2

Geography

In this chapter we introduce and discuss a series of maps that were especially prepared to serve as visual reference material for the chapters that follow. These maps reveal the regions of the world in which the need for new sources of protein is greatest. They also reveal the extent of our ignorance about the resources of the sea off the coasts of many of the densely populated underdeveloped regions of the world.

We shall see in this study that although most of the marine part of the world, from polar seas to tropics—"the sea"—may look monotonously like nothing but water, it is actually composed of many kinds of environments. Like land environments, these range in fertility from desert to rich pasture. They range from salt marshes to open seas, from the surface water masses to great depths at the bottom, and on the bottom, from great sandy plains to rolling hills and rocky mountains. They vary in the amount and quality of the organisms which they contain. Not all of those organisms which might be useful can be reached, for the prevailing weather varies from one place to another; therefore, the amount of time that can be spent fishing varies. In any given area, the abundance and availability of fishery stocks vary, going through rhythmic seasonal changes, as well as sporadic fluctuations.

Variation affects every facet of our problem, not only those that relate to the seas but those that relate to human affairs as well. Human environments are as variable as those of the sea. Human populations also differ in many ways. Like fishes, they are unevenly distributed, being densely concentrated in a few areas that are particularly favorable to human life and sparse in other (and very

large) areas that are unfavorable. There are many populations, with differing cultures and traditions and differing demographic properties. Birth rates and death rates vary widely from one population to another, and consequently, the age composition varies, as well as the rate of population growth and the prognosis for future courses.

The problems of producing enough food to support these growing populations differ according to the geography. There are large regions where masses of people have long suffered from chronic starvation. The extent, severity, and causes of this starvation vary. We are concerned with protein deficiency. This varies from one region to another. Therefore, the need of increasing the production of protein foods varies.

The means of increasing it also varies, for the wealth of nations is unevenly distributed. Economic systems and conditions differ; consequently the opportunity of the average man to improve his lot and the number of people in a position to invest money differ from one country to another. Some peoples strive ceaselessly to improve their living standard; others seem less interested in, or even passive toward, material advancement. This lack of ambition may be one symptom of starvation. It is hard to judge how much a prevailing lack of drive may be attributed to innate qualities, how much to malnutrition, and how much to choice.

One detail of human culture which bears most directly on sea fishery is love of the sea. Maritime peoples do not have this in equal degree. Those that have developed it most strongly are rich in ships and seafaring traditions. They are not afraid to go out beyond sight of land to fish on far distant banks or to trade with other countries. It is one thing to foster new sea fisheries in countries where there are already plenty of skilled shipbuilders, net-makers, marine engineers, sailors, and fishermen. It is quite another thing to attempt this in countries which are deficient in such labor forces and where there is no immediate enthusiasm to live on the sea. How to stimulate such enthusiasm is a problem in itself.

The degree of exploitation of marine resources varies over the world. In some regions, particularly in the North Atlantic and North Pacific oceans, where the oldest of the great sea fisheries are carried on, most of the usable fishery stocks are known and at least partly used. A few are overfished and could be made to yield larger returns only by scientifically controlling fishing rates. Obviously it is not there but in the underfished areas that efforts to increase production of sea foods might be intensified most effectively.

Laboratories for marine research tend to be more numerous in regions that are heavily fished than in those which are underfished. Thus the means of study and exploration, that is, the laboratories, research vessels, and scientists, are unevenly distributed over the world, and it is to be expected that knowledge about the seas and their resources should follow a similar pattern.

Whatever is done to encourage expansion in the use of the sea's resources to help satisfy human food needs, whether simple exploratory fishing or research in biology, oceanography, technology, or economics, it should be carried on where the needs are greatest, that is to say,

Where human populations are densest
Where protein starvation is most serious
Where poverty is most severe
Where the least is now known about the sea and its resources
Where fisheries are least advanced
Where the weather is favorable to fishing
Where the most countries could share in the benefits of the work

Thus we are dealing with a geographic problem. What are the regions that best meet all these criteria? The maps that follow provide some of the information needed for an answer. However, the correlation of the geographic factors remains a challenge for students of population and resources.

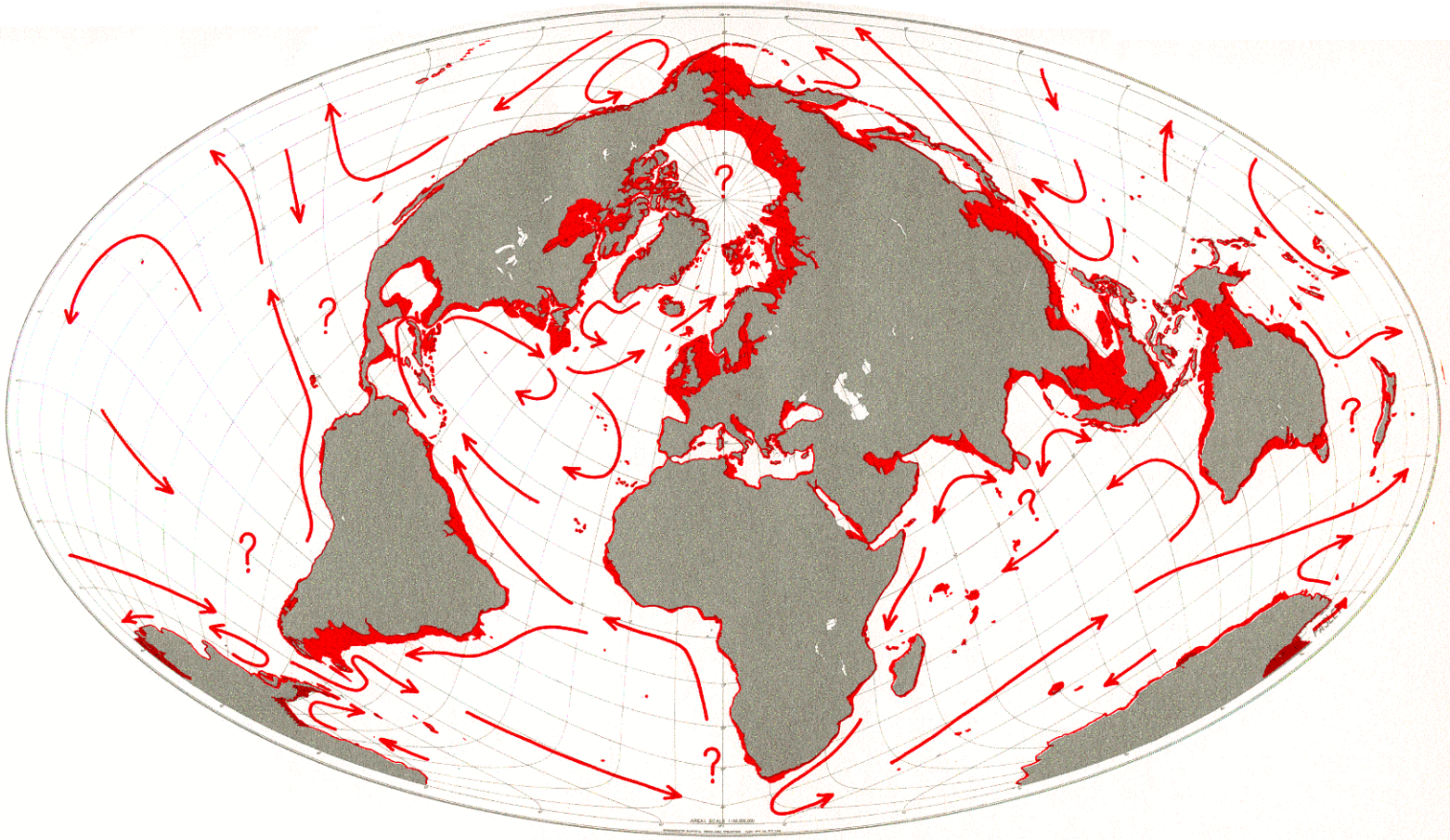

Fig. 1. The continental shelf and the principal ocean currents.

Discussion of Figure 2

Over 2,600 million people live in the world today. They are unevenly distributed, two thirds of them being concentrated within four regions, which together comprise only about one tenth of the land surface. The densest populations are in eastern Asia (China, Korea, Japan and Java), India, Europe, and the urban centers in northeastern United States.[1]

The distribution of people is influenced by combinations of many factors such as climate, soil fertility, physical relief, accessibility to the sea and to land routes of commerce, availability of raw materials, and the varying development of human institutions, culture and skills.

In any given area population growth is influenced by many factors, among them fluctuations in economic conditions, the practice of birth control, the incidence of calamities such as war, disease, and famine. Consequently it is impossible to predict with a very high degree of certainty the future of human populations. Nevertheless, demographers, studying assembled data in the light of indicated trends of population growth, agree that during the second half of the twentieth century, the number of people in the world will increase by some figure between 850 and 945 million. How this increase will be distributed (according to one estimate) is shown in the following table:

Table 2-1. Population of the World, by Continents
1950–2000
(millions)

	1950	2000	Increase 1950—2000
World	2,400	3,250	850
North America	166	220	54
Middle and South America	162	280	118
Europe, excluding U.S.S.R.	396	440	44
U.S.S.R.	193	260	67
Asia, excluding U.S.S.R.	1,272	1,750	478
Africa	198	280	82
Oceania	13	20	7

Source: W. S. Woytinsky and E. S. Woytinsky, *World Population and Production* (New York: The Twentieth Century Fund, 1953), p. 260.

