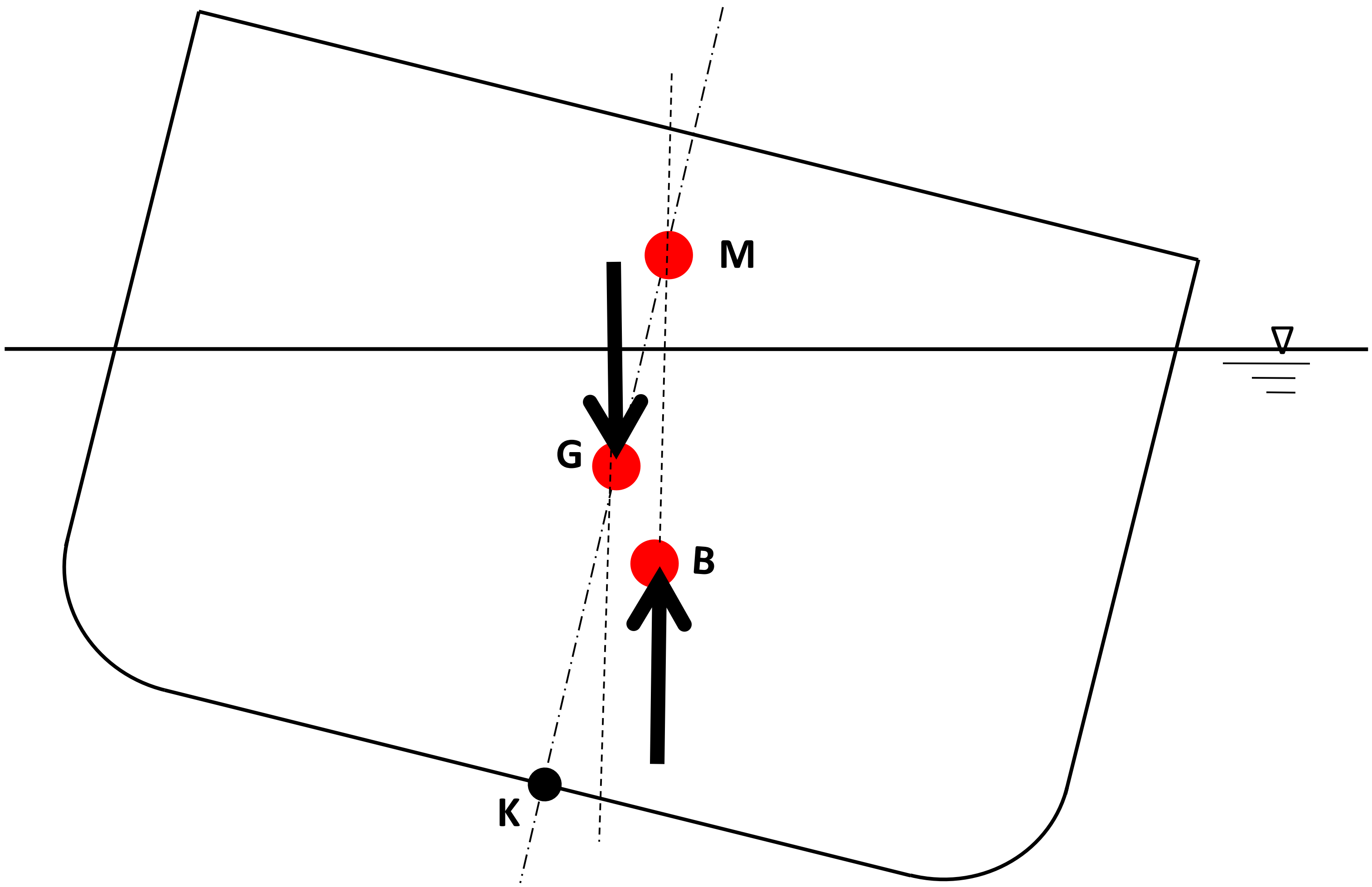
BLOCK COEFFICIENT

SOURCE: RAWSON, K.J. & TUPPER. E.C., BASIC SHIP THEORY, VOL. I, 2nd Ed., LONGMAN GROUP LIMITED, NY, 1981.

