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Also by the same author:
SURVIVE THE SAVAGE SEA

Sea Survival

A Manual

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DOUGAL ROBERTSON

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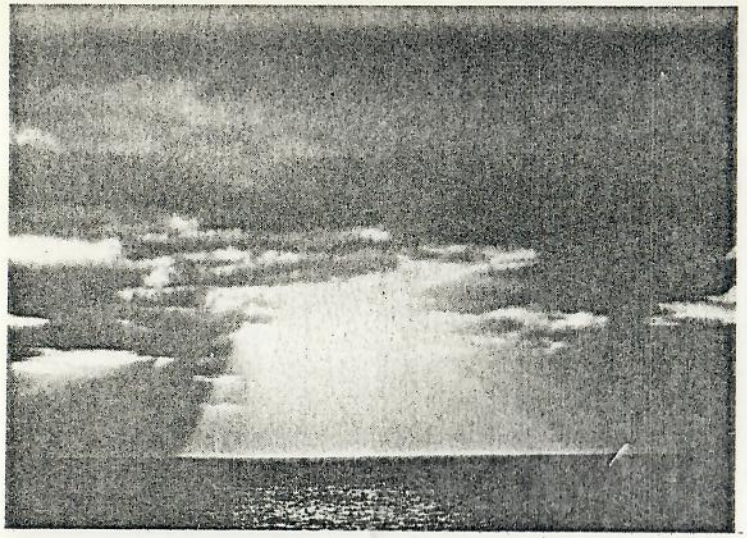
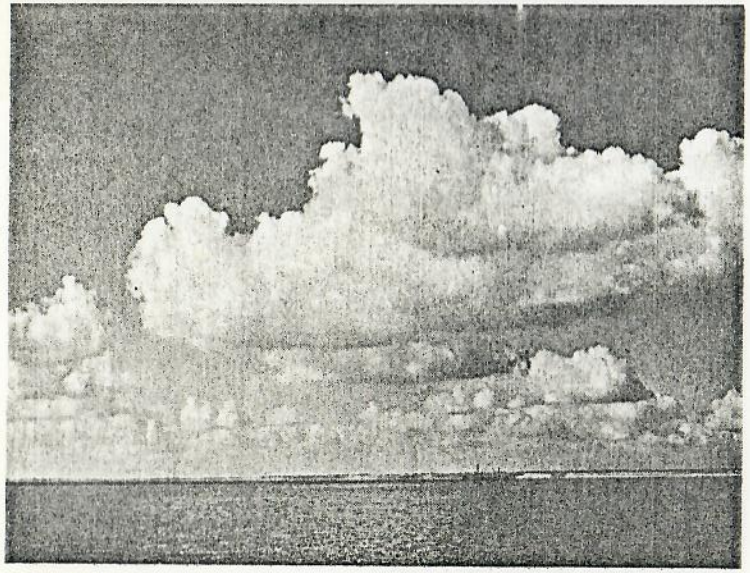
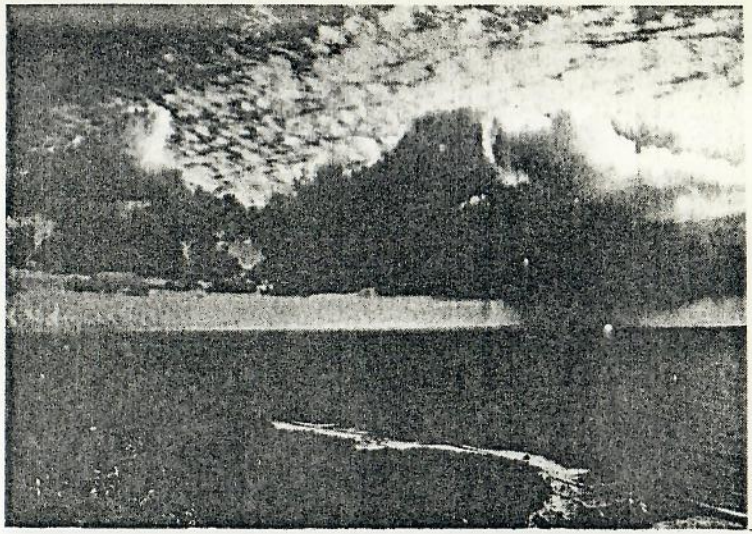
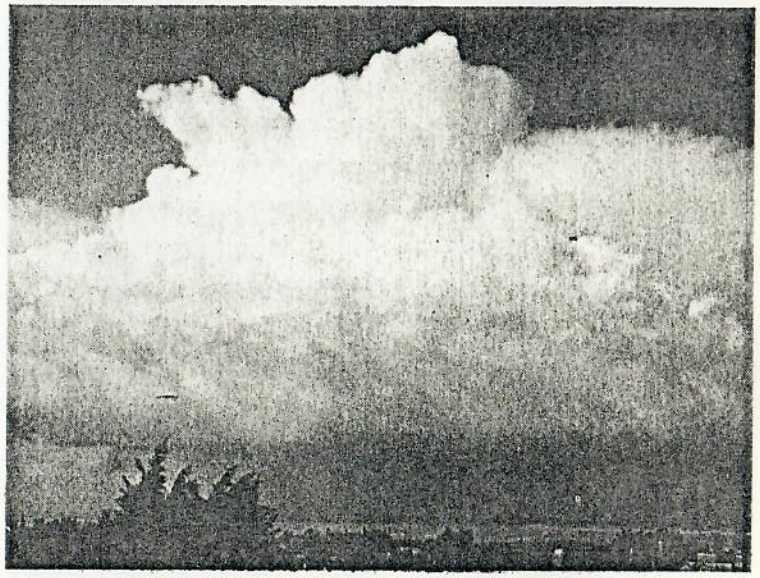


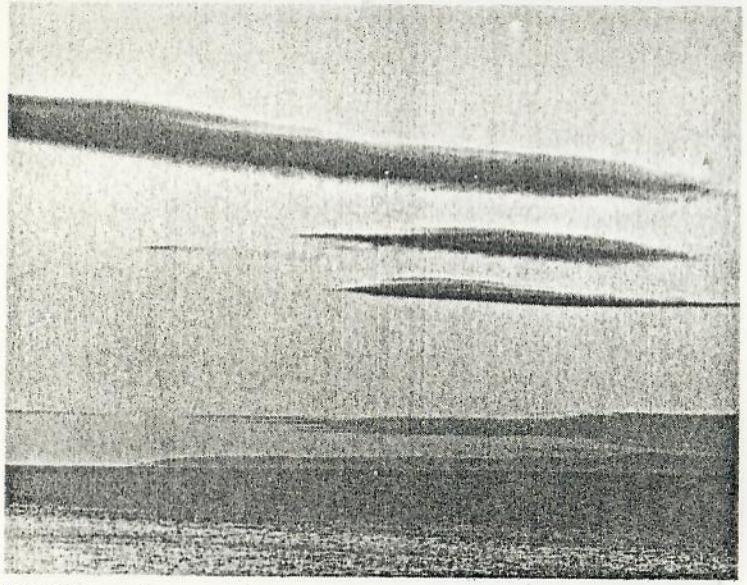


Top: Stratocumulus
Bottom: Fair-weather cumulus





Top: Large cumulus with a shower beneath it
Bottom: Cumulonimbus



Top: Stormy sky
Bottom: Altocumulus lenticularis

colder, skies will clear with a decreasing chance of rain, some showers may die away even as they approach the survival craft, and fine weather will be re-established, sometimes with high cirrus clouds but more often with clear blue skies.

Smaller weather systems in the form of troughs of low pressure have similar cloud sequences but with smaller rain areas, although good yields may be collected. They may be identified from a survival craft by the relatively short time in which they take to develop and pass over unless they are moving only very slowly. Winds are more squally in character and sea and swell less well developed than in areas with a longer 'fetch' (distance over which they are generated). In many cases, in both established depressions and isolated troughs of low pressure, the cloud sequence will start in the established pattern as the weather system approaches but because of occlusion (when the cold front overtakes the warm), the rainfall will be much reduced, even absent, and instead of an extensive area of cloud from which rain is falling, there will be a layer of altocumulus cloud yielding little or no rain. It is not possible to tell from a survival craft whether the approaching weather system is occluded or still active, so that hopes of rain should not be raised prematurely at the sight of cirrostratus or altostratus cloud.

(2) Rainfall areas

It is difficult to predict the incidence of non-seasonal rainfall over the sea, but the principal rainfall regions of the oceans may be listed as follows. *Doldrums*: at or near the equator, rain is encountered most of the year, particularly on the side where the sun is overhead. The rain area extends over a span of about 10° of latitude and is deflected southwards in the area of the north Australian coast in December. Doldrums weather is rarely experienced south of the equator in the eastern Pacific and the Atlantic oceans, and is absent during the northern summer months in the Indian Ocean.

On each side of the Doldrums *a belt of trade winds* extends to a latitude of about 30° north and south from the equator and, except in monsoon areas (which will be dealt with separately), the weather in these regions is usually warm and dry and skies have up to 50 per cent cover with cumulus cloud in various stages of development. Occasional shallow troughs may cause showery precipitation at about ten-day intervals, but these are unreliable as a source of water to the castaway and cannot be relied upon to sustain life. Yields can be improved if proper rain-catching equipment is carried in the kit (see diagram, p. 37) instead of having to rely upon a meagre section of salt-impregnated raft canopy for catchment, but even so, if there are many survivors in the raft, supplementary water from solar stills or marine life will be required to provide a bare maintenance ration. The eastern side of the oceans have least rainfall in these latitudes, and in areas adjacent to continental deserts little or no precipitation can be expected.

In latitudes of *summer high pressure,* 30° to 40° approximately, little rainfall can be expected in the fine weather conditions which prevail in these areas, and survival conditions are difficult. In winter time as high pressure weakens and moves towards the equator the weather systems which generate in these regions can be expected to provide rain before they move into higher latitudes.

In *temperate zones* (40° to 60° latitude) fronts are experienced during most of the year and rainfall is more frequent than in the subtropical or trade-wind latitudes. Rain is less likely on the eastern sides of the oceans during spring, or during occasional summer anticyclones, but otherwise reasonable quantities of rainfall may be expected to provide a maintenance ration for castaways.

In *arctic and sub-arctic regions* frontal activity extends upwards from the temperate zones but to a much lesser degree and precipitation is not so heavy or frequent. Alternative sources of water may be available to castaways from ice in these areas.

In the *Indian Ocean* the south-west monsoon spreads northwards through the Arabian Sea and the Bay of Bengal through May to September and rainfall is heavy, particularly near the coasts of the Indian subcontinent. During the remainder of the year (October to April), the north-east monsoon brings uninterrupted dry, hot weather, especially near coasts, and survival conditions are difficult. Chances of occasional showers improve when the light north-easterly wind has crossed a few hundred miles of ocean, so that near the east coast of Ceylon, and in areas to the west and south, rain may be found in greater quantities than in north-eastern areas of the Arabian Sea and the Bay of Bengal.

Monsoon winds from the south also affect the China seas and, although much lighter, bring moisture to southern coasts of land masses from Indonesia to China; during the latter part of this period (July to October) tropical revolving storms sweep northwards up the China coast to Japan. From November to March the north-east monsoon prevails and, with strong northerly winds, brings more abundant supply of rain to areas from China to the north Australian coast. The leeward side of the large land masses have much reduced rainfalls during the appropriate monsoon periods.

In south-eastern coastal areas of the USA and the north Caribbean Sea the months of November to March bring similar blustery northerly weather accompanied by heavy rainfall at fairly frequent intervals.

Winds bring little or no rainfall when they blow continuously offshore from large continental land masses. Particular areas to note in this respect are those adjacent to the north western Australian coast, the Arabian peninsula, the Mediterranean in summer time, the west-facing coasts of Africa, the west-facing coasts of India and Burma during the north-east monsoon, and the areas to the west of California and Chile.

Tropical revolving storms occur, under various names but

with the same characteristics, in the following areas: West Atlantic and Caribbean Sea; north-east Pacific Ocean, South Pacific, north-west Pacific and China Seas; Indian Ocean, Arabian Sea, Bay of Bengal; north-western Australian coast. These storms generate around latitude 10° from the equator and are most frequent in the late summer and early autumn of the hemisphere in which they occur. They travel in a westerly direction towards the respective pole until, in a latitude of about 15°, they recurve and travel polewards in an easterly direction. On occasions, especially when continental high pressure is declining in the autumn, tropical revolving storms fail to recurve and continue to travel westwards into the mainland areas. A distinctive feature which makes the predicted path of revolving storms more reliable is the heavy ocean swell which travels outwards from the storm centre, so that the castaway has only to face the swell in order to determine the direction of the storm centre. Depending on the area in which the survival voyage is taking place, the castaways can then decide if they are in the likely path of the storm and prepare their craft accordingly for heavy weather.

Note. The information in this chapter should be used in consultation with the wind and rainfall charts, to determine whether the survival craft may be heading towards a drier or a wetter climate, so that appropriate action can be taken. In general, downwind ocean navigation will probably result in the craft travelling towards rain, for the longer the air travels over the sea, the moister it becomes with the greater likelihood of showery precipitation.

15 LANDFALL PHENOMENA

(1) Birds

When a survival craft approaches land from seaward, the first sign that land is near is usually an increase in the

variety and number of birds. This is a very loose indication and should not be misinterpreted by castaways, as may be the case when crossing an overseas migration route. The route map shows the approximate location of overseas migration routes, but it must always be remembered that birds stray, become lost, or are carried out to sea in storms, and that no reliance may be placed on isolated sightings of land birds.

It is also well established that migrating land and sea birds are often influenced by seasonal winds and do not always follow the most direct route in migration flights. So, in fact, transoceanic migration routes may vary considerably from year to year and an observation of such migrating land birds is no indication of the proximity of land, or of a survival craft's position relative to a theoretical migration route.

On the other hand, it is possible to derive some hope of sighting land if seabirds which normally range within the continental shelf are sighted with increasing frequency, or if coastal migratory flights of land birds are observed. These are usually of a very distinctive nature in view of the large number of the same species of birds involved and should not be confused with a storm-driven miscellany of land birds or with a transoceanic migration of land birds. To help distinguish these ocean migrants I have tried to show on the route map the flyways used by certain species of land and shore birds as well as the areas in which the varied species of wide-ranging seabirds may be seen over the oceans.

(2) Sea and Sky Signs

As the ocean floor rises to the continental shelf the colour of the sea alters, becoming much lighter and sometimes taking a light green tinge. The extent of the continental shelves vary and approximate distances from the coast may be observed on the maps. The water may also be discoloured for many hundreds of miles out to sea by the emergence of

very large rivers, as in the mouth of the Amazon, so that note must be taken of the proximity to such rivers when discoloration is noticed.

The sky reflects this discoloration and such reflection is sometimes mistaken for land loom. When land loom is visible there are usually other signs to indicate its proximity, unless it is down wind in a trade wind or monsoon area when a craft may come up with low lying land overnight; the first indication would then be the sound of breakers. Bird life and an alteration in the type of marine life may give the castaway forewarning of this. In tropical areas, the heavy scent of plant life is often carried out to sea by offshore winds and may be detected at distances of 20 miles.

In tidal waters or in areas where ocean currents run parallel to the shore, drifting branches, fruits or nuts are often seen. Sawn timber, however, may be met with anywhere in the oceans, as may an oil slick from vessels which are clearing holds or tanks. Seaweed may also be encountered frequently in mid-ocean, especially in ocean currents and in accumulation areas like the Sargasso Sea.

Lenticular cumulus often develops over a land mass or fixed cumulus cloud, which appears in a cloudless sky or amidst moving clouds, may result from vertical wind currents above an island. Large coastal cities show a loom at night which may be visible from well over 100 miles away. Lighthouses with powerful lanterns may have a loom visible at distances of 40 miles. (Some large cruise liners may also be seen from long distances but unless the actual lights themselves are visible, no attempt should be made to attract attention by hand flares, although if there are rockets to spare and the area is not much used by shipping, an attempt could be made if in good visibility.)

When land is sighted, it should be remembered that high mountains may be seen at a distance of 50 miles in clear weather and that it may take three or four days to reach such land, perhaps longer if offshore winds are experienced at night.

In colder zones, atmospheric stability may cause abnormal refraction enabling sea level objects to be sighted at distances of 40 miles with considerable clarity. This is not an hallucination or mirage, and experienced seamen can recognise the weather conditions which make these sightings possible; they are usually associated with an atmospheric condition in which warm air exists above a cold surface, causing rays of light to be bent over the horizon. This may also cause objects to appear upside down or with other considerable distortions; these should not be mistaken for hallucinations either, but such conditions may not be suitable for the sighting of distress flares. Smoke or heliograph should be used until the object is well within normal sight before distress flares are used, otherwise they may be wasted.