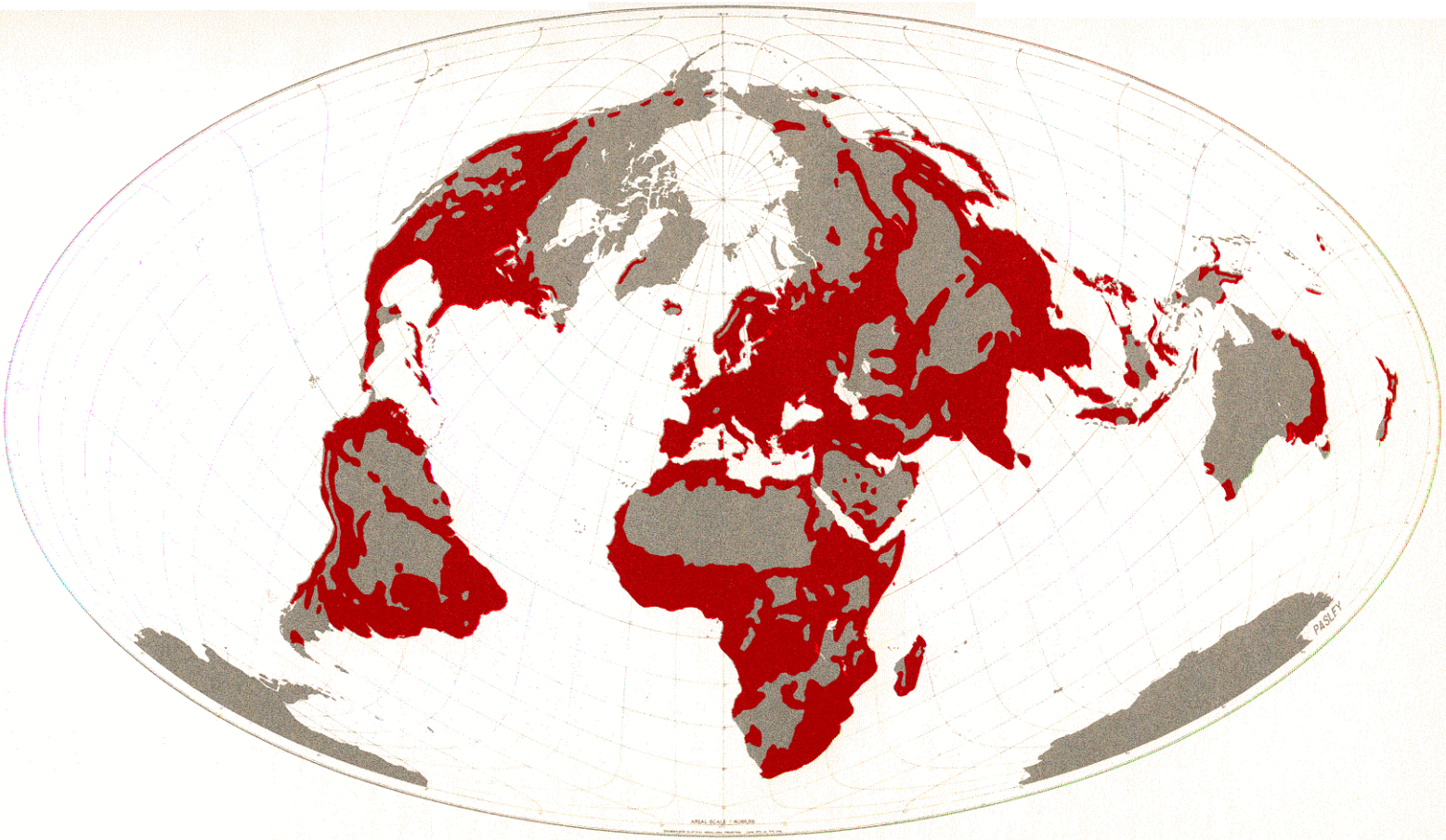

Fig. 2. Populated areas of the world. Courtesy American Geographical Society.

Discussion of Figure 3

In many areas of the world people suffer from partial starvation. They may get enough food to satisfy conscious feelings of hunger and yet not enough to satisfy their physiological needs. Growth and replacement of tissues in the human body depend on a diet containing carbohydrates, proteins, fats, minerals, and vitamins. If any one of these classes of nutrients is deficient for a long enough period, disease is the inevitable result. Because carbohydrates are cheap, filling, and a rich source of energy, those are the foods with which people in the poorer classes must usually fill themselves. In doing this they may appease the sensation of hunger, but they suffer in more obscure ways for want of other essential nutrients, and they die prematurely.

The most important of the other essential nutrients are proteins. These are derived from various sources, such as leguminous vegetables, cereals, milk, eggs, cheese, and the flesh of animals. Proteins differ in composition and consequently in their value for the synthesis of tissue. Proteins are complex nitrogenous compounds consisting of amino acids bound together by peptide linkage. The amino acid composition varies widely from one protein to another. Of the twenty-six or more known amino acids, the human body can synthesize all but ten. These ten, known as the "essential" amino acids, must be ingested in foods and must all be present in the body at the same time, in fairly specific proportions, if optimum tissue synthesis is to take place. The foods which contain the ten essential amino acids are called complete proteins, while those in which one or more of the amino acids is lacking are called incomplete. Proteins from animal sources, including fish, are complete, while those from vegetable sources, such as legumes and cereals, are incomplete.

It is possible to get the full complement of the essential amino acids in a suitable combination of protein-containing vegetables. However, to do this requires special knowledge which most people lack. It also requires an assortment of vegetables which is often not available in local markets. Proteins of animal origin, being complete, present no such problem. Unfortunately they are expensive. Indeed, in many parts of the world they are beyond reach of the great majority of people in anywhere near adequate amounts.

The results of amino acid deficiency are felt in several ways. One of the first, and perhaps the most widespread, is lethargy and reduced productivity. Reduced resistance to infectious diseases is frequent, and a number of pathological conditions, such as the syndrome called kwashiorkor, result from animal protein deficiency.

These illnesses impose a terrible drain on the economy of a country where they are prevalent. If they could be eliminated, an enormous improvement in productivity and living standards should result.

Figure 3 shows areas where diseases attributed to protein starvation are common.[2]