THREE IMPORTANT CENTERS IN SHIP STABILITY CALCULATIONS

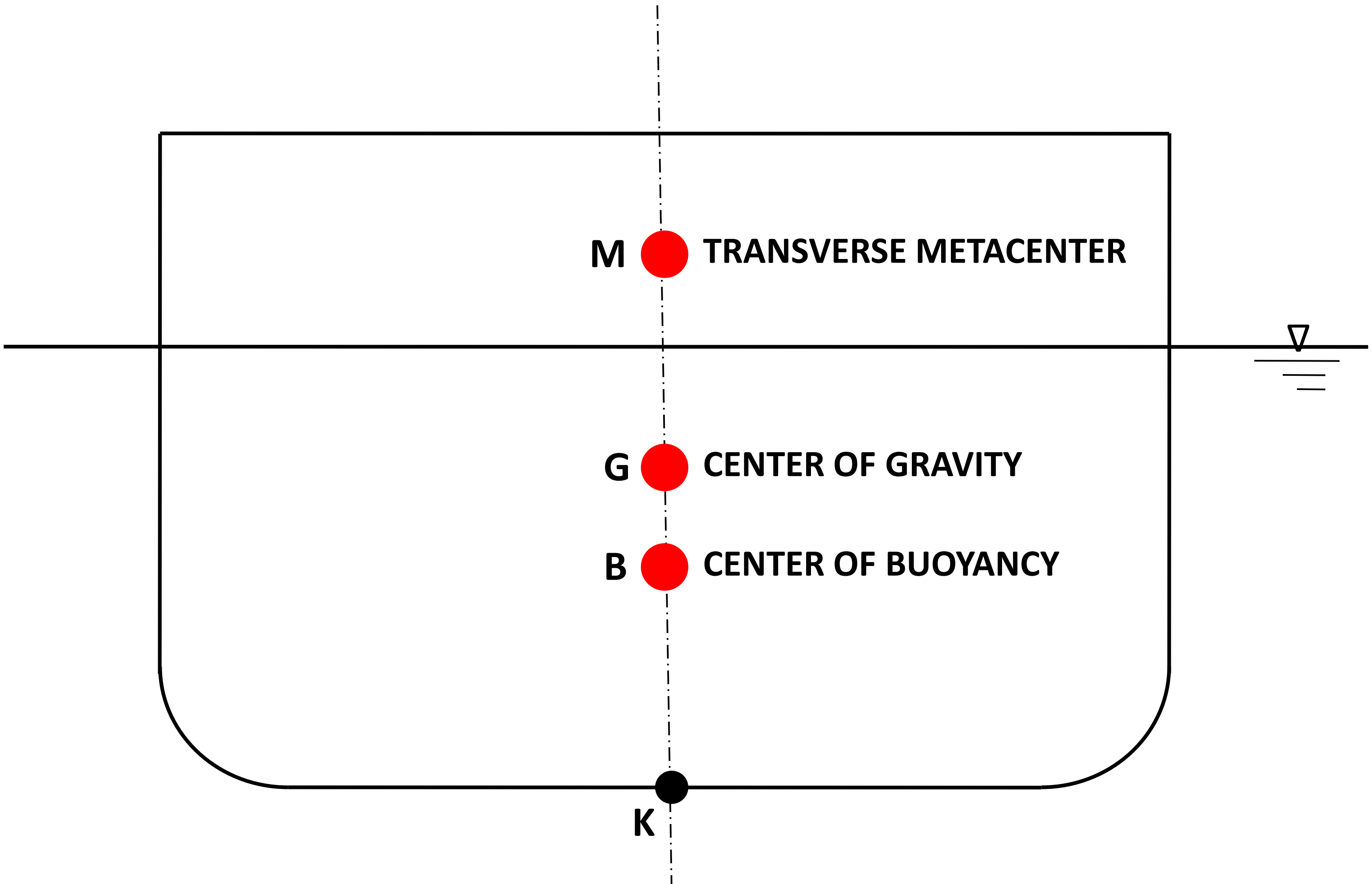


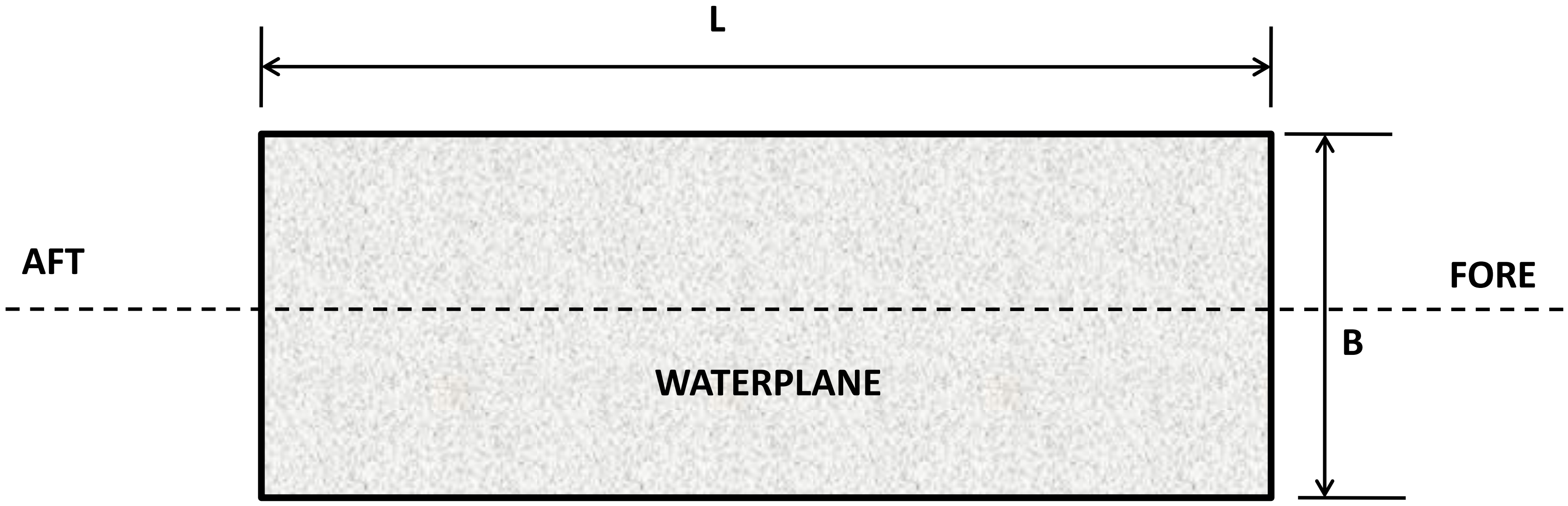
THREE IMPORTANT CENTERS IN SHIP STABILITY CALCULATIONS



$$BM = \frac{I_T}{\nabla}$$

WHERE I_T IS THE MOMENT OF INERTIA (SECOND MOMENT OF AREA) OF THE WATERPLANE AREA (A_{WP}) ABOUT A LONGITUDINAL AXIS OF ROTATION PASSING THROUGH THE CENTER OF THE WATERPLANE AREA AND ∇ IS THE VOLUME OF DISPLACEMENT OF THE VESSEL





FOR A RECTANGULAR WATERPLANE:

$$I_T = \frac{LB^3}{12} \quad (m^4)$$

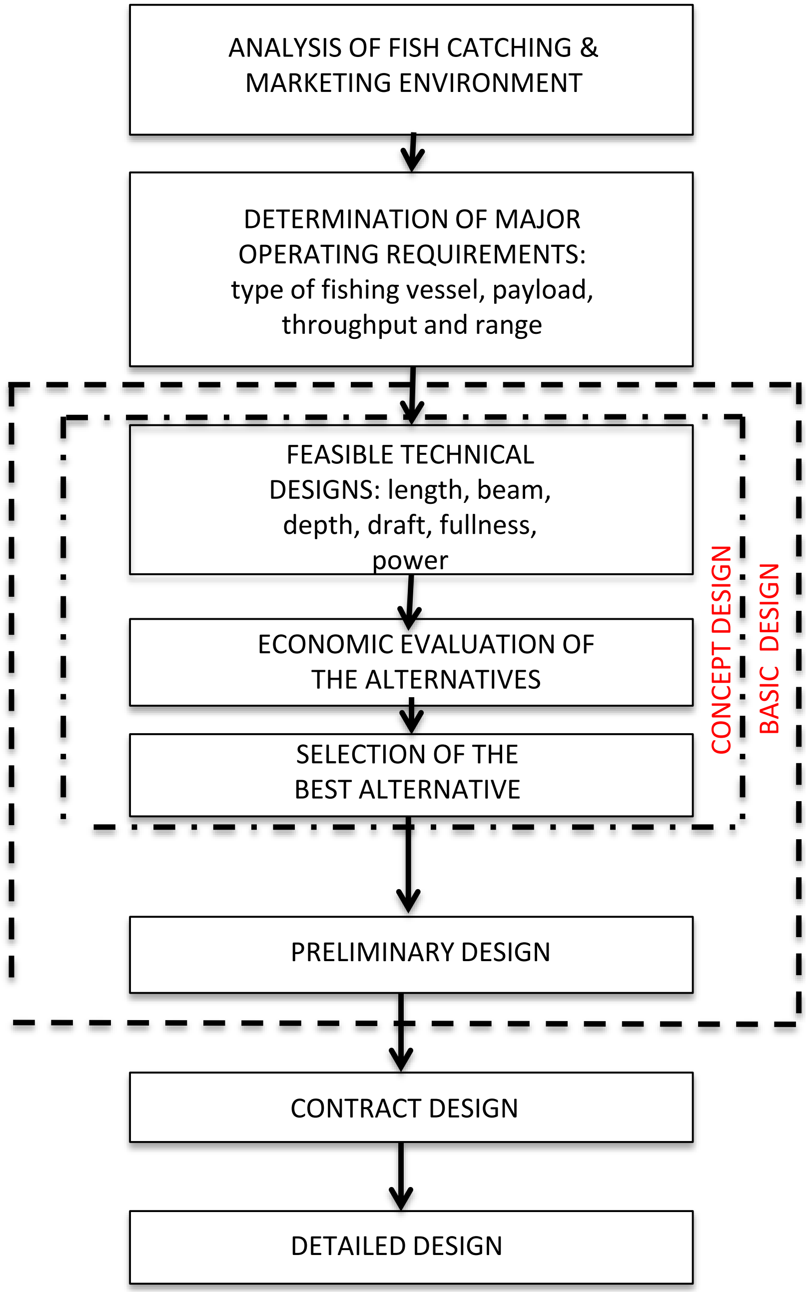
SHIP DESIGN VARIABLES

PRIMARY	SECONDARY	TERTIARY
○ Length ○ Breadth ○ Depth ○ Draft ○ Speed ○ Block coefficient	○ Number & arrangement of holds ○ Number & height of decks ○ Type & capacity of cargo handling gear ○ Machinery type & location ○ Structural; configuration & materials ○ Hull form characteristics ○ Superstructure arrangement ○ Tankage location & materials	○ Number & dimension of hatches ○ Number & type of propeller ○ Crew number & accommodations ○ Auxiliary machineries ○ Location & arrangement of equipment ○ Maneuvering devices ○ Extent of automation ○ Types of coating

The influence of secondary and tertiary variables is not nearly as strong as that of the primary variables.

Focus is on concept design. Alternative designs are evaluated for technical and economic feasibility. Better designs are chosen for further development.

Not an optimization, but evaluation of alternatives one at a time. Systematic parametric variation study may be done.



MAJOR STEPS IN FISHING VESSEL DESIGN

Input data include: length, breadth, depth, draft, block coefficient, midship coefficient, displacement, range & speed. Use sample ships to be in the ballpark.

Hull resistance is estimated from published statistical analysis of trawler resistance data.

Hull weight is a function of ship dimensions.

Fish gear weight about half the hull plus machinery weights.

Fuel oil weight also a function of cruising and trawling days.