16 LANDING ON SHORE

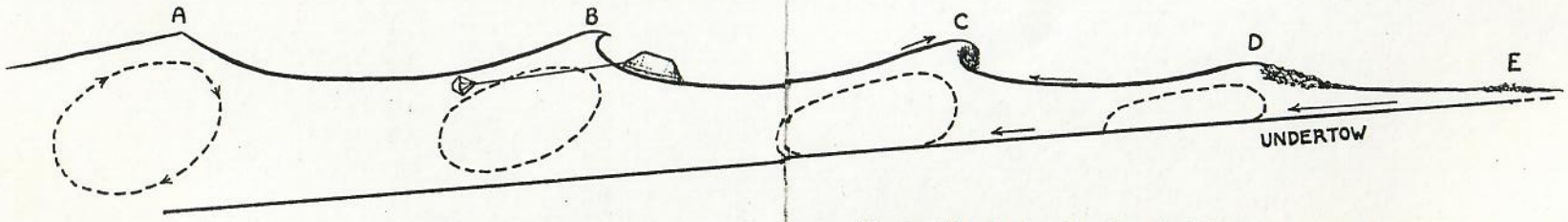
A considerable amount of advice has been written about landing from a survival craft in heavy surf. Only general directions can be given, for the forces involved may not allow freedom of action; but if the choice is available, *do not land in a surf.* Castaways in a condition of physical deterioration, particularly from dehydration, will be unable to walk, possibly unable to stand, and certainly unable to struggle for any length of time in the violence of a breaking surf and some will almost certainly die if such a landing is attempted.

(1) In Inflatable Craft

On approaching land in an inflatable it may be impossible to avoid being carried on to the beach by an onshore wind and selection of the best landing spot should therefore be made as early as possible so that any cross-wind navigation may be carried out. Since it is extremely difficult to gauge the extent of the surf from seaward, the nature of the beach coupled with its angle to the breaking surf, should be the

basis of selection (see diagram, p. 88). If possible never drive directly on to a shore which faces seaward and lies parallel to the approaching waves since this is the area where there will be the highest incidence of rock and undertow, with the most violent breakers.

On approaching the shore, lash stores and water to the raft, if possible in watertight containers, cut the canopy away from the flotation chambers at the sides of the raft, so that escape will be more easily effected if the raft is overturned or deflated and then stay with the raft for as long as possible. Ground swell will increase and as the raft surges to the top of the swell, try to glimpse an area where a shelving beach will allow survivors to crawl above the water line. It is important to remember here that dehydrated survivors will be unable to walk. A light sea anchor at this stage will help to keep the raft from capsizing prematurely in the surf. As soon as the primary breakers are reached survivors should be congregated at the seaward side of the raft with the strong swimmers in the water holding on to the grab lines to keep the raft stable. Life jackets and clothing should be worn for protection against pounding on sharp rocks and coral. The raft should be filled with seawater before entering a heavy primary surf (by piercing the raft floor if necessary) to



SURF DIAGRAM—PROFILE

(A) When a wave builds up on approaching land this is distinctly noticeable when the depth of water becomes less than half the wave length from crest to crest

(B) Surf begins to break when depth of water is 1½ times the wave height

help stability, but in cold water this should not be done until the latest moment to ensure the shortest spell of immersion. If the water is very cold the castaways must decide for themselves whether the cold or the surf is the greater danger, and flood the raft or not accordingly. However, a capsized raft is going to flood anyway, and it is difficult to prevent capsize if the surf is violent. If the raft is overturned, cling to the grablines but be prepared to make for the shore independently, for the raft can now cause severe injury if a survivor is trapped between it and a rocky seabed. The raft may be re-joined when the violence of the primary breakers has been passed, for if it is still afloat, it is still the best means of transporting the weaker survivors to the shore. The raft remains should be assisted ashore by the stronger survivors so that the stores and equipment lashed within can be saved before they are damaged beyond recovery. Very weak survivors should remain within the raft at all times for their chances of surviving a violent surf independently are not good.

(2) In Rigid Craft

When approaching land in a rigid craft a different technique must be adopted. If oars are available, the craft should be

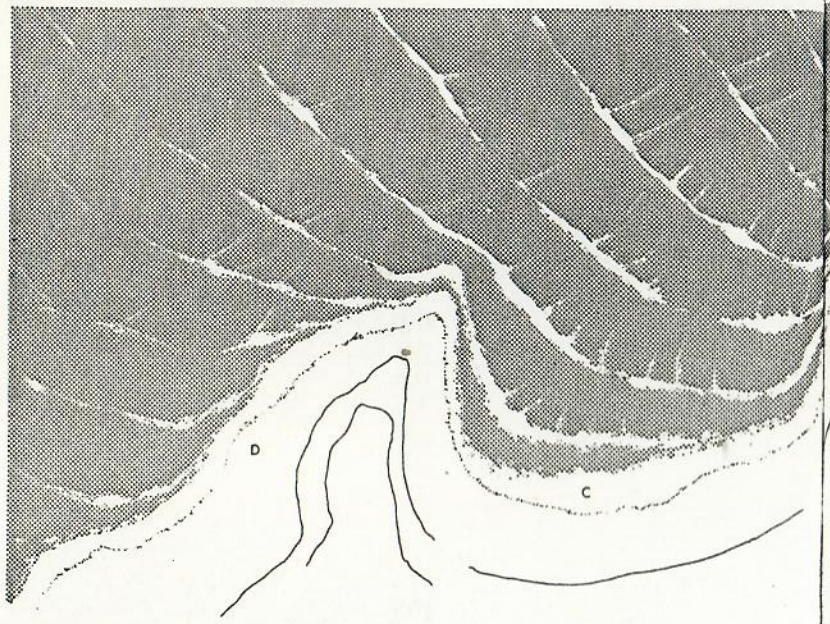
(C) Surf breaks heavily when depth equals wave height. At this point the survival craft enters the area of danger to castaways through injury from the craft itself

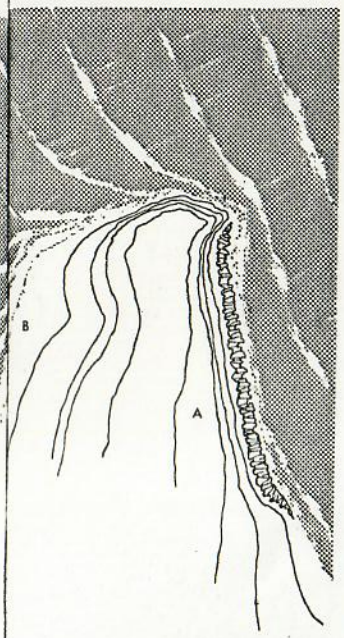
(C) through (D). Area of strongest undertow where weakened castaways are at maximum risk through injury from the seabed and from drowning

(D) to (E). Survivors who have reached safety should remain in this area to assist others at point (D)

held off the shore and navigated round the coast until a sheltered landing place is located, or until the help of local inhabitants can be enlisted. *No deliberate attempt should be made to land a rigid boat in a heavy surf.* It is far easier for survivors to travel round the coast by boat than on foot, and, in a raging surf, the boat which has sustained

SURF DIAGRAM—REFRACTION





(A) 'Steep to' headland produces area of confused seas dangerous to all craft
(B) The best area for landing is on the opposite side of a 'steep to' headland and where surf makes the largest angle to the original wave direction
(C) Difficult conditions, with surf of long duration, and severe undertow
(D) Next-best landing area to (B). Surf is reduced by half when it is deflected by more than 100° from its original direction

life at sea becomes a fearful weapon of destruction to castaways struggling in the water.

If a landing is unavoidable because of storm conditions, and the boat has to be beached, the sea anchor should be streamed to present the most seaworthy part of the boat to the oncoming waves. The oil bag, if available, should be well filled and fixed to the sea anchor; any other oil available should be held in water tins with slow leakage holes ready to release before entering the surf. As the crests of the waves approach, the sea anchor should be streamed full open but as soon as the forward impetus of the crest is experienced the sea anchor must be immediately tripped and the boat assisted to run in on the back of the breaker; the sea anchor should again be allowed to open fully as the next crest approaches (The tripped. sea anchor will not appreciably hinder the boat's assisted progress towards the shore and has great value in preventing the boat from 'broaching to' as the crest approaches.) When and if the boat finally overturns the sea anchor should be left open to prevent the boat's further speedy progress inshore where it could smash down on top of the survivors struggling in the water.

Light flotation pieces of polystyrene or lifejackets should be used to help survivors to ride the surf in towards the shore ahead of the craft; avoid oars or heavy thwarts as a means of support as these can inflict crippling blows in a heavy surf. The boat will eventually be washed ashore and any pieces of equipment lashed to it should be recovered at the earliest

opportunity before they are dispersed if the boat should break up.

When survivors are forced to take to the surf, some may become unconscious through cold, fatigue, near-drowning, or by the buffeting from the surf. It will fall to the conscious survivors to try to remain with and bring ashore these casualties. It is imperative that the weak and injured be removed from the water quickly before they drown, and those who have reached a position of safety should not proceed further towards the shore without looking around and helping those in need. Sharp rock or coral outcrops may lacerate buoyancy apparatus or lifejackets and valuable stores of food and water, as well as lives, may be lost at this time, so it is worth repeating that survivors with adequate reserves of strength should remain as near the surf as safety permits, to carry out rescue and salvage operations. In tropical zones, legs and feet should be covered to protect them from contact with sea urchins, especially in rocky areas; oilskins will give the body some protection against the penetration of urchin spines, which can cause very painful stings especially where pressure is unavoidable, as on the soles of the feet and palms of hands.

17 LIVING FROM THE LAND

(1) On Islands

If the condition of the survival craft makes it imperative to land on a remote island or uninhabited shore, there are ways in which life may be made more tolerable until a rescue is effected. A study of primitive tribal life in remote areas establishes the best methods in which survival may be continued for an indefinite period. The following are personal observations of existing practices.

On small low-lying coral islands with palm trees as the

principal vegetation, water holes for sweet water should be dug inside the vegetation line and not in the sand on the beach. This does not include mangrove trees which grow with their roots in salt water. A low-lying area should be selected for the water hole since the water table will be level across the island.

A wide variety of edible marine life exists within the shallow reef area from conch (which makes very fine soup) and other shellfish to a wide variety of small reef fish, which may be caught easily with the small hooks, using pieces of crushed crab for bait.

Very small fry are difficult to catch without a baited fine mesh net but a swift blow with a paddle on the seaward side of a shoal of small fry swimming close to the beach may panic some into stranding or may stun some if they are very close to the surface. They make excellent bait with which to catch jack and other such larger edible reef fish. Spear fishing in deep water reef areas is difficult without a mask but in shallow areas crayfish and lobsters may be caught, especially at night with the aid of a light. Care is necessary to avoid stepping on venomous fish or small sting rays which lie in the sand in shallow water. Small sharks may also be found in shallow reef areas and these can be readily speared or gaffed but larger varieties of shark in deeper water should always be avoided.

Larger barracuda, jack, snappers, etc. can be taken on heavier lines using small jack as bait and trolling swiftly, but the tackle can be lost in bottom fishing if a grouper or rock fish is caught and allowed to 'hole up' through inattentive fishing. Avoid eating older barracuda, parrot fish, puffer fish, or large-toothed coral eaters as their flesh is often poisonous. Fish with stings can be eaten but care is necessary to avoid injury in catching them. A precaution worth noting is that if a grouper is caught, it should be carried by the tail, or by the thumb and finger in the eyes, since the gills have needle-like teeth which can inflict painful injury if the

deficiency of salt can quickly incapacitate an otherwise healthy survivor. Sea salt is in common use for the supply of human needs, but only enough should be taken to maintain health. The excess of sodium chloride in seawater cannot be tolerated by human bodies unless non-saline fluids in normal quantities are also available.

APPENDIX A: SUGGESTED EQUIPMENT FOR A SURVIVAL CRAFT

(1) Water and Food

Water in tins: 5 pints per person.
Glucose sweets: 20 oz per person.
Hard biscuits: (vitamin fortified) 10 oz per person. To be reserved until water is available.

Any supplementary food should be chosen for its keeping quality, energy or vitamin content. For ease of distribution, avoid crumbly substances, which are difficult to pass around and eat on an unsteady craft. The more individually they are packed, the better, for seawater may enter an opened box and spoil valuable quantities of food.

(2) Fishing Equipment

Good quality lines of varying size from 25 lb to over 100 lb breaking strain and not less than 50 fathoms of each. (Fishing line may be required for many other purposes.) Also stainless steel trace wire, for use with larger lines, preferably with hooks already attached. It is unlikely that the speed of the survival craft will be fast enough to allow trolling (at least four knots), so lines will have to be cast and pulled in swiftly if game fish are sought. Medium lead weights of torpedo shape to fasten around the line are best for this purpose, so that the line will be carried out well when cast but will not sink too quickly. Hooks are best baited with whole small fish and pulled swiftly across the surface of the sea (sometimes fast enough to allow the bait to skip) or with other lures described in the section on page 47. Heavier weights are required if baited large hooks are to sink swiftly below the reach of surface small fry or scavenger fish. In this case it is necessary to cast well out to avoid the scavenger fish surrounding the survival craft. Hooks should range in size from very small trout hooks upwards. In certain areas, line fishing may not be

practicable (p. 48) and other methods will have to be adopted. Gaff and spears are the best selective hunting weapons, and the type of gaff illustrated (p. 49) could usefully be included in the survival kit, while a Hawaiian sling or spear gun should be high priority if time allows when abandoning the parent craft. It should, however, be remembered that some strength is required to operate a Hawaiian sling, whereas the gaff is merely pulled into the fish. A spear gun with a trigger mechanism is also fairly easy to operate. Ensure that a guard is secured around any sharp points.

A fine muslin net, of the type illustrated (p. 51), may not only be used for catching plankton, but also for the storage of dried fish and turtle which tends to sweat if kept in plastic bags. Part-dried food also tends to warm up by a form of spontaneous combustion if put together before thoroughly dry, and this causes it to go mouldy. It should be frequently inspected and aired to prevent this happening in the initial stages of storage.

(3) Water Containers

One of the most important items of equipment to be stored in a kit are the spare water containers. For obvious reasons of bulk and weight, large quantities of water or desalting apparatus cannot be stored, but once heavy rain is encountered, water problems can be greatly alleviated if adequate storage is available. There is no reason why three or four gallons of container space per person should not be stowed in the kit in the form of tough durable waterproof bags which, when filled with fresh rainwater, may be floated alongside the craft or towed astern. The bags should be strong enough to use as pillows, to resist damage when fallen on, and to act as buoyancy apparatus in a heavy surf.

(4) Other Equipment for an Inflatable Craft for Ten People

Repair outfit consisting of:
- Two patches 1 foot square
- Six patches 3 inches square
- Twenty patches 1 inch square
- Repair clamp and hole stoppers (including pinhole stoppers)
- Solution (three tubes)
- Epoxy resin (two tubes)
- Leak finder
- Glass paper

One pint bailers: three (one for each end of the raft and one spare for use as urinal)

Quarter pint beakers: six (to be used as feeding cups)

One pint, clear, screw-topped jar for use as a water bottle to pass round

Mopping-up sponges: four

Sea anchors: two, with tripping lines and oil bags

Bellows: of good quality, in particular with reference to non-return valve. Bellows tube should be long enough for watchkeeper to reach all inflation valves without disturbing other people

Mouthpiece for bellows pipe in case the bellows fail

Can openers: six (of the type that makes a large triangular hole to make refilling easy)

Flashlight: suitable for signalling, waterproof, with spare batteries and bulb, with wrist-strap

Knife: one of the blunt-nosed type

Knife: one pointed blade of at least 6 inches, single-edged and sheathed

Knife sharpener: one, of the wheeled type for stainless steel blades

Electricians' or forceps-type pincers: one (particularly useful in releasing valves and making tools)

Paddles: three, sectional

Rescue quoit with 20 fathoms $\frac{1}{4}$ inch nylon line (one for each door)
Solar stills: five
Heliograph: one
Rain catcher: one (plastic material)
Plastic buckets: two (2 or 3 gallon type)
Plastic bags two foot-square: two (dry storage of goods)
Compass: one pocket type, luminous
Radio beacon: one activated by sea cell battery
Magnifying glass: two (one reading)
Handflares: six
Rocket flares: two
Smoke flares: two
In cold-water areas: A waterproof survival suit or bag may save the life of a survivor suffering from acute hypothermia and hoods and gloves may usefully be stowed for use by lookouts
One good survival book, with charts, maps, paper, pens and pencils, sheathed dividers and 6-inch rule
Sunglasses: two pairs

Supplementary equipment for rigid craft would include repair kit composed of tools (small hacksaw, epoxy resin, nails) but would still include repair patches

(5) First-Aid Equipment

Injuries incurred at the time of the disaster should be treated in the manner directed by good medical practice wherever this is possible. In survival conditions this is not easy to achieve even by practised seafarers who are also doctors, therefore medicine and equipment should be of the type which requires the least expertise in administering or use and involves the least amount of attention after application. The first-aid equipment is inevitably subject to diverse other requirements, and should be assembled with this in mind;

it doesn't help if first-aid equipment is made in such a way that it is deliberately awkward to use for other purposes, for the good survivor will always try to put it to other uses, and whether he does so successfully or not is immaterial to the first-aid box, once it has been used. When making up a kit, it should be remembered that:

Adhesive tape is more economical than bandages, and is generally a more useful material for binding objects together. Triangular bandages have many uses and should be given preference over ribbon-type dressings which are difficult to use again, once soiled.