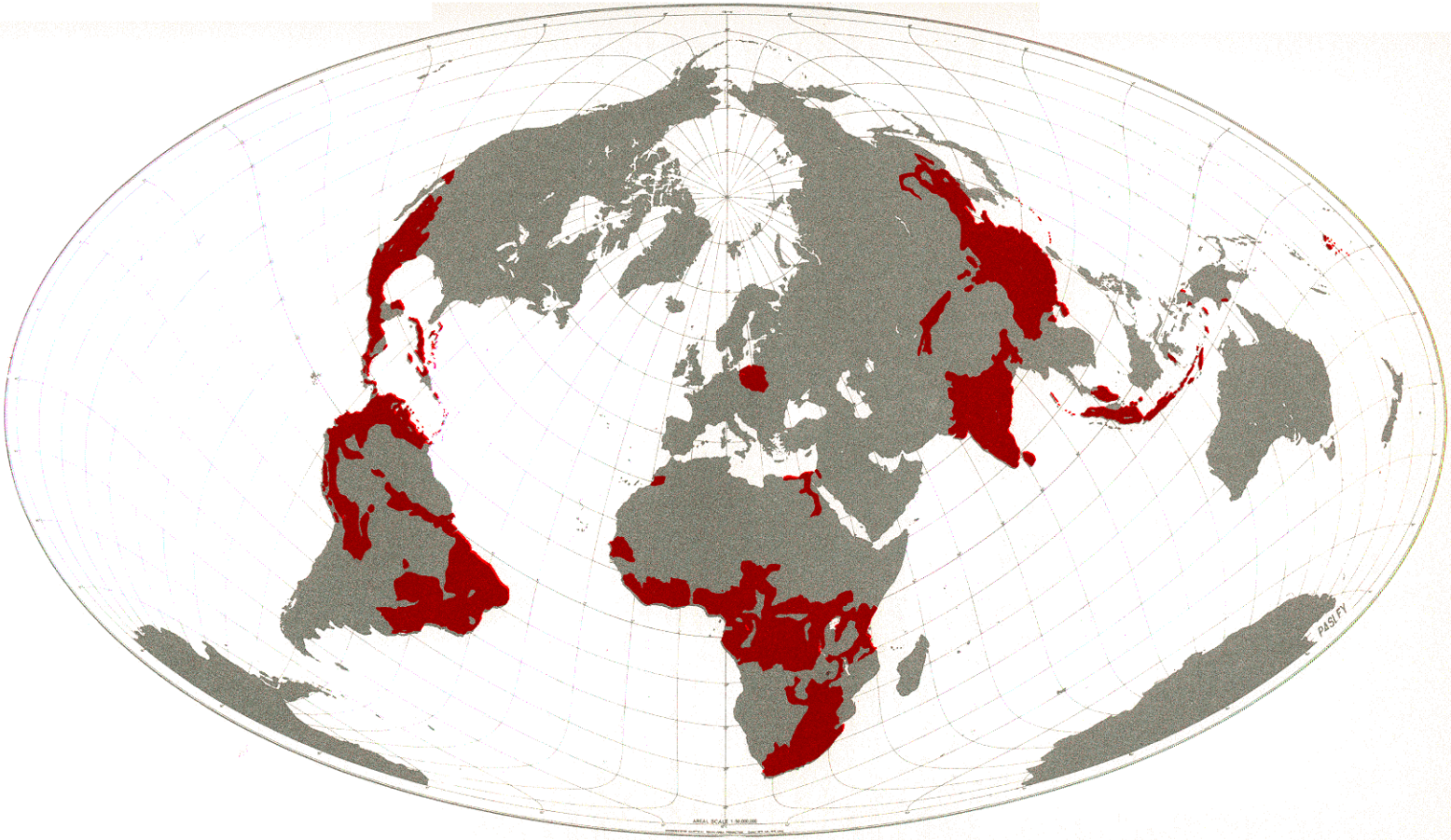

FIG. 3. Areas of protein starvation. Courtesy American Geographical Society.

Discussion of Figure 4

Figure 4 shows the distribution of the two types of economies.[3] In the regions shaded red, which include 74 per cent of the world's habitable area and 76 per cent of its people, a peasant agricultural economy predominates over all activities.[4] People grow crops, raise livestock, carry on primitive hunting and fishing, and engage in handcrafts primarily for home use. Only sometimes, after paying taxes and the profits owing to the landowner or boat owner, does a subsistence farmer or fisherman have left any surplus that he can sell on the local market. Although subsistence producers sometimes manage, on the whole, to satisfy their moderate needs, they are, as a class, among the poorest people in the world. In general, it is in these countries that effort to improve fishery industries is most needed, and it is in these countries that the most difficult obstacles to industrialization will be found.

In the stippled areas, the market-and-money economy prevails; that is, people produce food and goods primarily for sale or exchange. There is much variation from one area to another in the proportions of labor devoted to food-producing and non-food-producing occupations. In general, a relatively high proportion of the labor force in industrial production, commerce, and professional services indicates a country that is technologically advanced and rich.

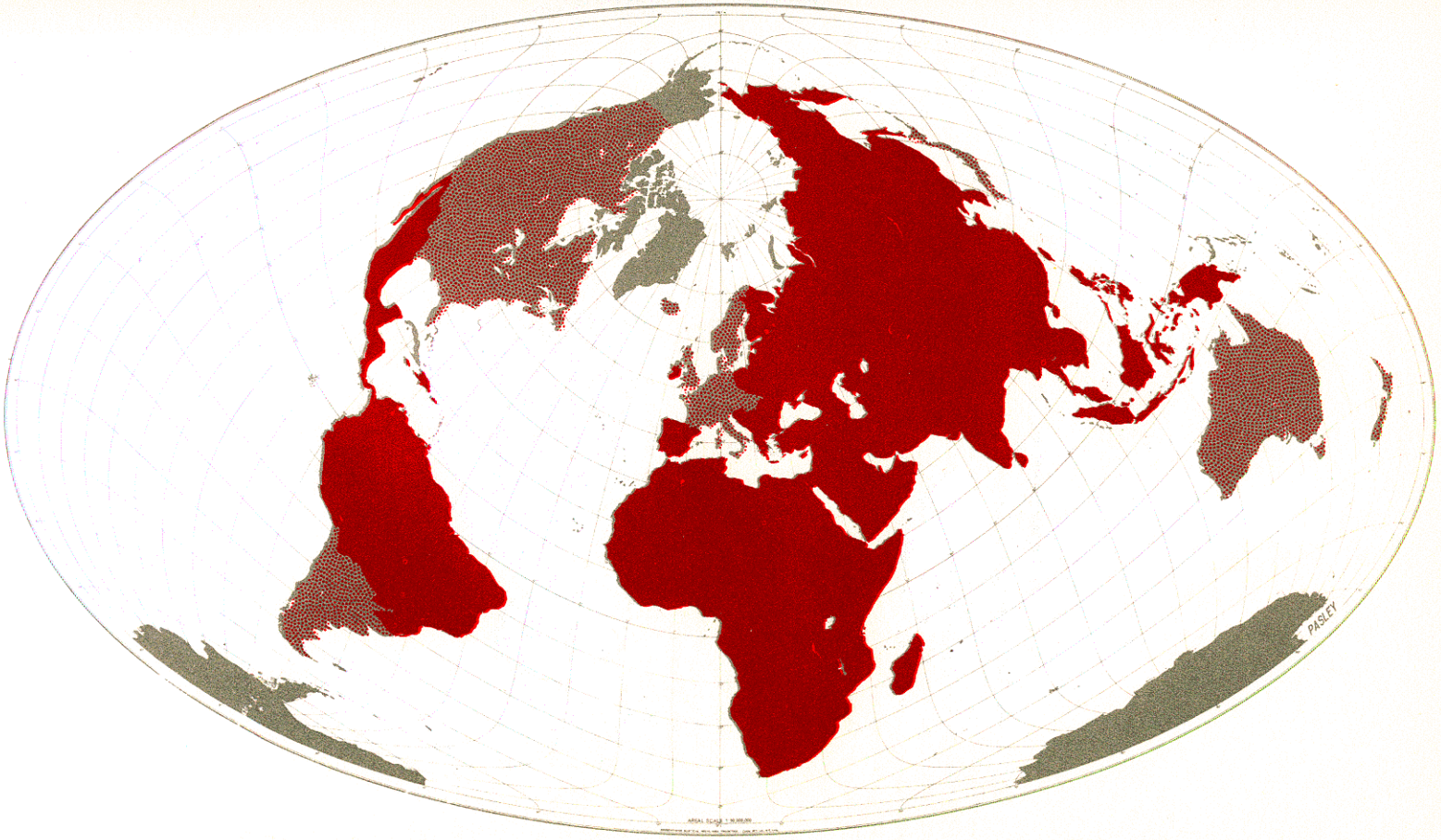

FIG. 4. Generalized types of economic activity: subsistence economy and money economy. Courtesy Twentieth Century Fund.

Discussion of Figure 5

High seas fisheries (as contrasted with shore fisheries) are most highly developed in countries where a seafaring tradition is strongest, and this in turn is reflected in the means of going to sea. In Figure 5 the per capita tonnage of merchant vessels which are 100 gross tons or more has been rated in five orders of magnitude as listed below.[5] Countries whose flag is used by foreign owners and whose per capita tonnage figures would otherwise be similar to those of their neighbors (i.e., Panama, Liberia, Honduras, Costa Rica) are unshaded.

1. Countries with over 0.5 gross ton per capita: Iceland, Norway.
2. Countries with 0.1 to 0.5 gross ton per capita: Denmark, Finland, Greece, Netherlands, New Zealand, Sweden, United Kingdom, U.S.A.
3. Countries with 0.02 to 0.1 gross ton per capita: Argentina, Australia, Belgium, Canada, Chile, France, Germany, Hong Kong, Israel, Italy, Japan, Portugal, Spain, Switzerland, Turkey, Uruguay, Venezuela.
4. Countries with 0.004 to 0.02 gross ton per capita: Brazil, Cuba, Dominican Republic, Ecuador, Egypt, Eire, Mexico, Nicaragua, Peru, Philippines, Poland, U.S.S.R., Union of South Africa, Yugoslavia.
5. Countries with less than 0.004 gross ton per capita: Albania, Bulgaria, Burma, Ceylon, China, Czechoslovakia, Egypt, Guatemala, Haiti, Hungary, India, Indonesia, Iran, Iraq, Korea, Lebanon, Morocco, Pakistan, Rumania, Salvador, Saudi Arabia, Sudan, Syria, Thailand.