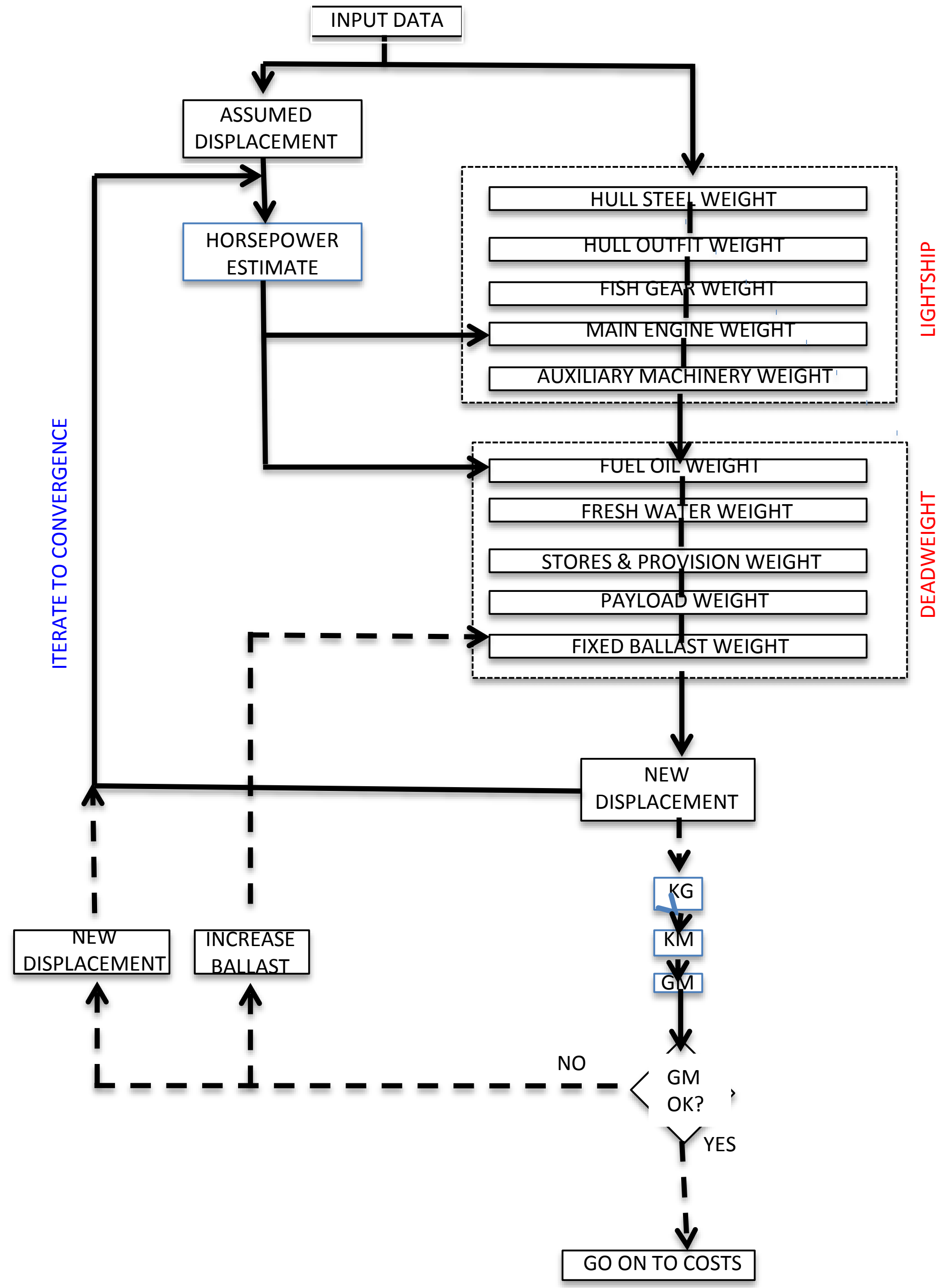
Fresh water & stores/provisions weight a function of days at sea.

Payload based on empirical data shown in next slide.

Consistency in speed, power and displacement is sought.

Solution is iterative because power depends on displacement and displacement in turn depends on power.

An outer loop representing the satisfaction of stability requirements may be added. Most trawlers though do not require any ballast. Stability is important because when the fishing is good it is almost certain that the crew will overload the vessel.