Safety pins are very easy to lose in odd corners of a raft, where they may cause chafing damage. (It may be argued that safety pins may be used to catch fish but fish-hooks are undoubtedly more suitable.)

Tapes secure dressings more efficiently than pins, if with a little more trouble, and have many alternative applications in an inflatable raft.

Surgical needles, pre-threaded, save much time in stitching bad wounds; they can also be used to stitch bad gashes in raft fabric.

Standard, ready-to-apply dressings for wounds become sodden with seawater very quickly, as does cotton wool unless protected by a waterproof covering.

Small, shaped, inflatable cushions or splints are easily stowed and are very useful for protecting injured limbs against knocks from other castaways. They have many alternative uses. Useful splints may also be made from glass fibre and resin, which also have important repair applications.

Artery forceps should be of good-quality stainless steel and strong enough to use as pincers for other jobs around the craft. This is one of the most useful tools in the whole survival kit.

Sharply pointed forceps, for extracting splinters, can be kept in a sheath until required. They are most useful where

small cavities require probing (non-return valves on bellows and raft, etc.).

Scissors should also be sharply pointed (and sheathed) so that the blades may be used as spearheads or knives if necessary.

Scalpel blades with foil sheaths are extremely useful for paring rubber, dressing turtles, and dressing fish, apart from their normal medical uses.

An enema tube would also be a useful addition with a special pint-sized enema bag to contain water.

Medicinal substances: Anti-seasickness tablets, which cause drowsiness, should not be taken by all the survivors in a raft, particularly in cold-weather areas where a major leak of carbon dioxide into an enclosed canopy would not be detected, if none of the occupants was sufficiently alert. Anti-seasickness suppositories are useful where seasickness has already started and pills cannot be swallowed.

Antiseptic barrier cream used on skin surfaces should be protected from contact with raft fabric which quickly rubs it off.

Petroleum jelly may also be used to keep metal accessories free from corrosion.

Soluble aspirin should be individually wrapped in foil, or in small quantities in airtight packets.

Eye ointment and drops may well be needed.

Antibiotics are required for treatment of sepsis and for cases of severe burn; also for lung infection which may result from near drowning or hypothermia.

Multivitamin tablets in small watertight containers to be taken daily as a protection against scurvy, etc. (These may include some form of iron supplement.)

Bicarbonate of soda in small (acceptable) quantities can assist in counteracting acidity in recovered drowning and hypothermic survivors.

Some form of *calcium,* if not included in the stores, should

be supplied in the first-aid kit. Milk tablets could usefully fill this need.

Morphine injection capsules, for use when extreme pain is causing too much distress, or when violence in delirium, or from other causes, cannot be treated in any other way.

Remarks

A comb promotes good hygiene, keeping hair tidy and giving a feeling of well-being.

Skin conditions from saltwater immersion sometimes cause extensive areas of tenderness around the crutch and under arms. If in the tropics, discard wet clothing which aggravates this condition and try to keep the affected area dry. This advice need not interfere with that of keeping clothing wet during the heat of the day, for such clothing can be arranged to avoid contact with the sore area of skin. Wash in fresh water if showers permit.

Do not expect *bowel movements* when living on survival rations. These may eventually take place if adequate fresh water and seafood are available but castaways have gone thirty days without bowel movement, with no ill effects, and while eating small quantities of fish or turtle each day. Fresh-water enemas, if the water is to spare, can assist the castaway in ease of bowel movement. Urination should continue at a much reduced rate daily even while the castaway is dehydrated and although the urine becomes dark coloured and is sometimes painful to pass, this is neither unusual, nor harmful in conditions of dehydration. Urine should not be drunk.

APPENDIX B: BIRDS

Many sea birds undertake such extensive migration flights that in some cases it seems that a large part of their lives is occupied with the business of travelling to and from their

seasonal habitats. Some land birds also undertake long flights overseas on regular migration routes and in the following pages the general routes which they follow, and the sea areas in which they may be encountered, are listed. There are, of course, many vagrant flights which take place under difficult weather conditions, or simply by a failure, particularly in young birds, to navigate properly. The number of birds involved in these vagrant flights is small enough to enable the castaway to distinguish quite easily between a true migration and a wayward group of birds so that an unexpected encounter with a stray flight can be recognised and noted in its proper context.

For seaborne castaways, bird life is the closest, possibly the only, link with the environment which they are striving to regain (apart from being a practical source of food in time of need) and it is hoped that this section will help towards a better understanding of the activities of the birds which are likely to be encountered on the high seas (see also plates and diagrams as a guide to identification).

(1) Oceanic Sea Birds

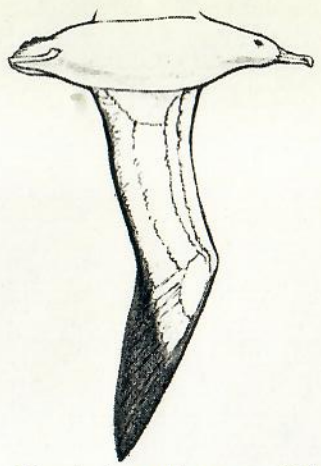
(*a*) *Albatross*

Southern oceans: *wandering, royal, waved*

North Pacific: *Laysan, black-footed*

The albatross is found mainly in the southern hemisphere; it spends most of its life over the ocean, where it depends on variations of wind velocities for flight. It lands, only to nest, on small islands and atolls once every two years, and may perform a complete circumnavigation of the world in the southern seas between nesting periods. Nesting grounds are usually on top of high cliffs on the windward side of islands to facilitate take-off.

The *Laysan* and *black-footed albatross* inhabit the northern Pacific Ocean, nesting on Laysan Island 1000 miles west of Hawaii and also on other isolated north Pacific islands such



Wandering albatross, 48″

Black-footed albatross, 28″

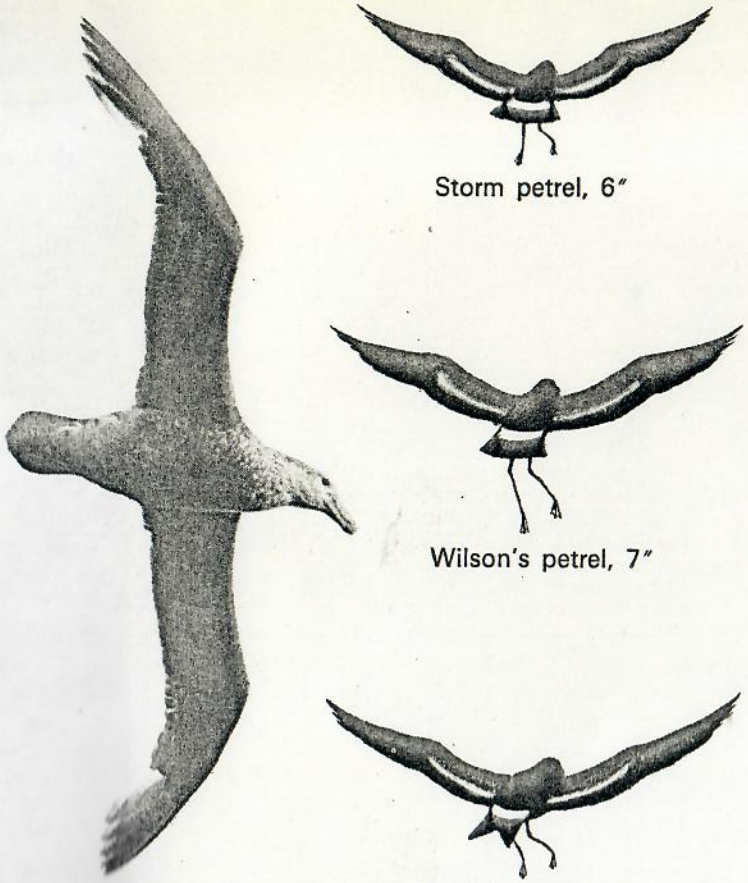
Galapagos (waved) albatross, 28″

as Midway, and have characteristics similar to those of the southern albatross.

(*b*) *Petrel*

Wilson's, Leach's, storm

Seasonal flights of various species of petrel cover enormous areas of ocean.



Storm petrel, 6″

Wilson's petrel, 7″

Giant petrel, 36″

Leach's petrel, 8″

Wilson's petrel breeds in the American sector of Antarctica during summer (January and February). They travel northwards in flocks during March and April, by which time they cover a large area of the southern Atlantic and the western North Atlantic. By June, Wilson's petrels have migrated into the northern Atlantic and may be found in large groups, sometimes 1000 strong, off the American coast and are generally distributed over the area covered by the Gulf Stream. September and October find large numbers moving to the eastern Atlantic and then southwards, following the pattern of prevailing winds to travel along the South American coast (to their breeding grounds in the Antarctic), where they remain until February. Migration does not occur along established routes but more as a general drift along belts of prevailing winds. In other areas, Wilson's petrel moves northwards from the Antarctic continent to the seas around north Australia and New Guinea, while in the Pacific it migrates along the line of the Humboldt current as far as the Doldrums. From the Indian Ocean, Wilson's petrel moves north into the Red Sea, often in large numbers.

Leach's petrel breeds in the northern hemisphere on both sides of the Atlantic: from Massachusetts northwards, in an area which includes Newfoundland and Greenland to the British Isles; and similarly in the Pacific from Canada across the islands to Japan. In the northern winter it migrates to the South Atlantic and the eastern Pacific oceans.

The *storm petrel* of the eastern North Atlantic which may also be found in the Mediterranean is smaller than Wilson's or Leach's and nests on the shores of the European continent, migrating during the northern winter to the Red Sea and the South African sea areas.

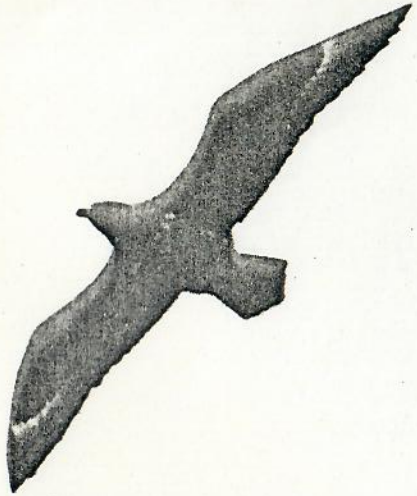
The giant petrel breeds around Antarctica and is to be found as far north as the subtropical latitudes around the whole of the southern hemisphere.

Cape petrel or *pigeon* breeds around the Antarctic islands and southern capes. It may be found as far as latitude 20° S outside the breeding season.

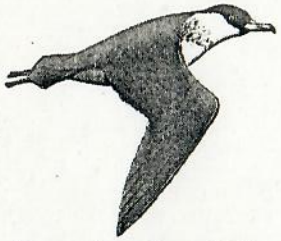
It will thus be seen that petrels of these and other varieties may be found in most oceanic waters of the world and their adjoining seas. They eat planktonic material and other small marine organisms, usually obtaining their food by fluttering low over the surface of the water; sometimes they maintain their balance by paddling their feet in the sea while still in flight.

Arctic skua, 18″

Long-tailed skua, 22″



Great skua, in flight showing white wing-patches, 23″



Pomarine skua, 20″

(c) *Skua* or *Jaeger*

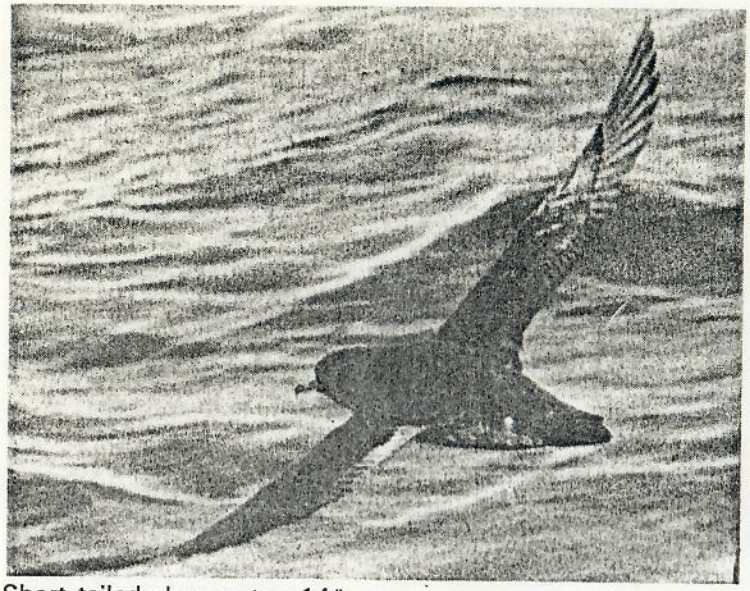
Great skua. Usually restricted to waters in middle or high latitudes, great skuas are found in both hemispheres, sometimes crossing the equator in their wide ranging flights which are more nomadic than migratory. They are parasitic by nature and may approach closely enough to a survival craft to be caught if bait is laid out.

Arctic, long-tailed, and *Pomarine skuas* (*or Jaegers*) are all northern species and nest in the Arctic tundras, wintering to the south in the Atlantic and Pacific. The skua is probably the most northerly and southerly-ranging species of bird, some individual sightings having been reported quite close to the poles.

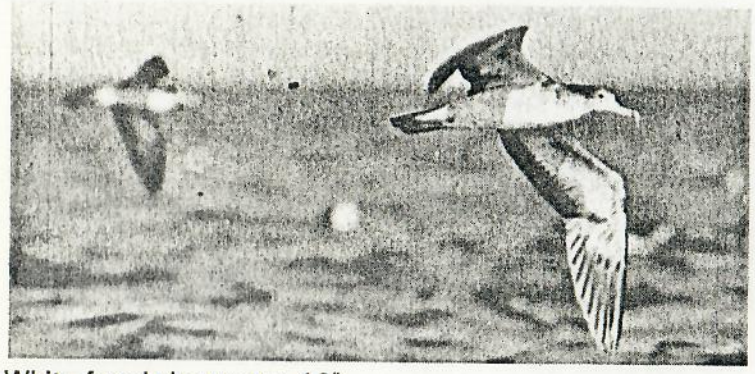
Fulmar, 18″

(*d*) *Fulmar*

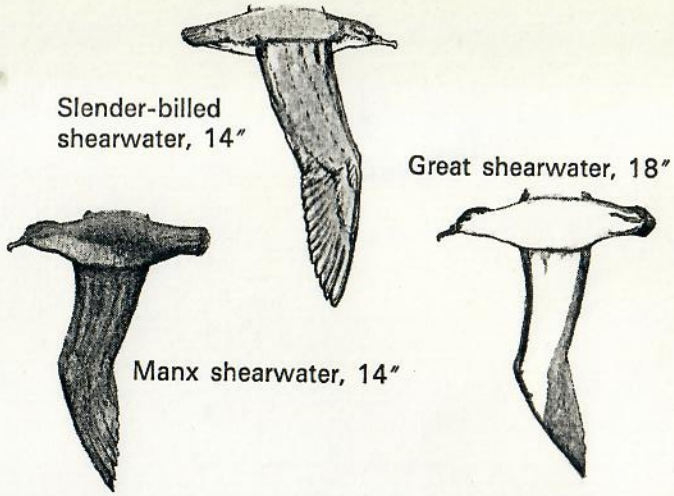
Another sea bird with wide distribution is the fulmar, which breeds in middle and high northern latitudes. During the breeding season it may be found up to 600 miles from its



Short-tailed shearwater, 14″



White-faced shearwater, 16″



breeding ground and has a wide ocean distribution at other times of the year; a slightly different species of fulmar spreads northwards from its breeding grounds in Antarctica into subtropical southern ocean regions.

(*e*) *Shearwaters*

Greater, sooty, short-tailed, flesh-footed (*Indian Ocean*), *Manx Greater shearwaters* may be found over the whole of the Atlantic Ocean from the Falkland Islands to Greenland, with migratory flights, emanating from Tristan da Cunha, in a similar pattern to those of Wilson's petrel. After their nesting period from January to March, they move north and may be found on the Grand Banks of Newfoundland in June; they then fly eastwards to Greenland and Iceland, reaching the British Isles in August. The western Atlantic birds fly southwards again from mid-August but in the east they remain around Europe until late October before moving south again.

The Pacific Ocean is also well populated by the *short-tailed* (or *slender-billed*) *shearwater*, which performs a cyclical flight from its nesting area around Tasmania and South

Australia, crossing the Tasman sea to New Zealand and moving northwards to Japan around June. It then crosses the North Pacific from west to east in the northern summer, turns south along the eastern Pacific in August, and returns to its breeding grounds by a direct route from California to Australia in September.