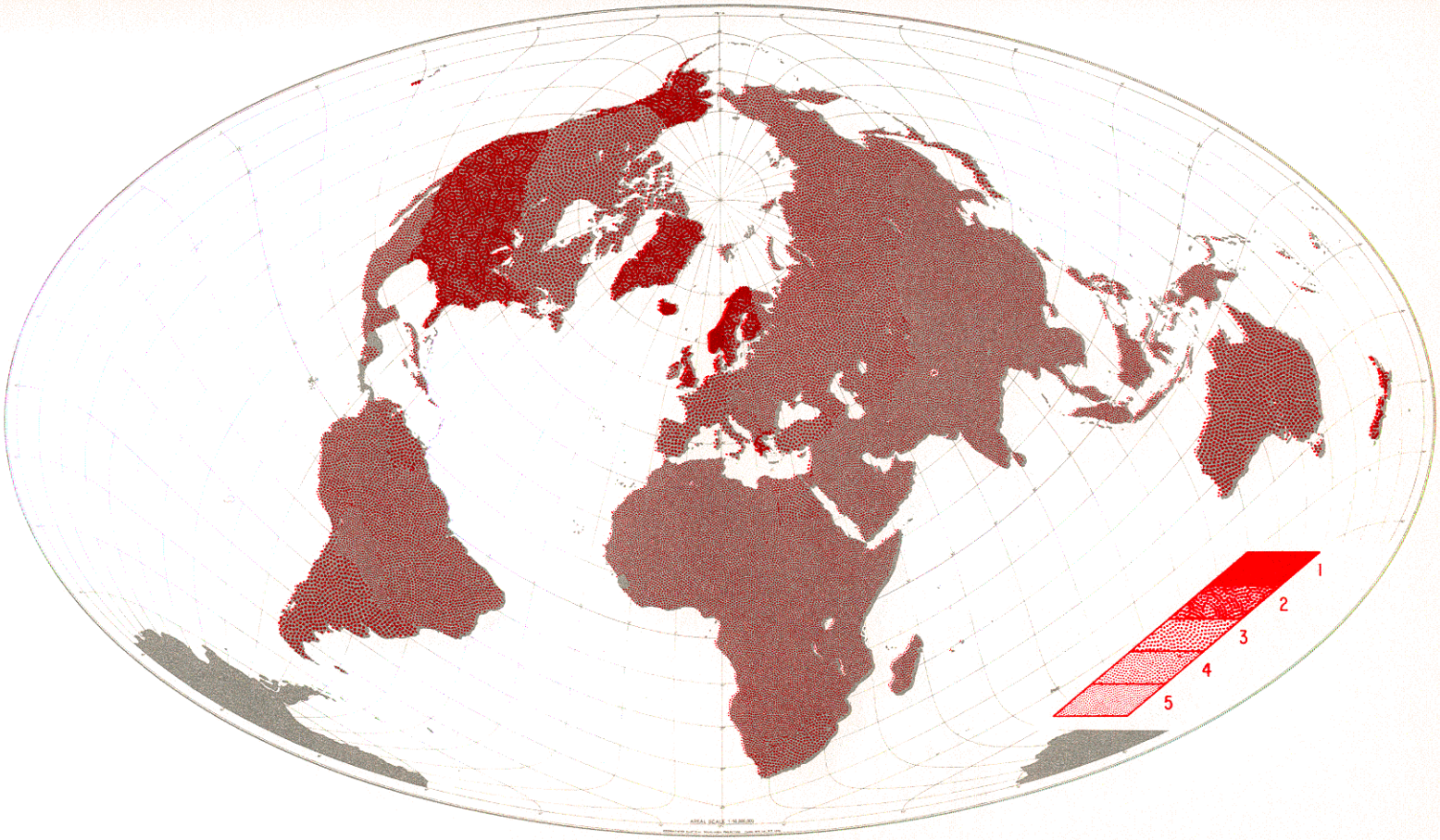

FIG. 5. Merchant shipping fleets of the world. Countries are shaded according to their relative tonnage of merchant shipping, on a descending scale from 1 to 5 (see text discussion).

Discussion of Figure 6

Areas readily accessible by railroads and highways are shown in Figure 6.[6] The distribution of fishery products from sea coasts to consumers living inland depends on fast mechanized transport. Some densely populated areas in Asia, Africa, the Caribbean, and Latin America still depend on animals and men for the transport of goods. Consequently, in these areas the kinds of fishery products that can be transported over long distances are generally restricted to those which will keep in hot weather without refrigeration, that is, dried, salted, or canned fish.

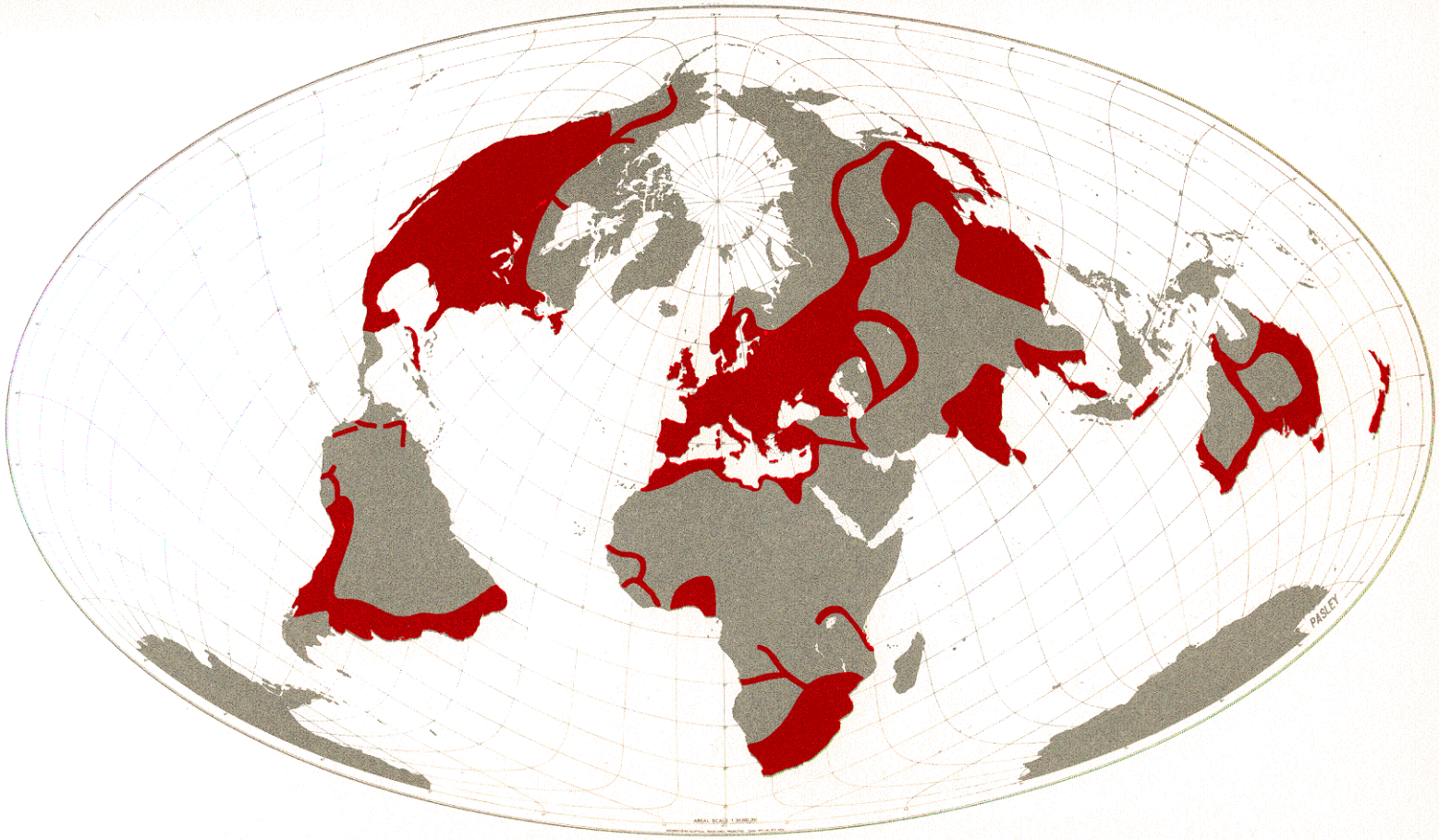

FIG. 6. Areas readily accessible by modern surface transport facilities. Courtesy Twentieth Century Fund.

Discussion of Figure 7

Knowledge about any part of the oceans must be more or less proportional to the number of observations made there. In Figure 7, areas have been shaded according to the number of occasions that research vessels have stopped to collect considerable oceanographic data (i.e., the number of "oceanographic stations occupied") per quadrangle of 5 degrees of latitude and longitude.[7] Probably the number of biological observations is more or less similarly distributed, since biological and physical oceanographic researches are often, if not usually, associated.