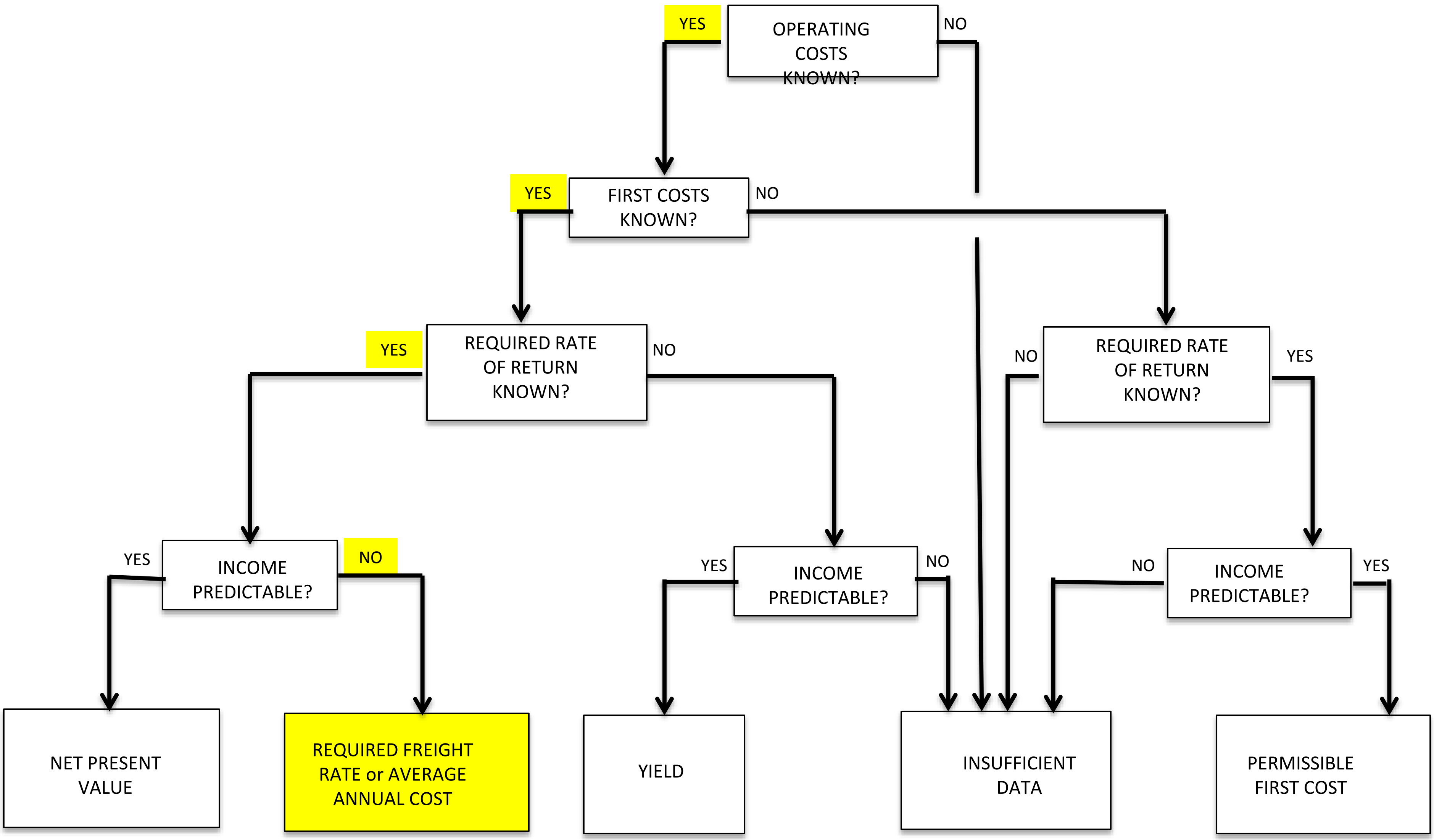
ALGORITHM TO DETERMINE TECHNICAL FEASIBILITY

FISH WEIGHT FROM FISH HOLD VOLUME [FHV]*

	SHIP 1	SHIP 2	SHIP 3	SHIP 4	SHIP 5	SHIP 6
Fish hold volume [FHV] (m^3)	77	154	152	126	1300	232
Cargo deadweight (t) [iced fish in containers]	65	114	117	99	1300	149
FHV/cargo deadweight (m^3/t) [*stowage factor*]	1.18	1.35	1.30	1.27	1.00	1.56