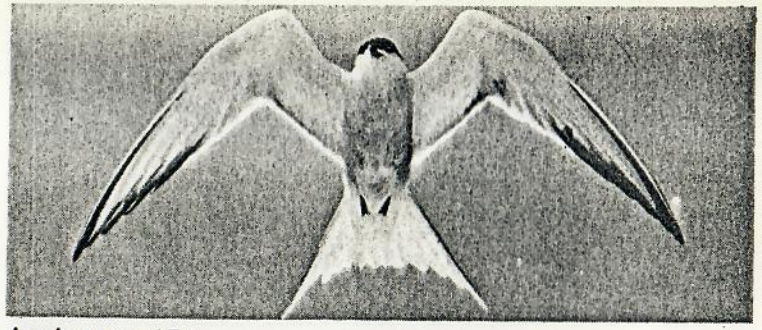
The Indian Ocean also has its species of shearwater, notably the *flesh* or *pale-footed shearwater* of eastern Australia, while the *Manx shearwater* breeds on the islands and coasts of the North Atlantic, migrating into the South Atlantic during the appropriate summer seasons.

Shearwaters, like petrels, have been used by fishermen as bait and may be caught in large numbers when on actual migration flights (a torch may be of help in this at night), but trapping is extremely difficult when dispersal has taken place after the destination has been reached. Shearwaters, larger than the petrels, are used for food in southern Australia, and valuable oil may be extracted from both species.

(*f*) *Terns*

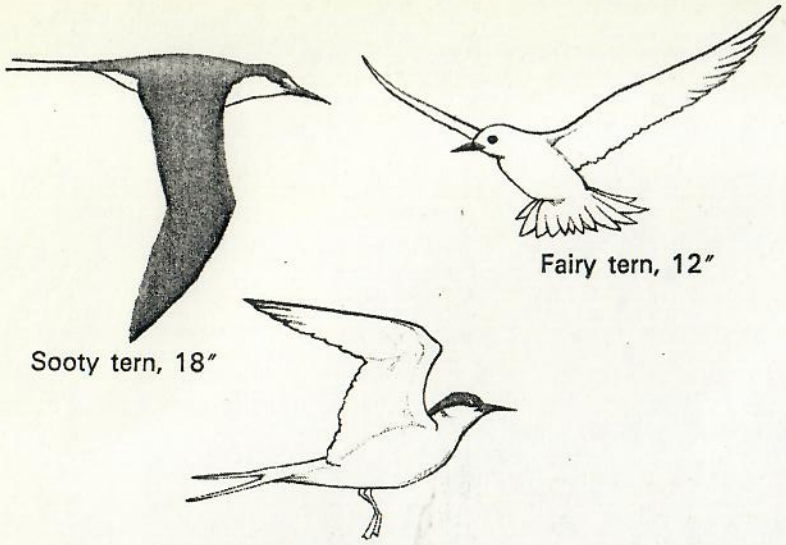
Arctic, common, sooty, brown noddy, roseate, fairy

The *Arctic tern* has probably the longest migration flight of any bird. It nests along the northern coasts of Europe, Asia, and North America during the northern summer and spends the northern winter in the Antarctic having migrated through nearly 140° of latitude. Autumn flights of American and European birds move down the eastern Atlantic, avoiding the warmer western waters and, of course, following the cyclical wind pattern. Similarly, Pacific migrations take place along the west coast of the USA. The Arctic tern begins migration from the northern hemisphere at the end of July in the west, continuing into October in eastern regions. The return flight in the spring generally follows the eastern coasts of South and North America in the Atlantic but some may be found near the African Coast; they arrive in Europe in April and disperse eastwards, as do the American coastal birds, but



Arctic tern, 15″

Common tern, 15″



Fairy tern, 12″

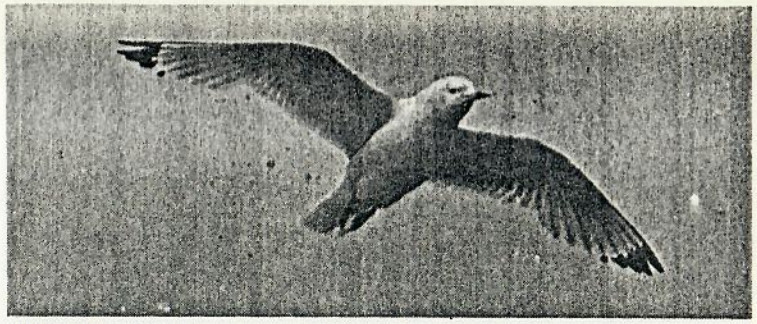
Sooty tern, 18″

Roseate tern, 16″

little is known of the prenuptial flight dispersal. In the southern summer, they may be found as far south as the Weddel Sea so that in the southern oceans a wide dispersal of these birds into all regions takes place.

Other species of terns make long seasonal flights and although some birds may be found in the open ocean, they generally stay near to coastal waters. Some European *common terns* winter along the shores of west and south-west Africa, while others go to Madagascar and even as far as India. In America the common tern winters in the Mexican Gulf and the coasts of South America. Asiatic common terns may be found on the southern and eastern coasts of that continent during the northern winter. Other terns with a world-wide distribution, particularly in tropical island regions, are the *sooty*, the *roseate* and the *brown noddy*. *Fairy terns* are widely encountered in the central Pacific area.

Although terns are very difficult to catch at sea they are



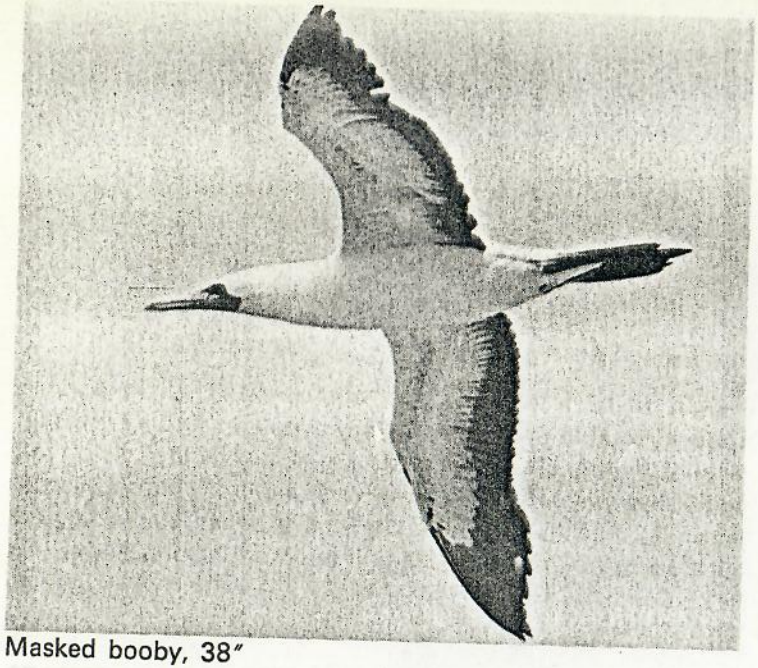
Kittiwake, 16″

usually to be found in areas where small fish or shrimps abound, so that the castaway may expect to find a fairly high level of marine life where terns are seen feeding, diving in a distinctive way after their prey, and usually flying off directly they return to the surface. On land they lay single eggs in burrows or on low branches and are more easily caught.

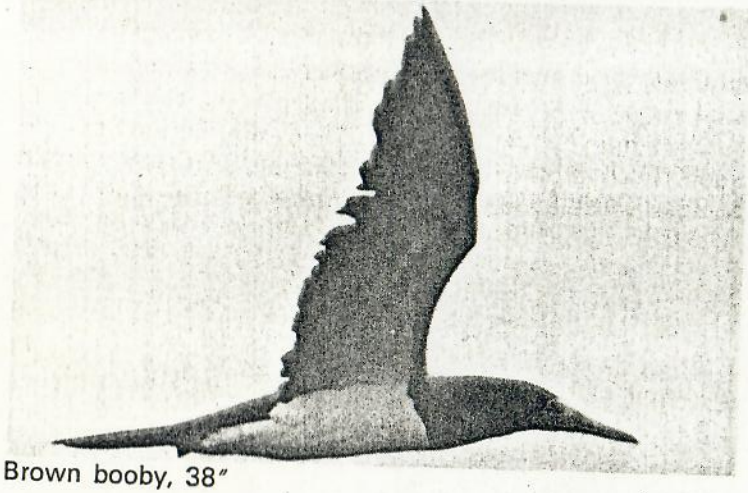
(*g*) *Kittiwake*

The kittiwake only visits the coast during the breeding season and spends the rest of the year on the open ocean. Widely distributed around the world in the middle and high northern latitudes, they leave the high seas about June and are then observed only around their nesting places; this migration includes the younger birds which may still be too young to breed. Their return to the sea takes place from August to October and they are then distributed all over the oceans.

Red-billed tropic bird, 24½″



Masked booby, 38″

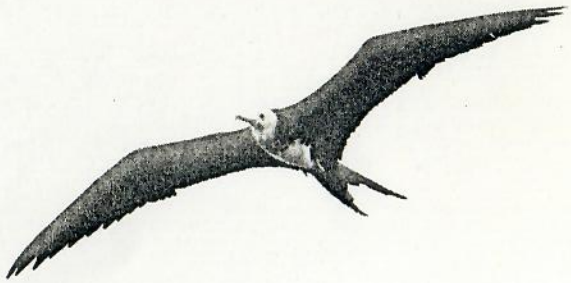


Brown booby, 38″

They are to be found from November to April over the North Atlantic from 60°N down to the tropics but their migration does not follow any particular pattern and may take place in a westerly as well as a southerly direction.

(*h*) *Tropic birds*

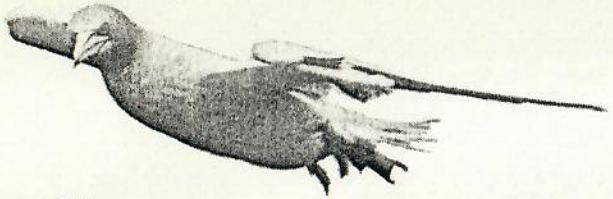
Tropic birds, sometimes called *bosun birds* after the marlin-spike appearance of their tail plumage, are mainly encountered world-wide in tropical and subtropical areas, as their name suggests. Although they do not migrate they may be encountered many hundreds of miles from land and are not gregarious by nature except when nesting. Although they may circle a survival craft closely they seldom alight, and after a casual inspection continue towards their destination. They feed by diving for fish and squid.



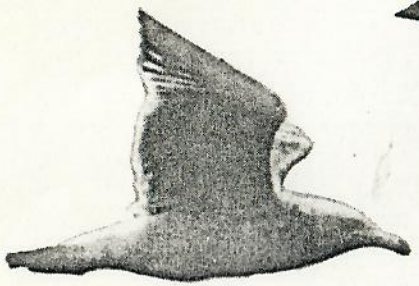
Magnificent frigate bird, 40″

(*j*) *Boobies*

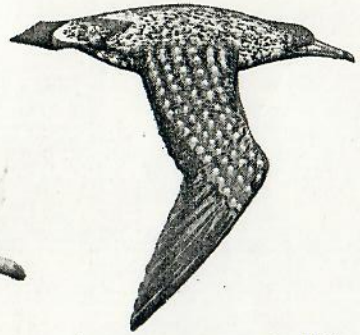
Boobies have a similar distribution to that of tropic birds and, though not migratory, may also be found many hundreds of miles from land. They are, however, extremely curious and quite fearless; they will not only approach a survival craft but will alight upon it, or even the castaways themselves, if nothing is done to frighten them away. Since they are huge birds and make good eating, they could well make a useful contribution to the castaway's diet if food is in short supply.



Gannet, 36″

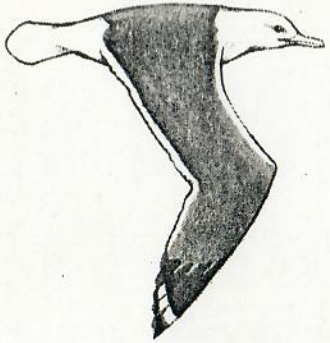


Herring gull, 24″



Immature gannet, 26″

Great black-backed gull, 29″



Common gull, 16″

(k) Frigate birds

Found mainly in tropical and subtropical island areas in the Atlantic, Pacific and Indian oceans, these birds live mostly by hunting flying fish and by marauding attacks on boobies, gannets and other sea birds, forcing them to disgorge their prey to escape attack. Like boobies and tropic birds, they may be found many hundreds of miles out into the ocean and have a seemingly unlimited capacity for remaining airborne. It is unlikely that frigate birds will approach a survival craft near enough to be caught unless they land on the sea in error and from which they find it very difficult to take off again.

(l) Gannets

Gannets have a world-wide distribution but are less venturesome in the migratory sense. Although young birds may travel 4000 miles in a coastwise direction, the adults rarely travel half that distance and usually remain within the area of the continental shelf, often close to the shore-line, feeding on schools of fish by diving into them from a height.

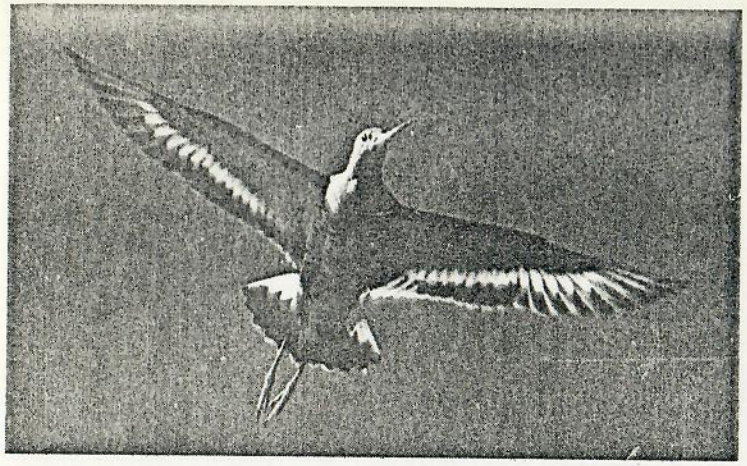
(m) Gulls

Herring, great black-backed

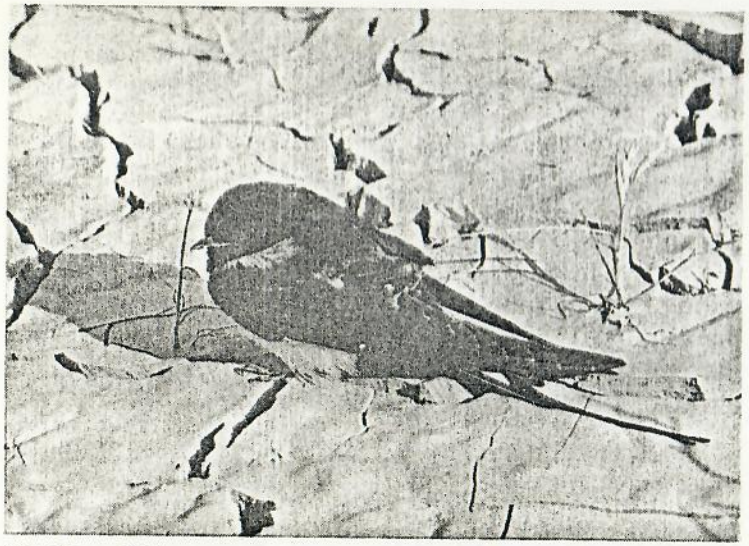
Gulls are probably the most familiar type of sea birds known to man but they are strictly coastal inhabitants and seldom venture beyond coastal waters. Some younger birds will cross the ocean but these are isolated cases. As a general rule, the gull family sticks to shallow waters, living from a wide range of marine food and scraps. They are difficult to catch unless they can be snared or caught with bait, but are quite edible if skinned. Like fish in polluted waters, they should not be eaten if there is a risk of contamination.