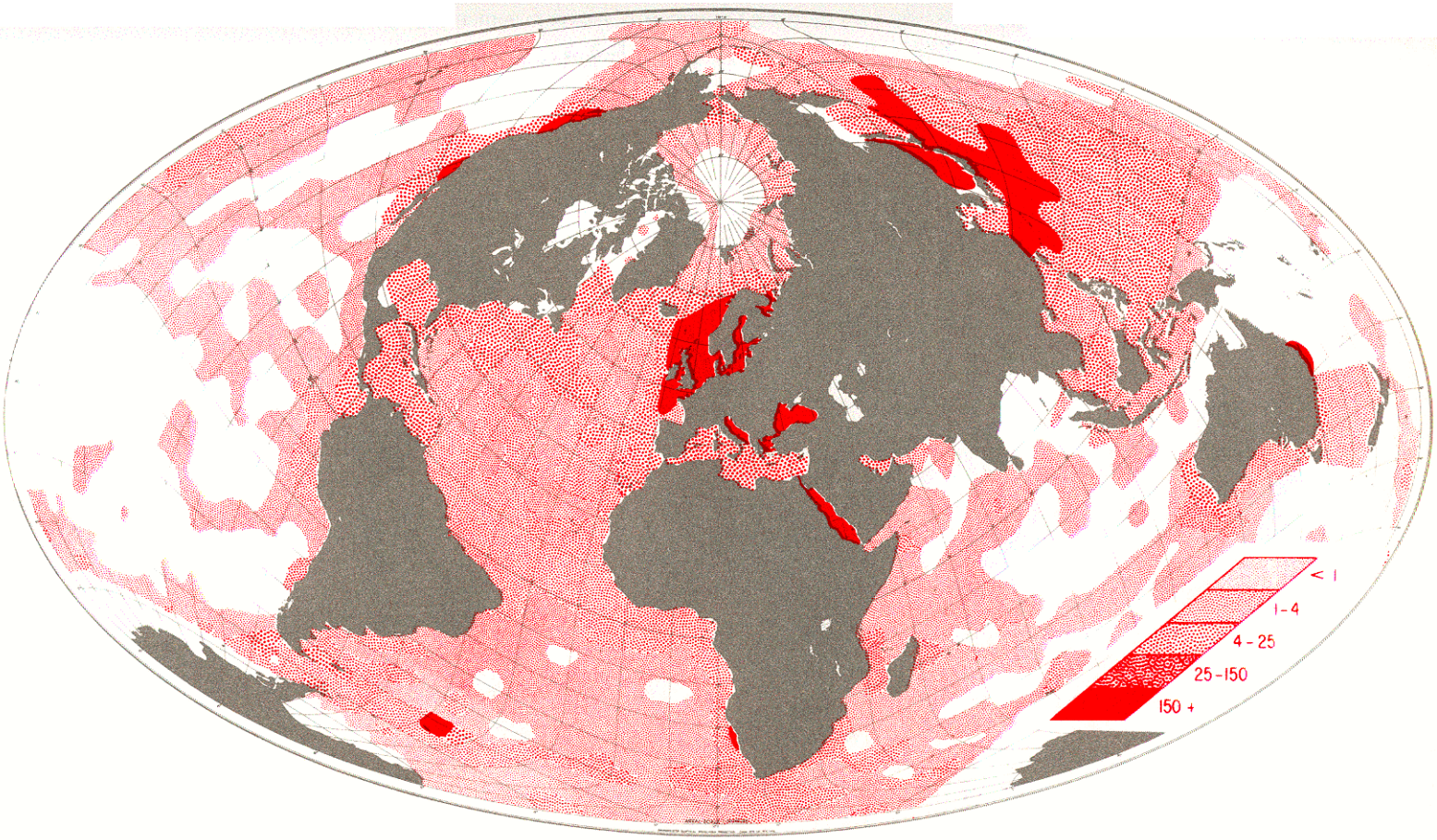

FIG. 7. Knowledge about the seas. Legend indicates the number of recorded occasions on which data were collected by oceanographic vessels, as plotted on quadrangles of five degrees of latitude and longitude.

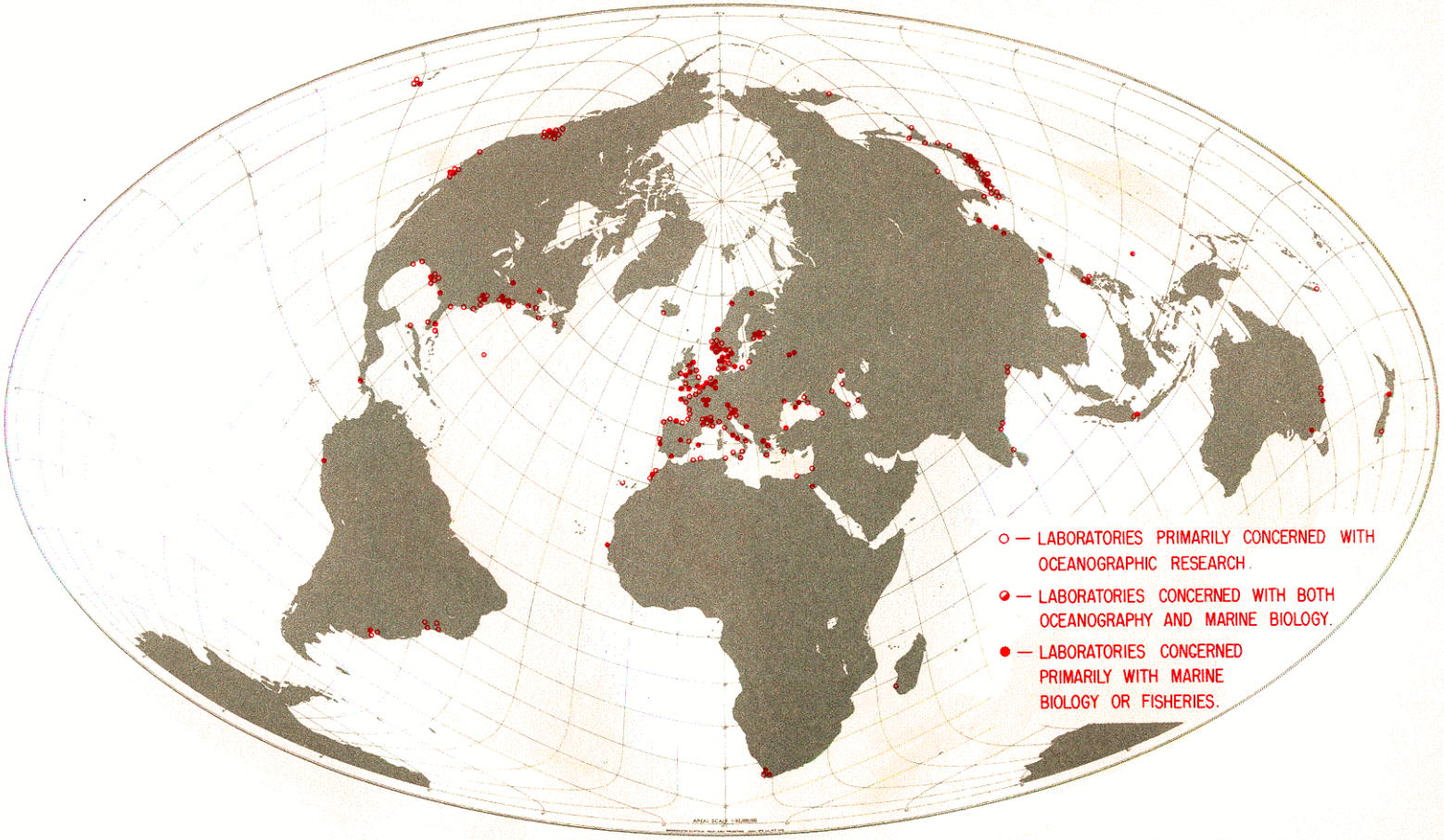

FIG. 8. Distribution of marine laboratories. (See p. 65 for a discussion of this map.)

Discussion of Figures 9-12

In judging where new fisheries might be developed, how much money to invest in an enterprise, and what kind of vessels and equipment would most likely be needed, it is necessary to consider the weather.

In Figures 9 through 12 the isopycnics (lines of equal quantity) represent the average percentage of time that weather would probably be favorable enough for vessels of 100 feet or more to fish during February, May, August, and November, respectively. For smaller vessels conditions would probably be less favorable than the figures indicated on these maps, especially in areas where the percentage frequency of favorable fishing is relatively low.

In drawing up these maps, oceanographers at the U.S. Navy Hydrographic Office assumed that fishing must be limited by sea ice, topside ship icing, high swell, and high winds. They made a statistical analysis of data on all of these factors to reach the indicated estimates. They disregarded ordinary precipitation and assumed that, under modern conditions, heavy fog or other visibility restrictions would not hamper fishing operations, and that the occurrence of very heavy sleet, hail, or snow would be very rare and therefore need not be taken into account.