Effective weight **(t) [fish + ice *sans* containers]	40	90	90	75	1000	110
Fish weight** (t) [determined for revenue estimates]	20	45	45	38	500	55
Fish weight/cargo deadweight	0.36	0.39	0.38	0.38	0.38	0.37

* FHV/displacement usually given in published ship data

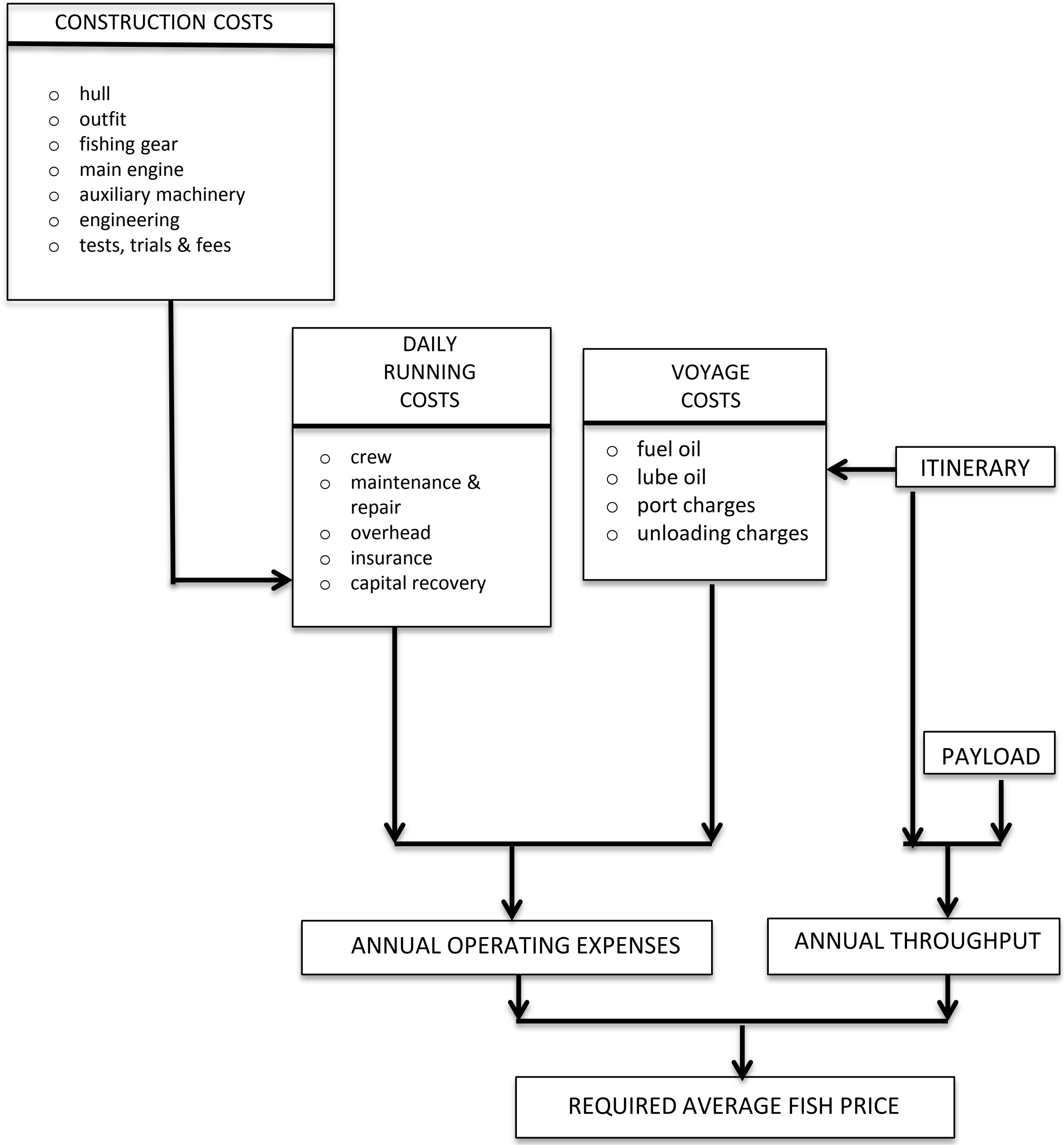
** A 1:1 fish to ice weight ratio is assumed 9info from local fishing boat operators)