(2) Shore and Land Birds

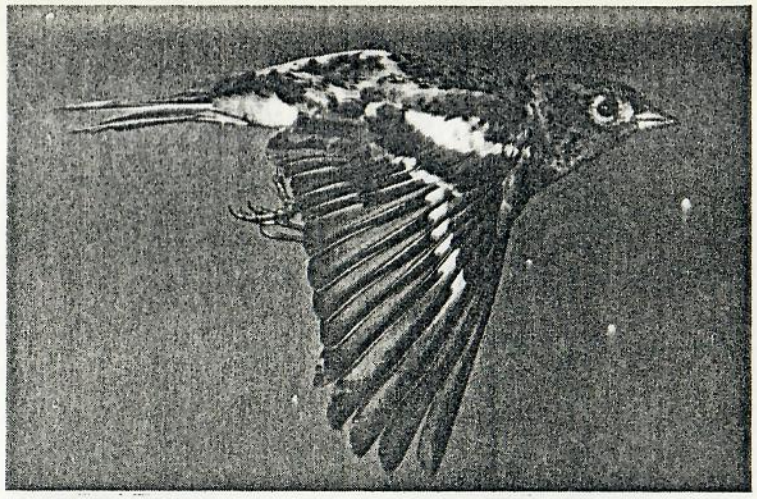
Shore birds often make long migratory flights to their winter feeding grounds and their flyways often cross large stretches



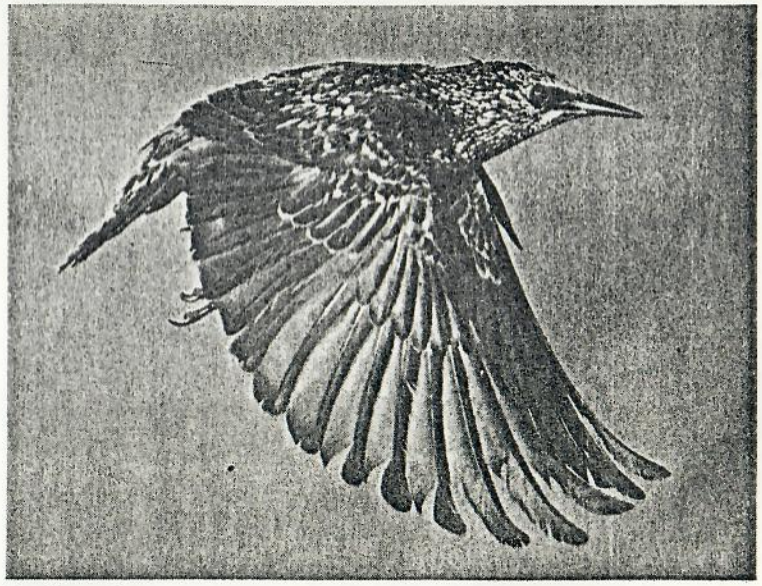
Bartailed godwit, 16″



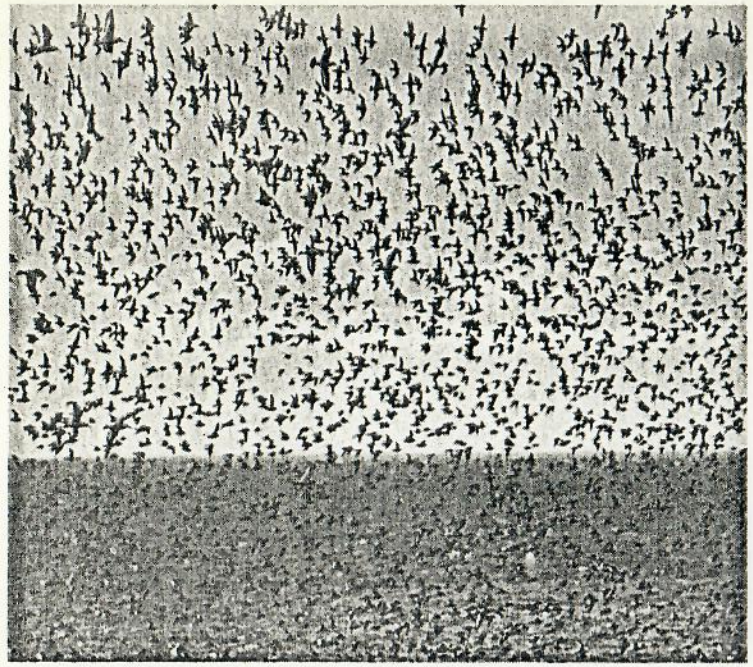
Swallow, 7½″



Brambling, 5¾″



Starling, 8½″

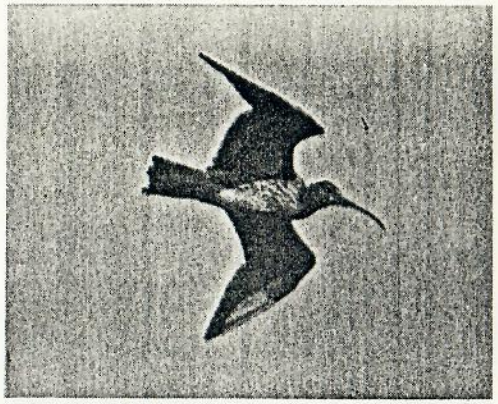


A pack of knots, 14″

of ocean. This list includes only the regular migratory species with this particular characteristic, for shore birds may be seen quite frequently in coastal waters, especially where land is separated by only a few hundreds of miles of sea, offering little obstacle to strong fliers.

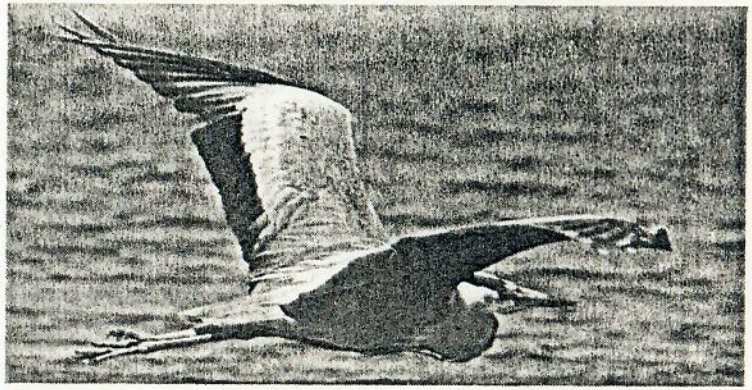
Land birds are rarely seen over large stretches of ocean, for their migration routes are selected to cross seas where islands offer convenient stepping stones or where the narrowest channels offer least obstacle to less robust fliers. Exceptions to this rule are vagrant flights, for instance, from Northern America to Europe, which are accomplished by most unlikely species of small birds. It is thought that the birds are probably carried eastwards in the high speed 'jet-

streams' of upper altitudes and that many perish en route, which would explain why many small exhausted land birds are recovered by ships in mid-ocean. It is unlikely, however, that even the less discerning of castaways would confuse these isolated recoveries with flights from a nearby land mass or a



Curlew, 23″

regular migration flight. (It is also unlikely that the exhausted vagrant will live, for starvation coupled with severe dehydration is probably the cause of its inability to remain airborne.)

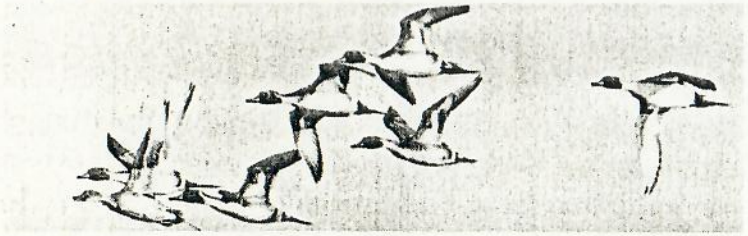


Heron, 36″

(a) *Golden plover*
One of the most spectacular ocean migrants amongst the shore birds is the golden plover. From their breeding grounds in Alaska across to Siberia, they migrate to the southern hemisphere in three flyways: (a) from West Siberia through Europe to the Mediterranean; (b) from Labrador by way of a route east of Bermuda and the West Indies to south Brazil and

Cormorant, 30″

Snow-geese, 28″



Pintail, 30″

Uruguay; (c) from the Aleutians and Alaska to Hawaii, thence through the islands to New Zealand, and from eastern Siberia to the Malaysian Archipelago.

(b) *Tattlers*
Similar flights are performed by many varieties of the *tattler* group of shore birds (the *bristle-thighed curlew*, for example, making a non-stop flight from Alaska to Hawaii). Many varieties of *godwits*, *sandpipers* and their allied families of waders also perform prodigious ocean crossings on regular migratory flights. Migrations take place in the autumn months of the northern hemisphere but the return flyway in the spring does not necessarily take the same route, the group which breeds in the Canadian northland, for instance, making its way up the American mainland instead of retracing the ocean passage of the autumn.

(c) *Herons*
Another widely distributed species, the many types of heron, frequents coastal and inland waters as a rule but on occasion may be found making long ocean passages between islands. The many varieties include *bitterns* and *egrets*, the latter sometimes crossing long stretches of ocean although they are, like the *cattle egret*, mostly land-orientated in their feeding practices. There are quite a number of instances on record of trans-Atlantic crossings by groups of these birds, indicating that their capacity for nomadic behaviour extends well beyond coastal regions.

(d) *Cormorants, geese, ducks*
Waterfowl of many species are well known for their migratory character, although their migration routes generally follow land contours and do not involve long ocean passages. Spring migration takes place usually from middle to high latitudes and vice versa in autumn, both routes generally in a north-south direction. Some very long coastal flights, extending

200 or 300 miles from land, may be observed in sea areas such as the southern approaches to Korea, and from Alaska to the Pacific coasts of America. Occasional American visitors reach British shores and considerable flights take place from western Europe to Greenland and the northern Eurasian mainland. In the southern hemisphere, similar migrations take place from continental America, Africa and Australia towards the islands lying to the south of these continents.

Near the coast of the country towards which migration is taking place exhausted stragglers may be found swimming in the sea, but if the flight is of *cormorants* they will be naturally found swimming submerged to their necks, a characteristic of this species.

(e) *Cuckoo*

Land birds which regularly migrate across stretches of ocean are rare, but some species, mostly the cuckoo, may be found widely distributed around the islands of the South Pacific. The *long-tailed cuckoo*, a native of New Zealand, spreads throughout the vast island area stretching from the Solomon Islands to the Pitcairn Islands in a migration to winter feeding grounds. The *bronze cuckoo* migrates from New Zealand to the Solomons in March and returns in September, a long ocean passage of over 2000 miles; the Australian members of this species cross the Timor Sea to New Guinea and the islands westward.

From Madagascar also there are several species of land birds which regularly migrate to winter feeding grounds in Africa but this does not entail long ocean passages as the flights are coastal. The flyways taken by European land birds often cross the Mediterranean but are largely north to south. Species whose flight is dependent on vertical air currents cross only where the stretches of sea are narrowest.

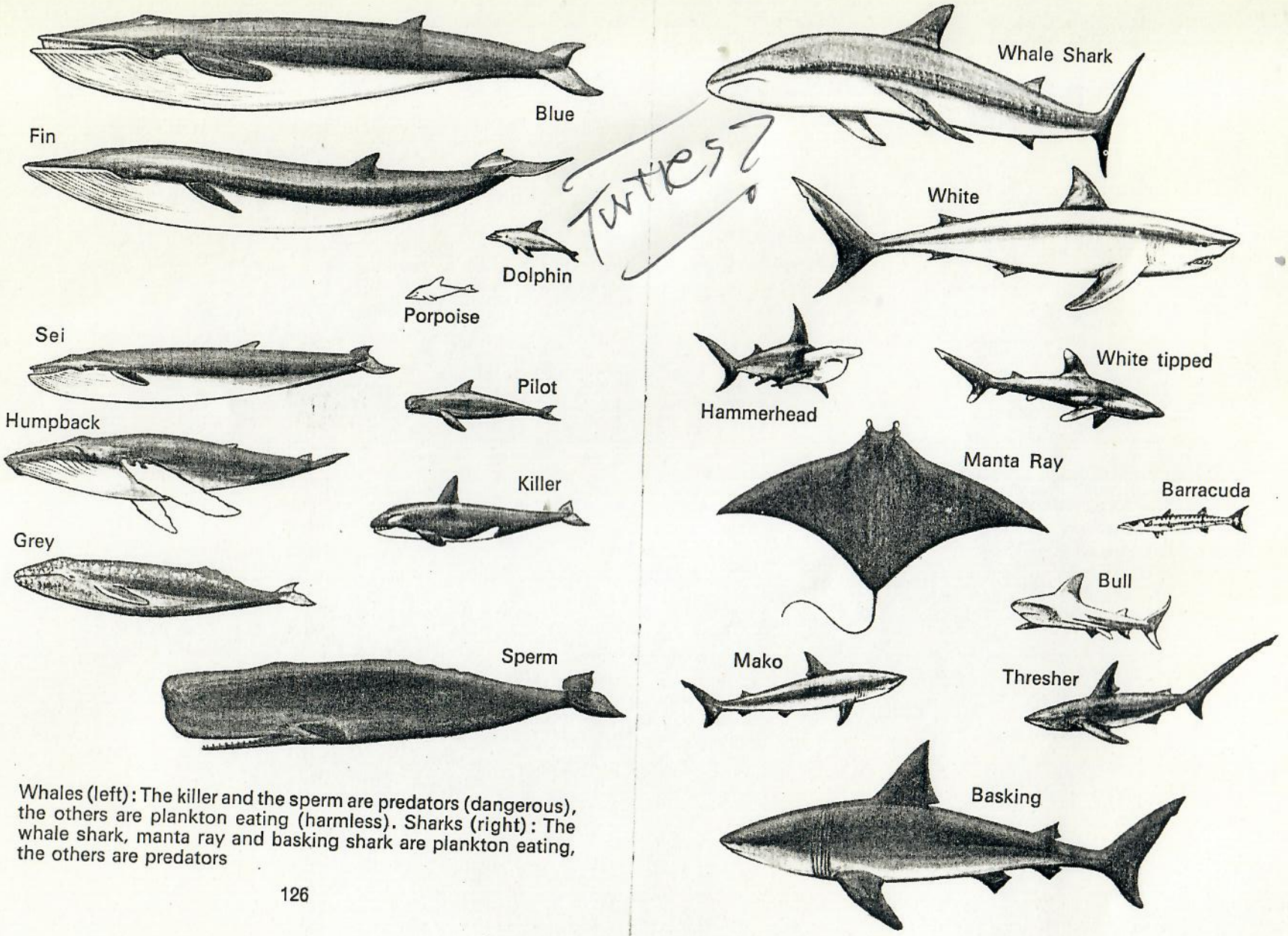
In general, it will be seen from the foregoing examples that,

during the migratory periods from March to May and from September to November, it is quite probable that shore birds of many species can be found in flight over the oceans in addition to the regular oceanic natives. That isolated flights of land birds may be sighted is also possible and no reliance may be placed on single observations to determine either the distance from land or the transit of the survival craft across a migration route. It can, however, be safely assumed that a general increase in non-migratory bird activity will be one of the first indications that a survival craft is approaching land. Unfortunately, oceanic migration routes cannot be accurately charted, for routes vary according to weather conditions as well as the separate species involved.

APPENDIX C: LIFE IN THE SEA

There are few places in the wide expanse of ocean surfaces where marine life of some sort does not exist. But, as on land, there are some areas where food is plentiful with a high incidence of life and others where, by reason of a low interchange of surface water, food is scarce and fishing poor. It is important that castaways should be able to locate the nearest areas of high density marine life, not only to improve their chances of catching food but also so that they may navigate towards an area where commercial fishing craft may be encountered.

The photographs of marine life on pages 44-45 are self-explanatory or have already been covered by the relevant chapter on fishing, and the areas of high incidence of marine life are shown on the ocean maps. It may however be of interest to those adrift on the ocean surface to have a brief explanation of the luminescence which surrounds them at night and a cautionary word about plankton and other forms of very minute life at sea.



Whales (left): The killer and the sperm are predators (dangerous), the others are plankton eating (harmless). Sharks (right): The whale shark, manta ray and basking shark are plankton eating, the others are predators

Vegetable plankton converts minerals into food through photosynthesis, and in the process gives off more oxygen than it requires, so providing for other sea animals as well. The most abundant types of vegetable plankton, called *diatoms,* are so concentrated at times of high growth rate that the sea is stained a brownish green. Another type of plankton of the vegetable type (but which may also be classified as animal) are the *flagellates.* When conditions (usually tropical) of growth permit, these organisms multiply so swiftly that huge areas of sea are coloured brown, red or orange and so intense is the concentration that the sea becomes deoxygenated and all marine life in the vicinity dies from suffocation. Flagellates possess luminescent properties and, with small types of jellyfish, are responsible for a great deal of the luminescence visible in the sea at night. These two types of plankton are too small to be trapped in a small mesh net, but since they are inedible this is of no consequence. However, the larger types of *animal plankton* and small crustaceans which may be trapped in a small mesh 'plankton net' (see diagram on p. 51) can contribute to the castaways' diet, but should be taken in small quantities only after the removal of any jellyfish and larger pieces of vegetable matter.

Much of this animal plankton rises to the surface of the ocean at night-time to feed, and is absent from surface layers during the day, so that the collection of plankton is best carried out as an overnight exercise, the net being withdrawn during the day.

Larger forms of marine life such as shrimp, squid, krill and small fish, some luring with and some attracted by luminescence, may also be trapped by the net and these form useful additions to the castaways' diet. Marine life of all sizes, from turtles to whales, rely on vegetable plankton and zooplankton for their nutrients, and because of their specially adapted feeding mechanisms they are relatively harmless to humans in the predatory sense, although they can inadvertently cause damage to survival craft. In spite of their immense size, there is no reason for castaways to be afraid of plankton-eating creatures and much of the alarmist folklore connected with these 'sea-monsters' is the product of old wives' tales rather than recorded fact. The accompanying examples of plankton-eating fauna (see pp. 126-7) are therefore included as much for the castaways' peace of mind as for their interest.