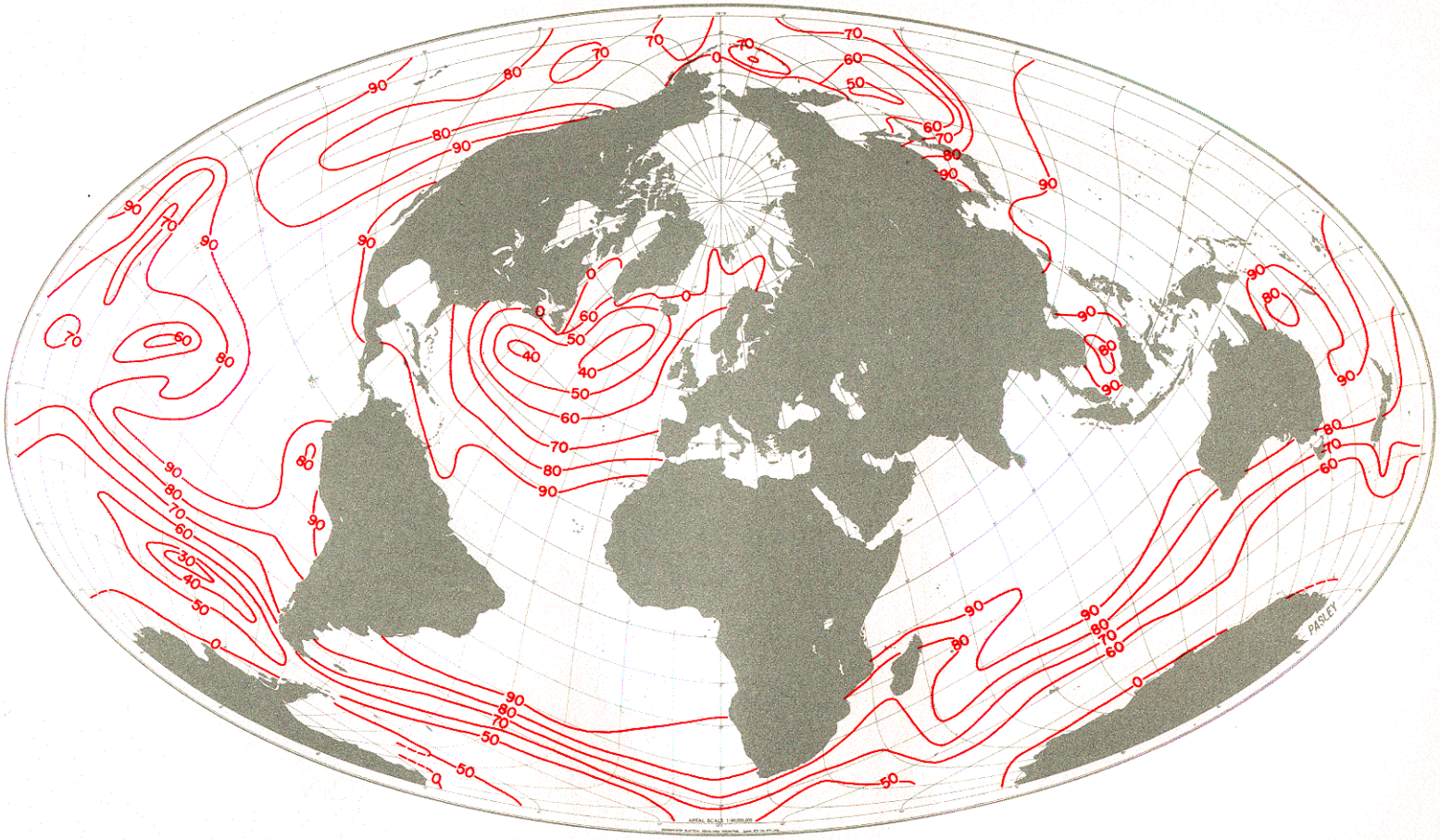

FIG. 9. Weather and fishing: percentage of time fishing is feasible in February.

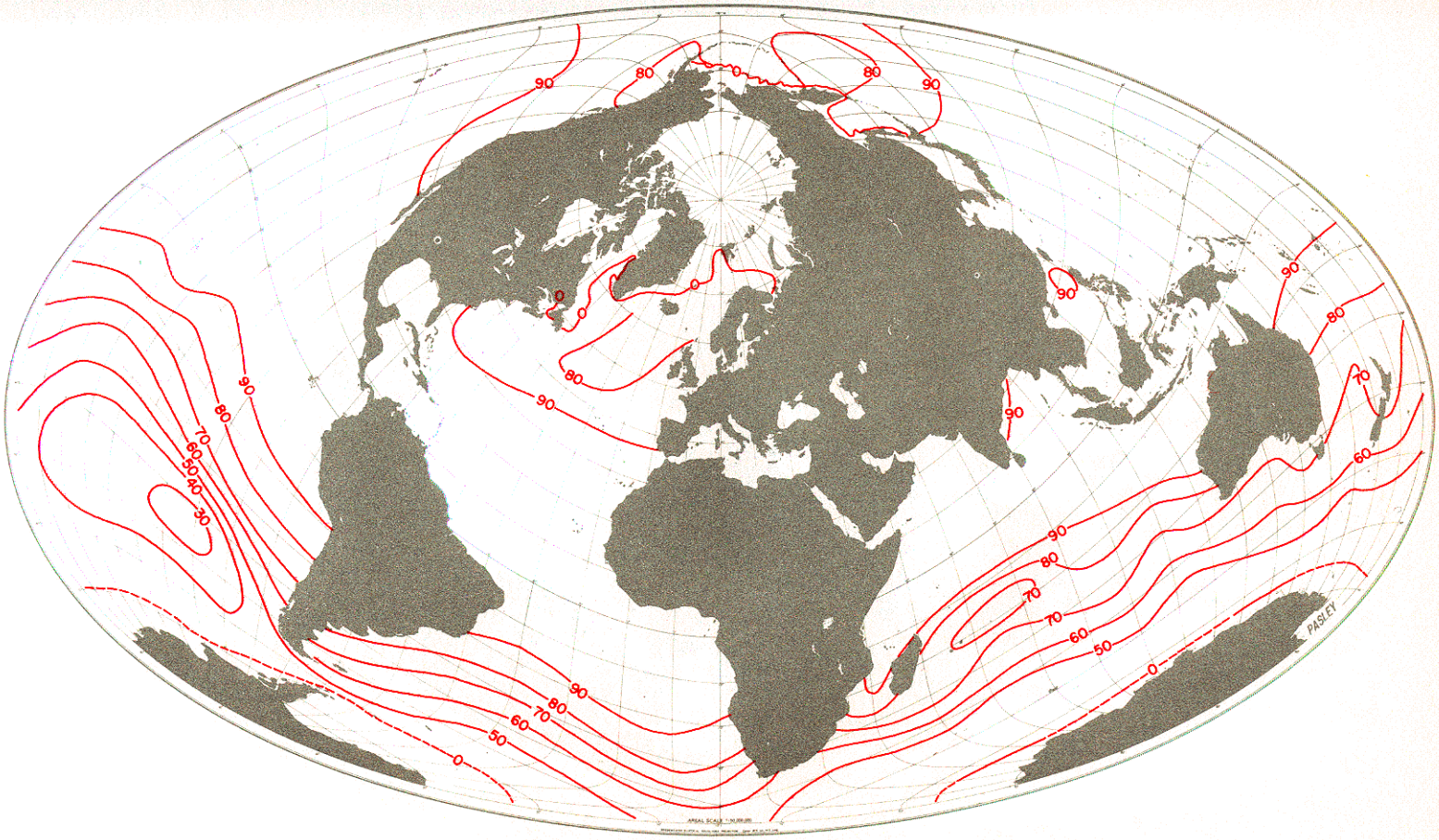

FIG. 10. Weather and fishing: percentage of time fishing is feasible in May.