DECISION CHART FOR CHOICE OF ECONOMIC FIGURE OF MERIT

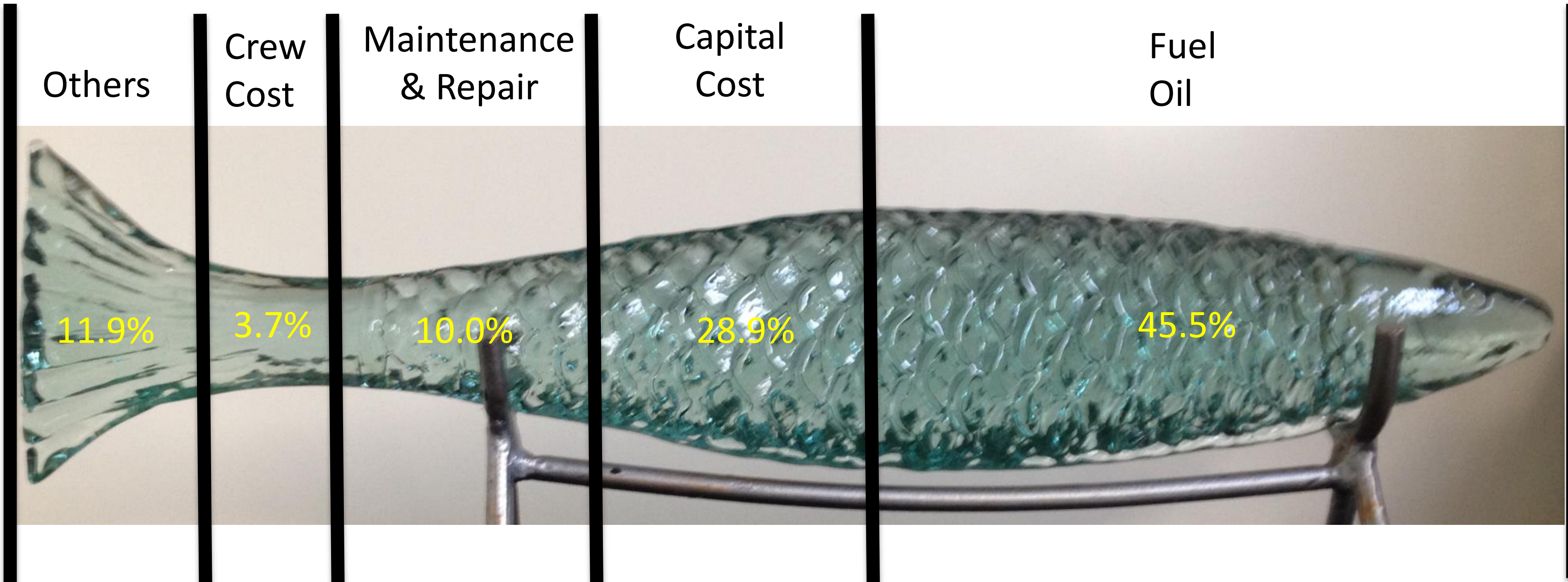
The Required Average Fish Price (RAFP) is the average fish price, after unloading from the vessel, which produces equal present worth of income and expenditure, i.e., zero Net Present Value. The lower the RAFP the better the design. The RAFP can be compared to the market price of fish to have a quick sense of feasibility of the design.

Construction costs are taken from published graphs. Need constant updating.



DETERMINATION OF REQUIRED AVERAGE FISH PRICE

COST COMPONENTS OF FISHING VESSEL OPERATION



THANK YOU!