APPENDIX D: NAVIGATIONAL DATA

Apart from rising and setting celestial bodies, it is possible also to find direction of travel from observations of the Pole Star, which is always within a degree of the true geographical North. If in the southern hemisphere, the Southern Cross provides a good indication of true geographical South as the top and bottom stars of the cross point to the pole's approximate position on the horizon (see star charts, pp. 133 and 134).

The declinations of moon and planets change too swiftly to include their tabulation in this section but sometimes the moon's position in the celestial sphere relates closely to the stars given in the table (see below), and when this occurs the amplitude of the brighter objects can be a useful approximation.

AMPLITUDES

(True bearings of rising and setting stars and planets)

Latitude N or S	Declination						
Lat.	0°	5°	10°	15°	20°	25°	29°
0°	0	5	10	15	20	25	29
10°	0	5·1	10·2	15·3	20·3	25·4	29·5
20°	0	5·3	10·7	15·9	21·4	26·7	31·1
30°	0	5·8	11·6	17·4	23·3	29·2	34·1
40°	0	6·5	13·1	19·8	26·5	33·5	39·3
45°	0	8·5	14·2	21·5	28·9	36·7	43·3
50°	0	9·4	15·7	23·8	32·2	41·1	49·0
55°	0	10·5	17·6	26·8	36·6	47·5	57·7
60°	0	12·1	20·3	31·2	43·2	57·7	75·8
62½°	0	13·1	22·1	34·1	47·8	66·2	—

Bearing of object is named:
- E when rising
- W when setting
- N or S according to declination

Example: Approximate latitude of survival craft is 45° N

June Sun's declination 23½° N
from page 132 rising bearing E 34½° N or NE×E

December Sun's declination 23½° S
from page 132 setting bearing W 34½° S or SW×W

Time for observation is correct when the lower rim of the sun is a semi-diameter above the horizon thus: O

In high latitudes the sun rises and sets with too much horizontal movement for accurate observation.

Recognition

Planets are easily distinguished from stars by the steady quality of their reflected light as opposed to the twinkling character of starlight.

Venus: Visible for a short time after sunset or before sunrise, has a bluish light and is the brightest of the planets.

Jupiter: Next in brilliance to Venus and much brighter than any of the fixed stars, Jupiter is easily discernible on the horizon in clear weather, when rising or setting. Both Venus and Jupiter may well be mistaken by uninformed lookout for the navigation lights of a ship.

Mars: Fluctuates in brilliance during the course of the year and is known for its reddish colour.

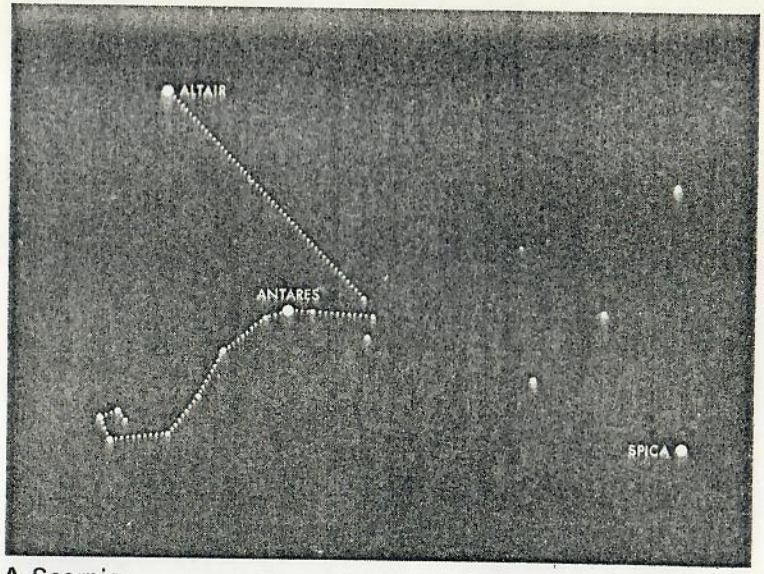
Saturn: Yellowish in colour, has least brilliance of these four planets and is equal in brightness to a first magnitude star.

DECLINATIONS

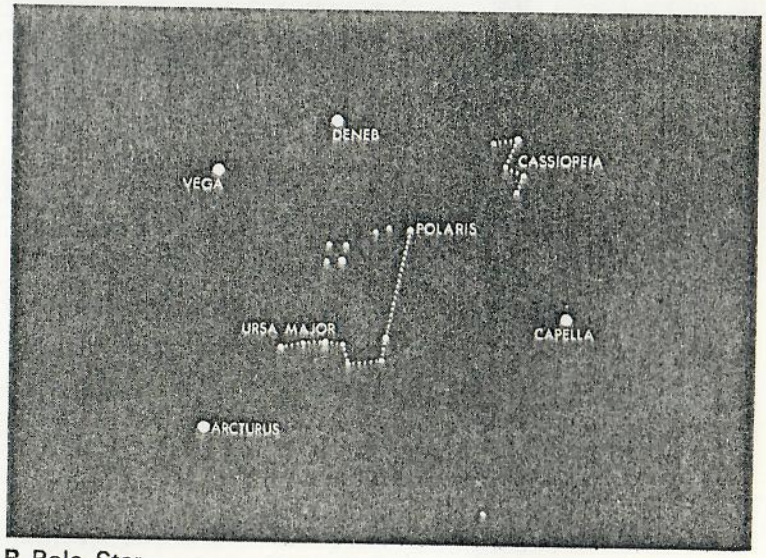
Mid-month	Sun	Stars	Mag.	Declination
January	21° S	Antares	1·2	26° S
February	13° S	Aldebaran*	0·2	19° N
March	2° S	Altair	1·7	6° N
April	10° N	Betelgeuse*	av. 0·5	7° N
May	19° N	Arcturus	1·1	16° N
June	23½° N	Bellatrix	0·9	9° N
July	21½° N	Procyon*	0·5	5° N
August	14° N	Rigel*	0·3	8° S
September	3° N	Sirius*	—1·6	17° S
October	8½° S	Spica	1·2	11° S
November	18½° S	Canopus*	—0·9	53° S
December	23½° S	Vega*	0·1	39° N

* Particularly bright stars.

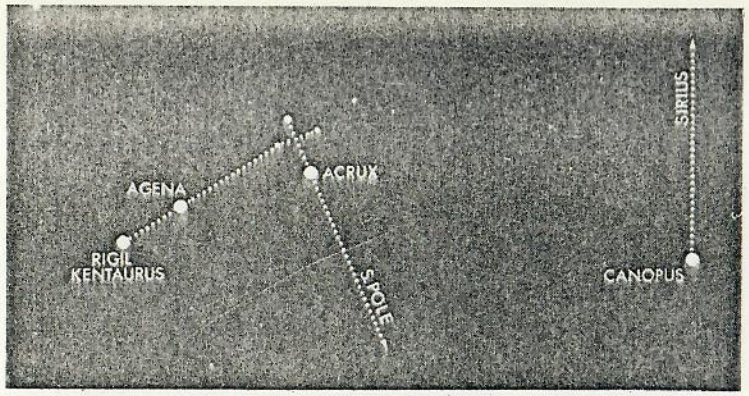
Note. The irregular movement of planets does not allow a permanent prediction for the declination of these bodies but their celestial position may be estimated in relation to the stars at zenith.



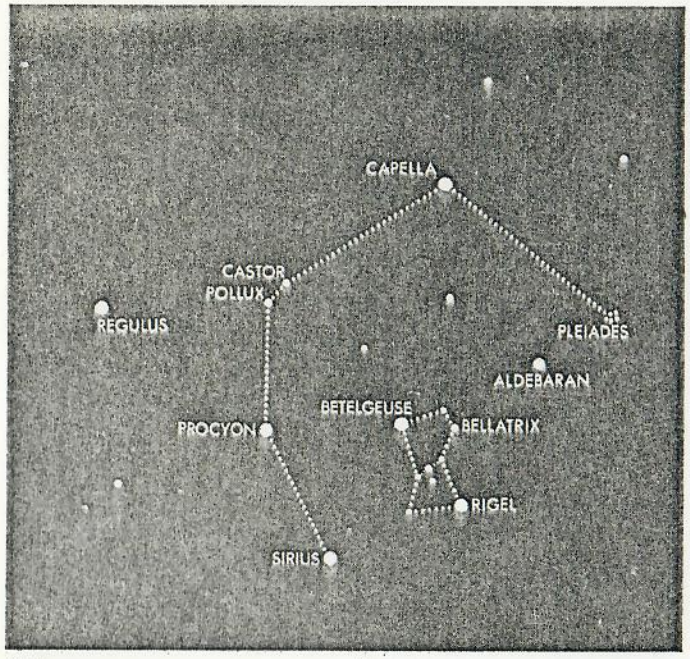
A Scorpio



B Pole Star



C Southern Cross



D Orion

APPENDIX E: SURVIVAL CHARTS

In the three oceanic charts, the five basic factors in survival navigation have been studied and recorded.

(1) Rainfall

Where possible, statistics for the ten-year period from 1951 to 1960 have been used to give a guide to normal rainfall levels. (Rainfall statistics are subject to considerable annual fluctuation so that these averages should not be taken as positive expectations.) The amounts for each month are registered in centimetres, to the nearest whole number, around the name of the island or station printed in the centre. The months are in rotation from January to the right of twelve o'clock, to December at the left. In ocean areas no statistics are available and I have tried to estimate the months in which survival amounts of rainfall may be expected, using 5 centimetres per month as the level above which enough rain may be collected to allow castaways to replenish supplies by reasonable means of catchment. Such months are coloured blue and the months in which less than 5 centimetres may be expected are left white but this does not necessarily mean that these months are entirely arid. Island statistics can be used in loose support of expected rainfall in sea areas nearby. Stations have been chosen for their proximity to sea level and their isolation from the higher land masses.

(2) Drift

Average seasonal wind values have been used to estimate the drift which a survival craft would experience during the summer and winter periods; this takes into account the proper management of the craft using the sea anchor and other aids to maintain stability and improve its seaworthiness in heavy weather. The drift experienced by a well sea-

anchored survival craft in gale force winds has a rate similar to that of a lightly sea-anchored craft in a moderate to fresh breeze, so that the rate of drift is no indication of actual wind strength.

Drift in the direction of the black arrows is unavoidable where a © indicates that the wind blows constantly in the same direction (such as in the trade wind belts). Choice of direction may be exercised by a judicious use of the sea-anchor where an ⊗ at the arrowhead denotes that the wind direction is variable but predominantly in the direction indicated by the shaft. Crossed shafts with a circle at each end indicate that there is no predominant wind direction in the area and that progress by drift is equally possible in any chosen direction but the rate will be very slow and in such areas the set of the ocean current may well dictate the direction of travel.

Each flight at the tail of the arrow represents half a knot in the direction indicated by the shaft but progress will be improved if assisted by sailing or rowing, depending upon the type of survival craft which is available to the castaway. In most areas the drift arrow drawn on the north side of the circle represents the months October to March and on the south side of the circle for the months of April to September. The exception to this occurs in the monsoon areas where the drift arrows are based on wind directions during the north-east and south-west monsoons.

(3) Surface Ocean Currents

The average set of ocean currents is shown by the blue arrows. Annual fluctuations occur in the paths taken by established currents like the Gulf Stream and the Kuro Shio so that they are not as wide as their charted positions seem to indicate. They are, however, fairly easily detected by their considerable difference in temperature from the surrounding

ocean waters or from nearby counter-currents so that the castaway will have little difficulty in determining his transit of the thermal boundary where these currents are in their well defined earlier stages. Thermal boundaries become more vague as the currents spread and mingle with static ocean waters but temperature still remains the best guide as to the direction in which the survival craft is being set. Local fluctuations in temperature occur from upwellings or from icebergs but these variations are usually of short duration or accompanied by visible phenomena.

Equatorial counter-currents have seasonal fluctuations but the boundaries of these currents may be located by a change in temperature or by the considerable eddies and upwellings which occur due to the convergence of the trade drift.

The arrows carry red circles to denote warm currents and blue circles for cold currents where these are juxtaposed. Current arrows change their colour to white where they cross the blue of the rainfall circles. The rate of the current in knots is given in blue numbers for the area in which it is situated.

(4) Inhabited Coasts

These are coloured yellow and have been included to indicate to the castaway the areas where he may find help after he has landed. In order to find assistance in landing it would be necessary to navigate the survival craft along the inhabited coast until a village was reached where a good landing area would be likely. In calmer weather it is easier to travel along the coast in the survival craft than to try to walk, especially after a long and difficult ordeal.

(5) Magnetic Variation

Green variation lines are at 10° intervals except where a 5° line has been introduced to clarify the gradient. Although the

annual fluctuation may amount to 1/5th° either way (change is greatest nearer the poles) these values (which are for the year 1970) are quite suitable for use in survival navigation up to the year 1990.

ROUTE CHART

Admiralty chart No. 3934 has been used as a base to illustrate the following information.

(1) Continental Shelf Areas

Sea areas with a depth of less than 1000 fathoms which are also associated with land masses or islands are white except where they are overlaid with the colour of a bird migration route. All other sea areas are coloured blue.

(2) Density of Marine Life

Ocean areas in which marine life is plentiful enough to attract commercial fishing fleets are hatched in white and bordered with a white broken line. All sea areas within the continental shelf, particularly in depths of less than 100 fathoms, have high fish populations and fishing fleets may be found working anywhere in these regions.

Ocean areas where fish are scarce have been given a tonal value of black dots. Commercial fishing vessels are unlikely to be encountered in these waters except when they are crossing them to reach a fishing zone.

All other sea areas have enough fish to attract occasional tuna fishing craft, especially within the regions inhabited by flying fish (latitude 30° N to 30° S approximately) or where the seabed lies within 100 fathoms of the surface. (Tuna long-liners stream buoyed fishing lines up to 7 miles in length.)

(3) Bird Migration

Migration routes originating in the nothern hemisphere are coloured pink, those originating in the southern hemisphere are orange. These routes are not rigidly followed by the species which are listed at the source and many divergences take place, for instance, when storms occur along the established routes. Land and shore species adhere more rigidly to established routes than do birds which live from the oceans. Short arrows denote species which migrate as individuals to warmer areas as the season demands (kittiwakes, fulmars, albatrosses, giant petrels, etc) and a note referring to the limits within which they usually range is placed near their breeding sites. Species which follow longer routes (shearwaters, Wilson's petrels, terns, etc.) migrate in flocks to summer feeding areas where they disperse for a few months before reassembling to return to their breeding grounds. Where return routes are not illustrated the species concerned either follows the same route back, especially where it depends on areas of dense marine life for food, or, in the case of land and shore species which undertake direct flights, the return route tends to lie to the westward of the outward migration. Good examples of this may be found in the return routes of the golden plover and associated species which, in the Pacific, travel northwards along a route which directly crosses Wake Island, 1000 miles to the west, or in the Atlantic where the return route (illustrated) runs directly up the land mass of Central and North America. Return migrations of the Arctic tern in the Atlantic, during the northern spring, take place up the eastern seaboard of South and North America as well as on the routes followed by the outward migration. Non-migratory species of seabirds which are sometimes encountered far from land are listed in the margins of the tropical zones.

No reliance may be placed on bird migration for navigational purposes, but castaways should expect to see some form of oceanic bird life around them and a familiarity with the species concerned will enable them to realise the significance of any

new sightings or whether an increase in numbers is due to the proximity of land or simply that the craft is transiting a migration route.

Migrations which are largely coastal, such as those undertaken by waterfowl and their associated species, have been omitted to avoid congestion.