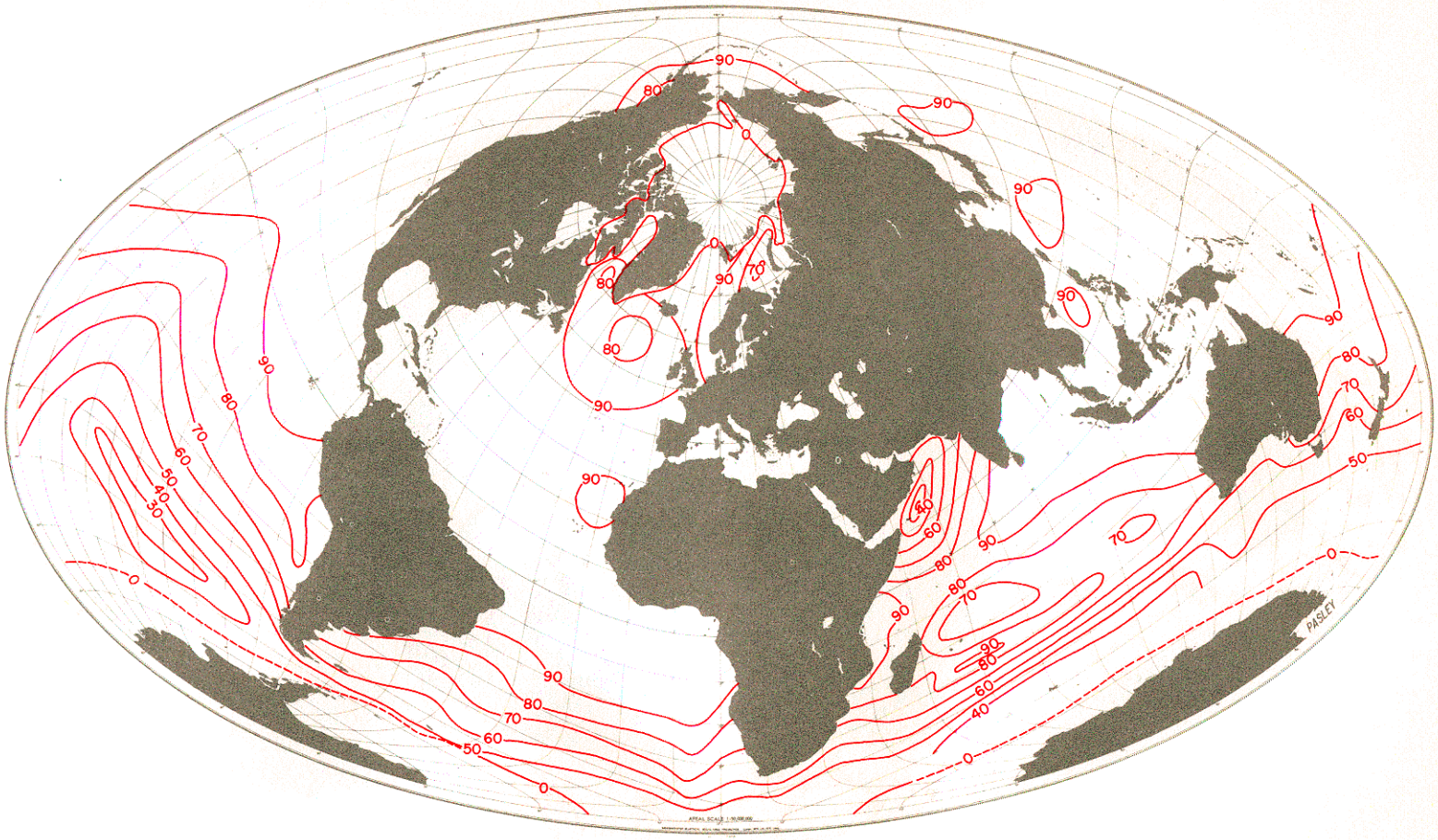

FIG. 11. Weather and fishing: percentage of time fishing is feasible in August.

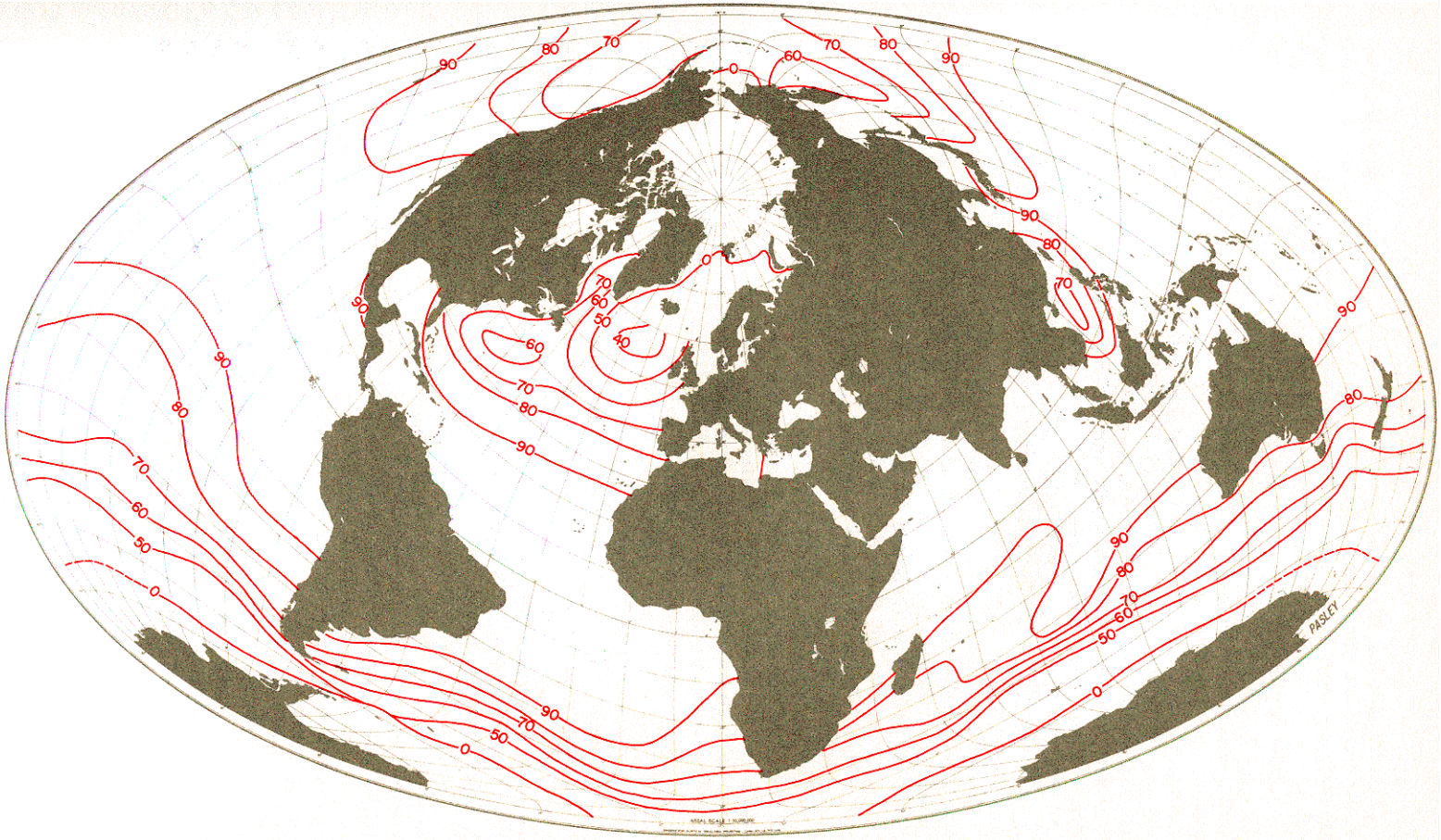

FIG. 12. Weather and fishing: percentage of time fishing is feasible in November.

Discussion of Figures 13 and 14

Taken altogether, the fertile areas of the sea are larger than the arable areas of the land. For the most part they extend far beyond the range of coastal fishing boats such as are operated by fishermen working for their own subsistence or for small, day-to-day markets. It is not only distance which limits the availability of the fertile offshore areas, but weather as well, for some of the most fertile parts of the seas are seasonally too rough for fishing. Even in the favorable seasons, bad weather prevails some of the time, so that vessels must be very stoutly built for distant sea work.

Obviously, offshore fishing is a demanding, difficult, costly undertaking, and one that is profitable only for relatively high-priced species such as tunas, salmons, swordfish, and certain of the groundfishes. The countries where distant offshore fishing is economically and sociologically feasible tend to fit into this common pattern: they have long traditions of seafaring; they are deficient in supplies of protein produced on the land, and therefore fishery products can compete successfully in their markets with meats and poultry; seafaring labor is abundant and relatively cheap.

Countries not fitting into this pattern tend to be more closely bound to the land. Where meat is plentiful and labor scarce and costly, it has generally not proved economically feasible to embark on very long fishing voyages, even though seafaring traditions may be long established. American tuna clippers, for example, stay out three or four months at most; North Atlantic trawlers, two or three weeks. It is hard to induce American fishermen to remain at sea much longer than that.

In the less advanced countries, on the other hand, fishermen do not venture far from land for other reasons. They do not have the traditions, training, or equipment for distant fishing. Furthermore, they are generally too poor to afford the high cost imposed by the operation of ocean-going vessels.

A few countries, notably Japan and the U.S.S.R., send factory ships and mother ships accompanied by fleets of scouting and catcher boats to fish on the high seas for fin fish. These go far from home ports and stay out many months at a time before returning home with their loads, which are sometimes predetermined by quota according to estimated demand. Some Japanese fishing vessels go across the Pacific, through the Panama Canal, and all the way to the coast of Africa on voyages lasting seven months. Others work in the opposite direction into the Indian Ocean. Several countries, chiefly Norway, the United Kingdom, and Japan, engage in whaling in the Southern Ocean, thousands of miles from home.

The problems of exploiting the offshore areas are exceedingly perplexing. Some of these are how to reduce the time required to locate and catch fish; how to operate in marginal weather so as to stretch the short season; how to make it economically feasible to use some of the less recherché species which are now discarded or avoided; how to design small vessels so as to extend the area which shorebound fishermen can exploit. These are problems on which special research needs to be centered in order to improve the utilization of the offshore fertile areas.

Figure 14 shows that the largest fertile areas are in the North and South Pacific, the North and South Atlantic, and the Southern Ocean. The Indian Ocean looks discouragingly poor. Its evident lack of extensive fertile areas on the high seas must limit fishery activities more or less to the use of coastal waters

and the cultivation of inshore environments. It must be observed, however, that the Indian Ocean has been studied very little and that its resources have not yet been fully assessed. It is there that extensive marine biological research is particularly needed.

The South Atlantic Ocean has very large fertile areas, rich fishery resources, and therefore high fishery potentialities. Favorable weather prevails most of the year. Countries bordering the South Atlantic need fish, for they suffer severely from protein deficiency. Yet the South Atlantic is far underexploited. There are few laboratories in the maritime countries of Africa and South America and there has been relatively little systematic research into marine fishery resources. Probably nowhere else in the world would fishery research prove more rewarding.

The Pacific Ocean has the largest fertile areas and is a region of tremendous fishery activity. Extensive marine research and offshore fisheries programs are directed from Japan, the U.S.S.R., Australia, the Hawaiian Islands, and North and Central America. The North Atlantic has long been intensively exploited and the subject of fishery research by all the maritime states of Europe and North America.

Considering, then, the criteria set forth on page 13, it is less in the North Atlantic and Pacific that new research is needed than in the South Atlantic and in the Indian Ocean.

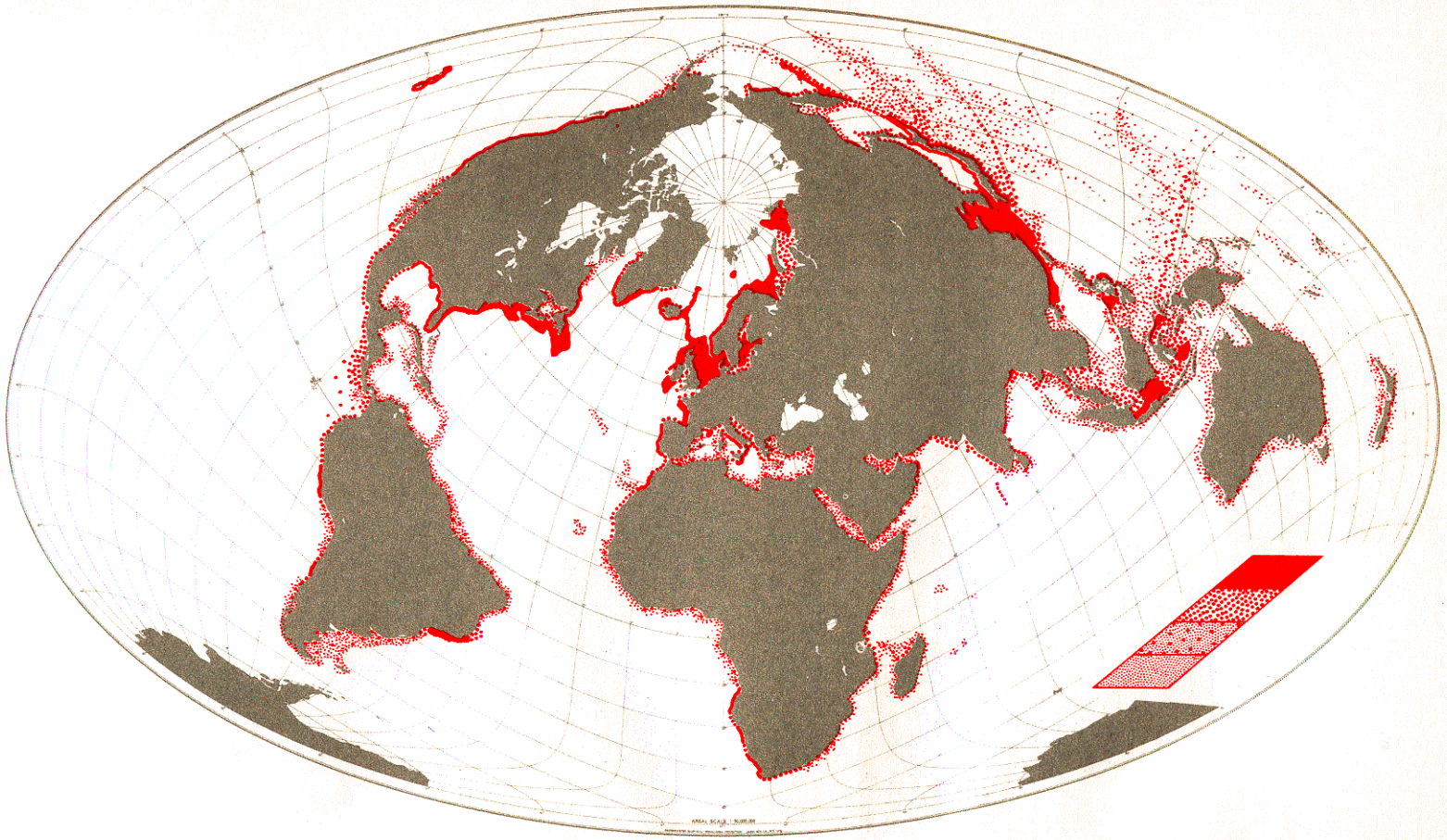

FIG. 13. Distribution of fishing grounds of the world. The yield of the sea is suggested by the relative intensity of the shading.

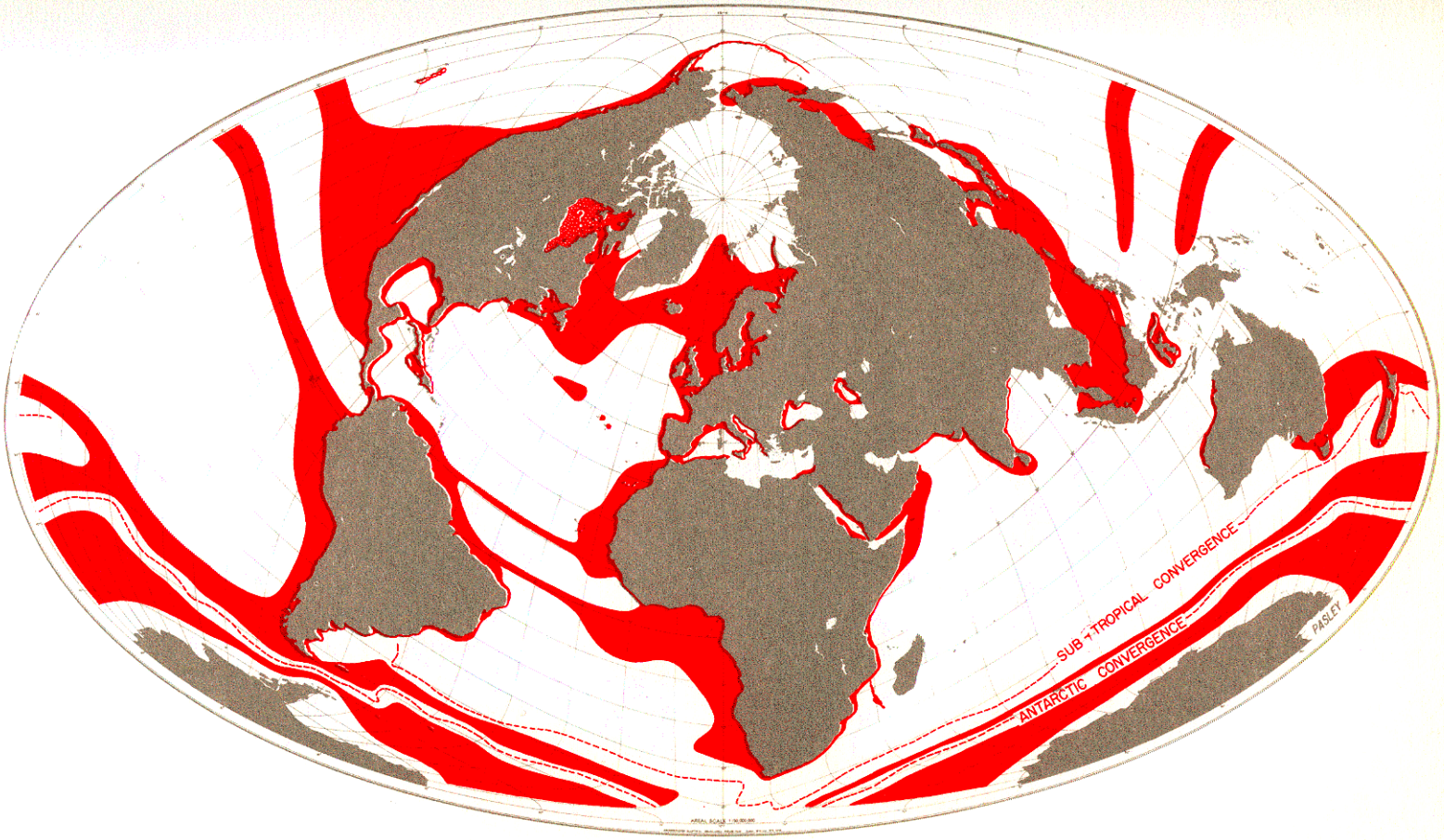

FIG. 14. Fertile areas of the seas. Red indicates areas where oceanographic processes are conducive to enrichment of surface water, hence to production of plants and animals.