(4) Tropical Revolving Storms

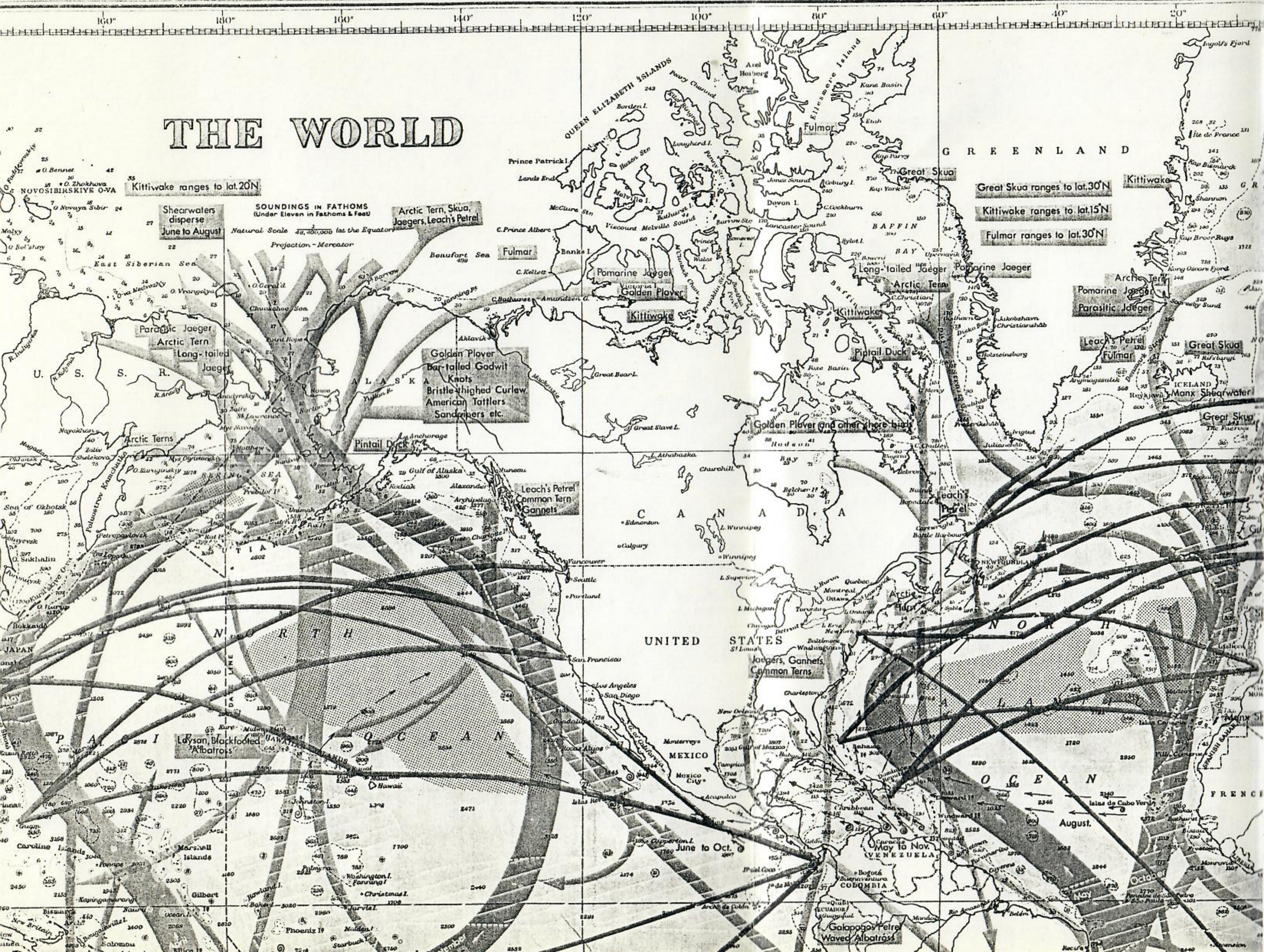
Areas where such storms develop are denoted by black arrows mostly around latitude 10° north or south of the equator. The circulation of the coil outwards from the centre gives the direction of the wind circulation of the storms in each hemisphere: examples of subsequent tracks are indicated by black arrows. The months in which they are most likely to occur are noted at the point of origin.

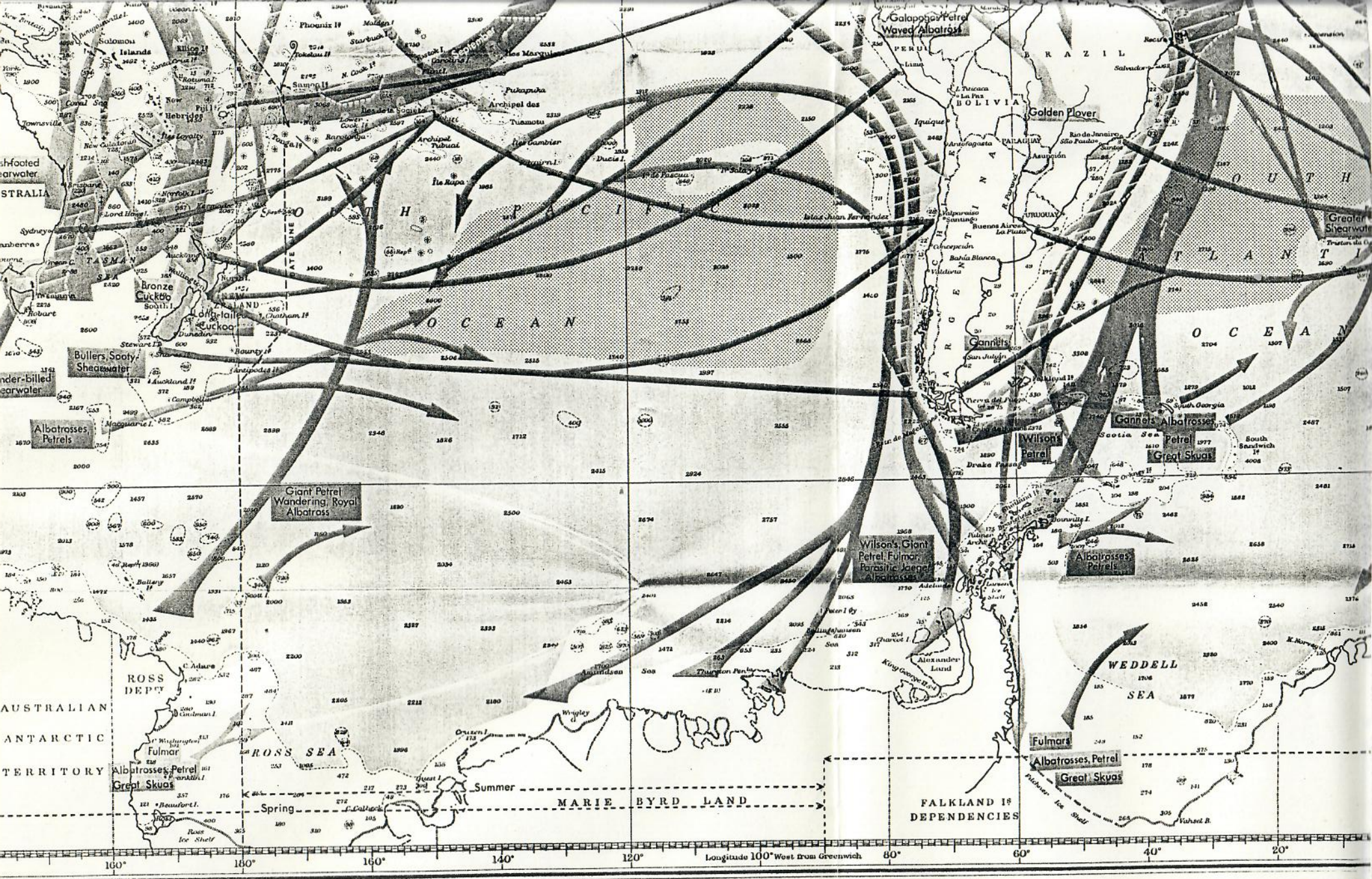
(5) Shipping Routes

Principal great circle routes, with modifications for bad weather zones, which are used by ocean shipping are illustrated in green. Straight lines should be drawn between relevant major ports to find the survival craft's proximity to the shorter shipping routes. The considerable distortions associated with Mercator's projection in high latitudes must be taken into account when estimating distances in these regions.

INDEX

References in bold type indicate illustrations


THE WORLD
SOUNDINGS IN FATHOMS
(Under Eleven in Fathoms & Feet)
Projection - Mercator
Kittiwake ranges to lat.20°N
Shearwaters disperse June to August
Arctic Tern, Skua, Jaegers, Leach's Petrel
Beaufort Sea
Fulmar
QUEEN ELIZABETH ISLANDS
Fulmar
Pomarine Jaeger
Golden Plover
Kittiwake
GREENLAND
Great Skua
Great Skua ranges to lat.30°N
Kittiwake ranges to lat.15°N
Fulmar ranges to lat.30°N
Kittiwake
BAFFIN BAY
Long-tailed Jaeger
Pomarine Jaeger
Arctic Tern
Kittiwake
Arctic Tern
Pomarine Jaeger
Parasitic Jaeger
Parasitic Jaeger
Arctic Tern
Long-tailed Jaeger
U. S. S. R.
ALASKA
Golden Plover
Bar-tailed Godwit
Knots
Bristle-thighed Curlew
American Tattlers
Sandpipers etc.
Pintail Duck
Leach's Petrel
Fulmar
Great Skua
ICELAND
Manx Shearwater
Great Skua
Golden Plover and other shore birds
Arctic Terns
Pintail Duck
Leach's Petrel
Common Tern
Gannets
Leach's Petrel
CANADA
Arctic Tern
UNITED STATES
Jaegers, Gannets, Common Terns
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
MEXICO
Laysan, Blackfooted Albatross
June to Oct.
May to Nov.
August.
VENEZUELA
COLOMBIA
Galapagos Petrel
Waved Albatross



CHART

H.P. Litherland Dougal Robertson

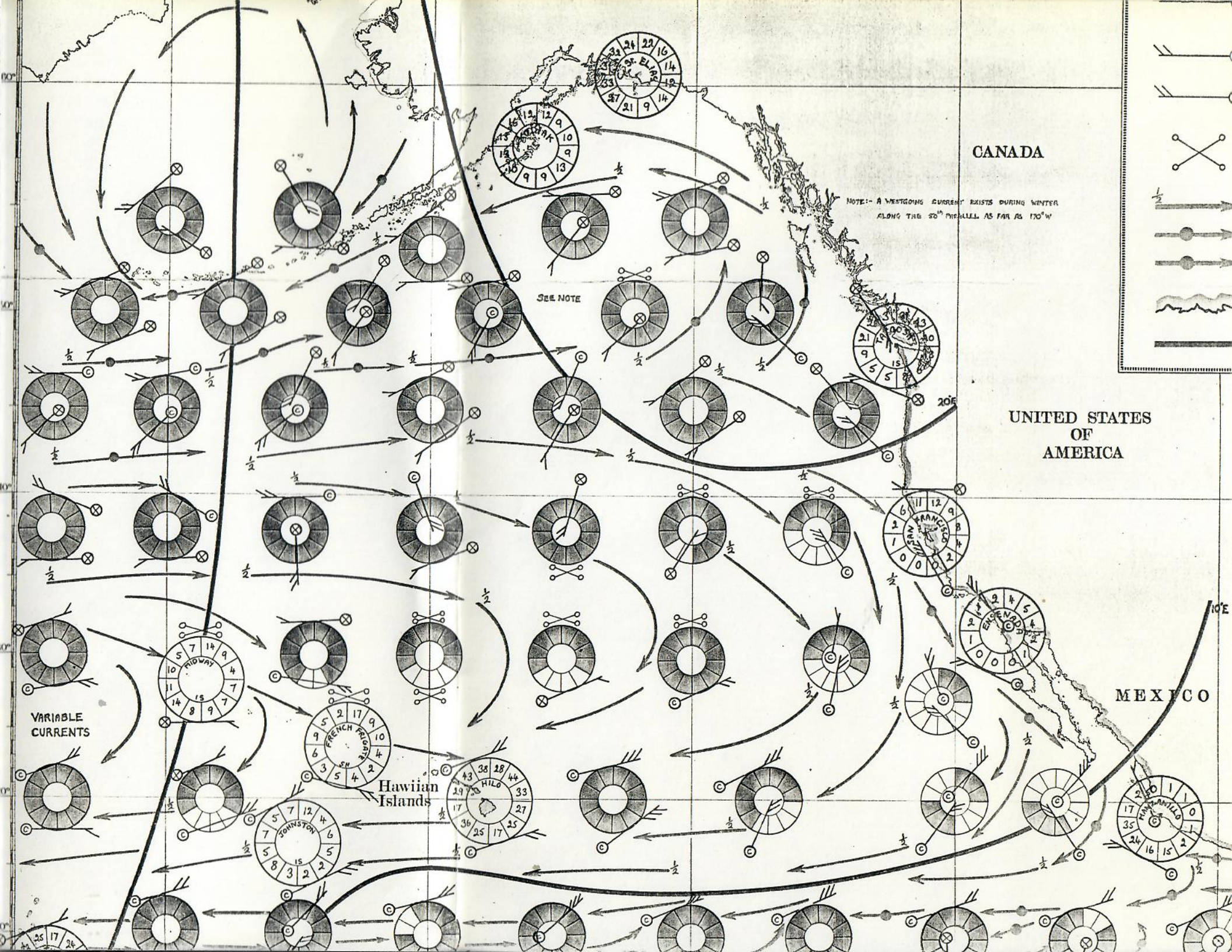
Continental shelf areas to 1000 fathoms

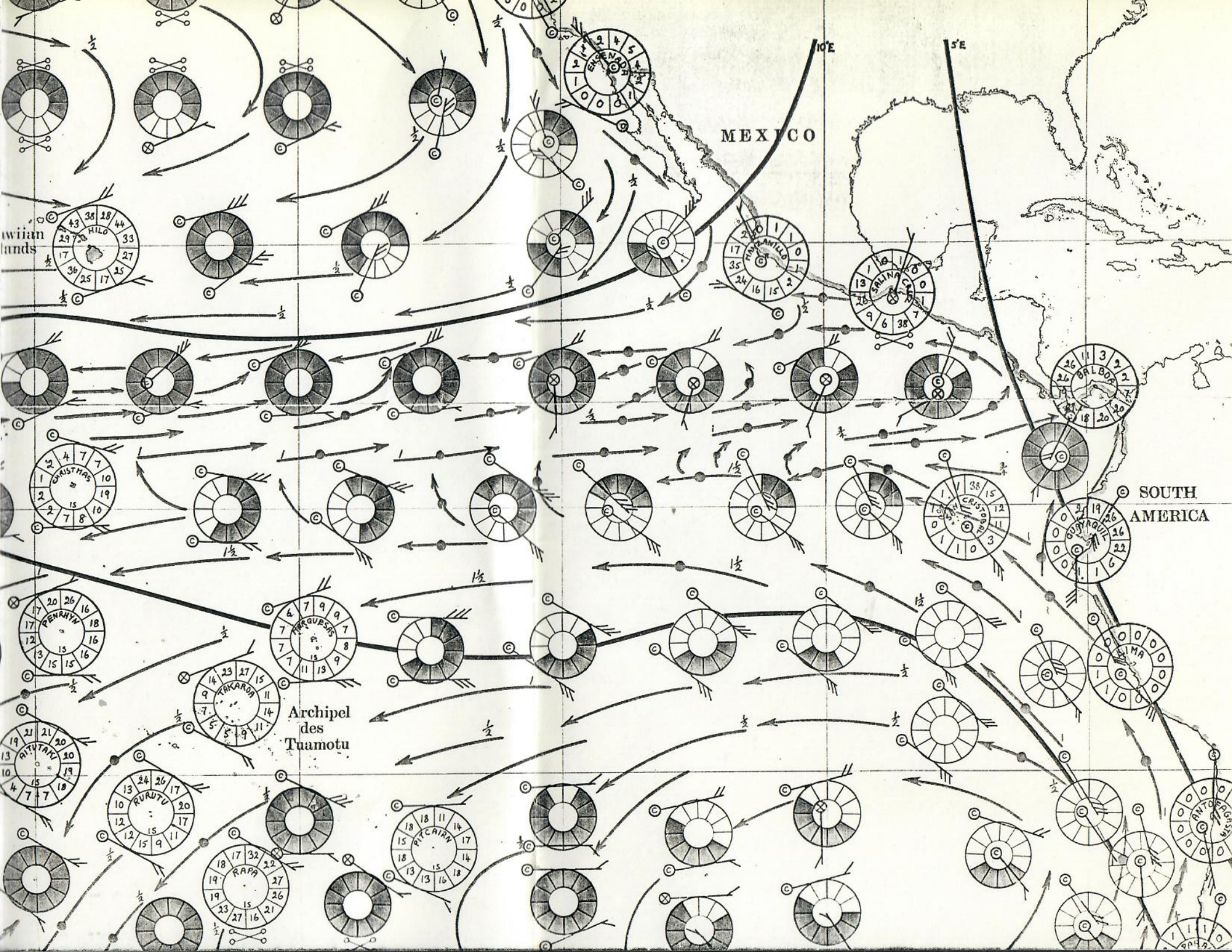
Ocean islands with adjoining depths of less than 1000 fathoms

Areas of low density marine

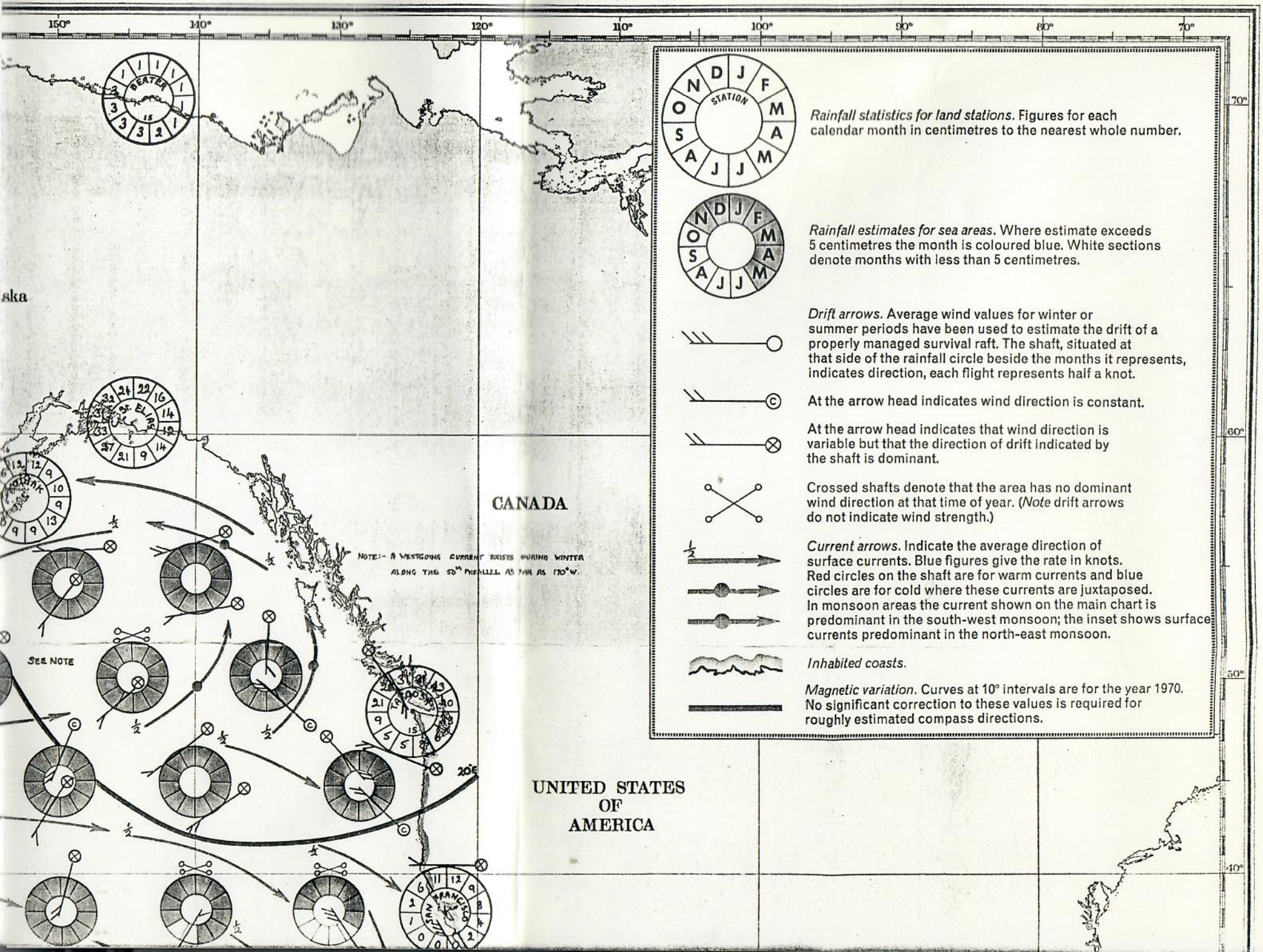
Areas of high density marine

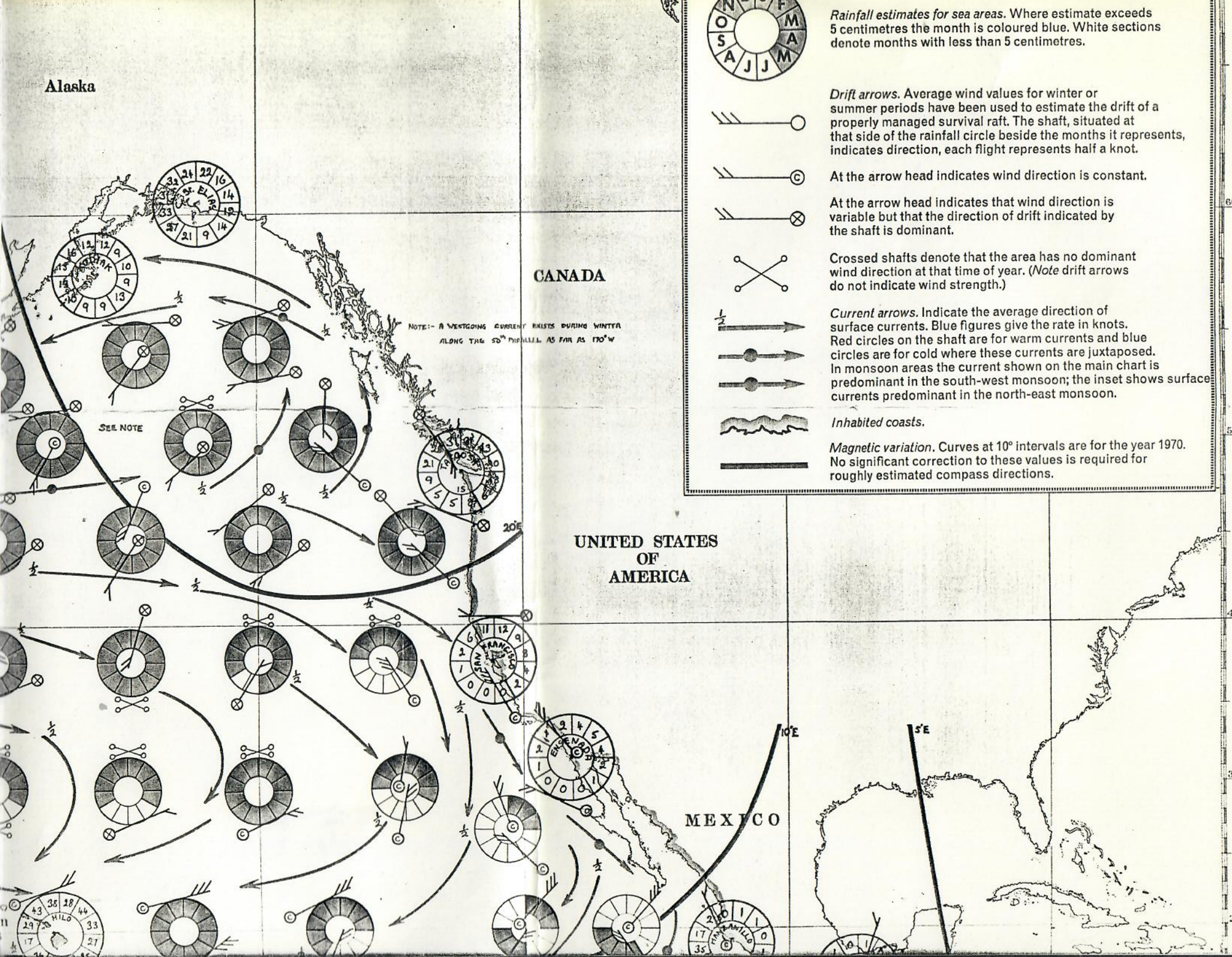
Migration routes of birds whi


CANADA
NOTE:- A WESTGOING CURRENT EXISTS DURING WINTER ALONG THE 50th PARALLEL AS FAR AS 170°W
SEE NOTE
UNITED STATES OF AMERICA
MEXICO
VARIABLE CURRENTS
Hawiian Islands
ELLIS
KODIAK
SAN FRANCISCO
ENSENADA
MIDWAY
FRENCH FRIGATE SH.
JOHNSTON
HILO
HONOLULU
20°E
10°E


MEXICO
SOUTH AMERICA
Archipel des Tuamotu
HILO
ENSENADA
MANZANILLO
SALINA CR.
BALBOA
CHRISTMAS
CRISTOBAL
GUAYAQUIL
PENRHYN
MARQUESAS
TAKAROA
LIMA
AITUTAKI
RURUTU
PITCAIRN
RAPA
ANTOFAGASTA
10°E
5°E

EASTERN PACIFIC OCEAN




Alaska
CANADA
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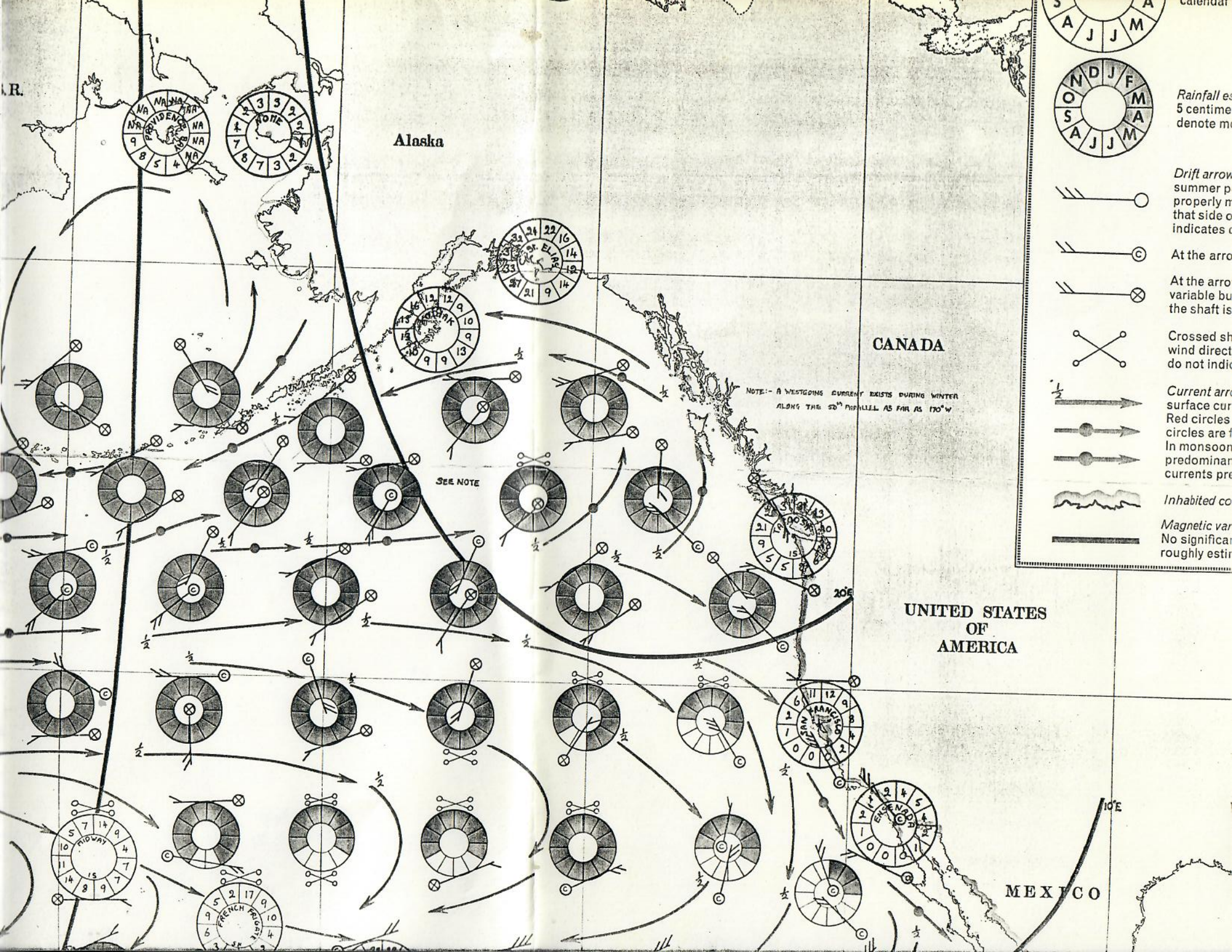
MEXICO
SEE NOTE
NOTE:- A WESTGOING CURRENT EXISTS DURING WINTER ALONG THE 50TH PARALLEL AS FAR AS 170°W
ST. ELIAS
KODIAK
SAN FRANCISCO
ENSENADA
HILO
AMARILLO
10°E
5°E
20°E
60°
50°
40°
30°
20°
Rainfall estimates for sea areas. Where estimate exceeds 5 centimetres the month is coloured blue. White sections denote months with less than 5 centimetres.
Drift arrows. Average wind values for winter or summer periods have been used to estimate the drift of a properly managed survival raft. The shaft, situated at that side of the rainfall circle beside the months it represents, indicates direction, each flight represents half a knot.
At the arrow head indicates wind direction is constant.
At the arrow head indicates that wind direction is variable but that the direction of drift indicated by the shaft is dominant.
Crossed shafts denote that the area has no dominant wind direction at that time of year. (Note drift arrows do not indicate wind strength.)
Current arrows. Indicate the average direction of surface currents. Blue figures give the rate in knots. Red circles on the shaft are for warm currents and blue circles are for cold where these currents are juxtaposed. In monsoon areas the current shown on the main chart is predominant in the south-west monsoon; the inset shows surface currents predominant in the north-east monsoon.
Inhabited coasts.
Magnetic variation. Curves at 10° intervals are for the year 1970. No significant correction to these values is required for roughly estimated compass directions.


Alaska
CANADA
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KODIAK
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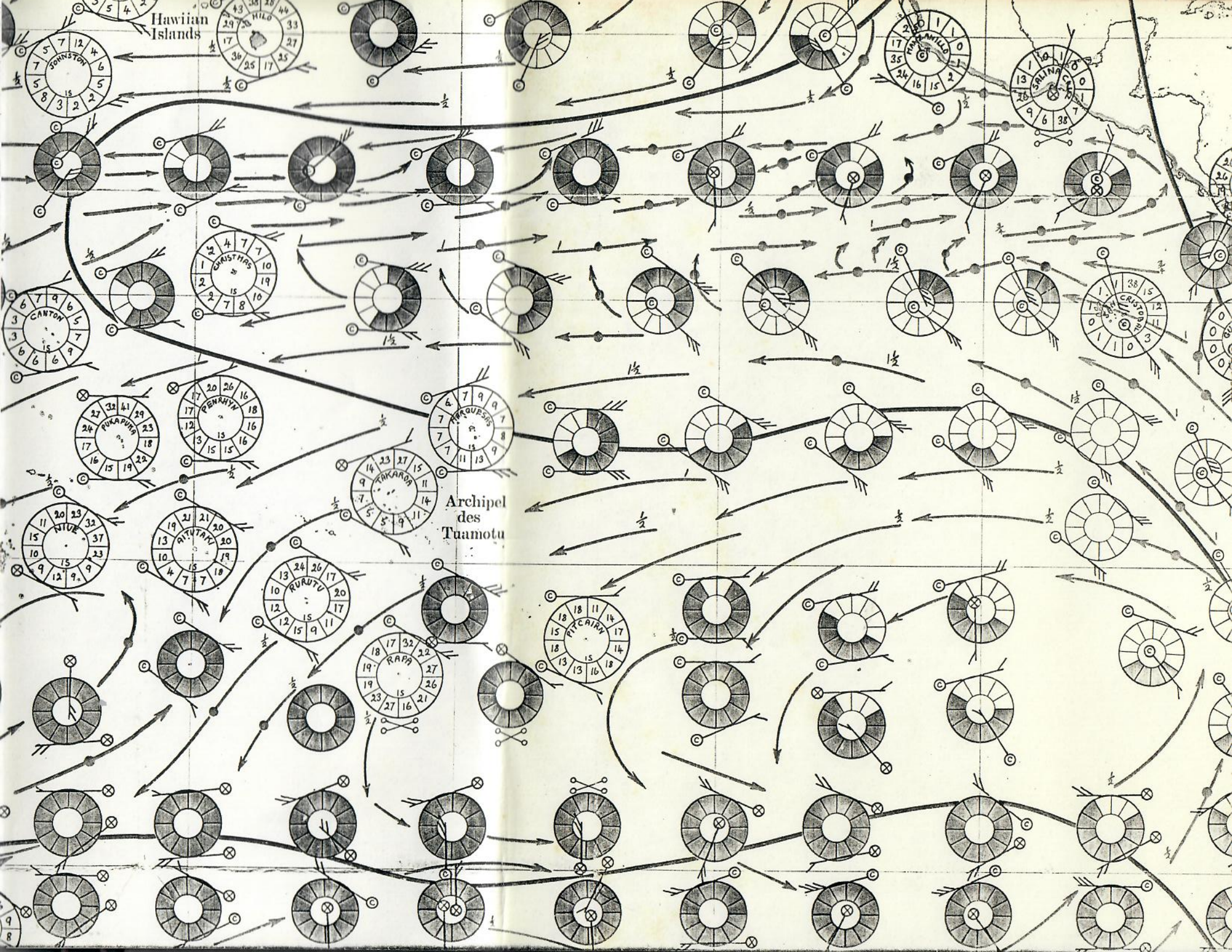
Hawiian Islands
HILO
JOHNSTON
CHRISTMAS
CANTON
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PUKAPUKA
MARQUESAS
TAKAROA
Archipel des Tuamotu
NIUE
AITUTAKI
RURUTU
RAPA
PITCAIRN
MANGAREVA
SALINA CRUZ
SAN CRISTOBAL