Chapter One

Tuning Your Eye

To the untutored eye, a marine radar display bears no resemblance to the real world. The images displayed there seem to be nothing but slowly changing patterns of light and dark. They certainly do not look like a map or a picture of the surrounding waters and land.

You have been told that radar is the best technology ever; radar will help you navigate at night and in fog; radar will help you avoid collisions. But when you look at the screen with its rotating patterns of light and dark, it makes no sense. And if it does not make sense, how can it be of any help at all?

I have seen intelligent, sensible people go into a state of panic on first introduction to a radar display because they cannot understand the images they find there. This isn't their fault. Of all the navigation technologies, radar requires the most interpretation. Most books and user manuals will tell you how to tune your radar set, but they fail to help you tune-up your own eyes and perceptions so you can focus on the relevant parts of the image.

So how do you figure out these patterns; and how will this help you navigate?

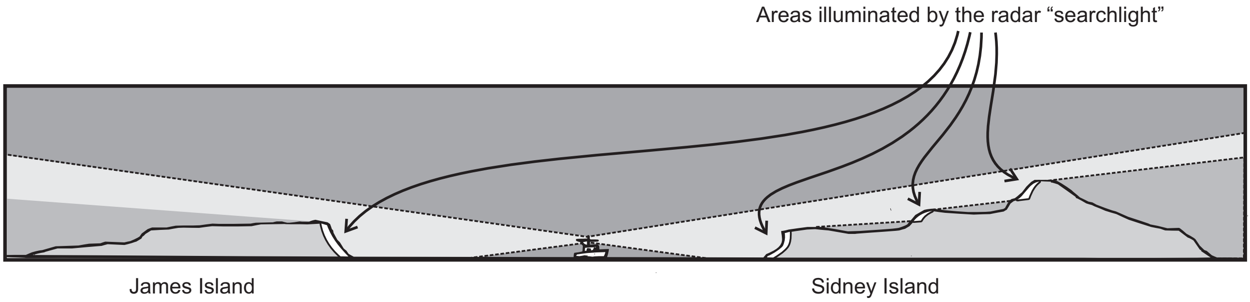
The Searchlight Principle

Imagine that your radar antenna is actually a very powerful searchlight. Also imagine that you are rotating the searchlight through 360°, and illuminating all the land and ships around you. It is the reflected light from the land and ships that enables you to see them in exactly the same way the reflected radar **beam** enables your radar to see through darkness and fog. However, you must remember this key concept—any object that is behind another, such as in a valley behind a hill, is not only invisible to your eyes, it is also invisible to your radar.

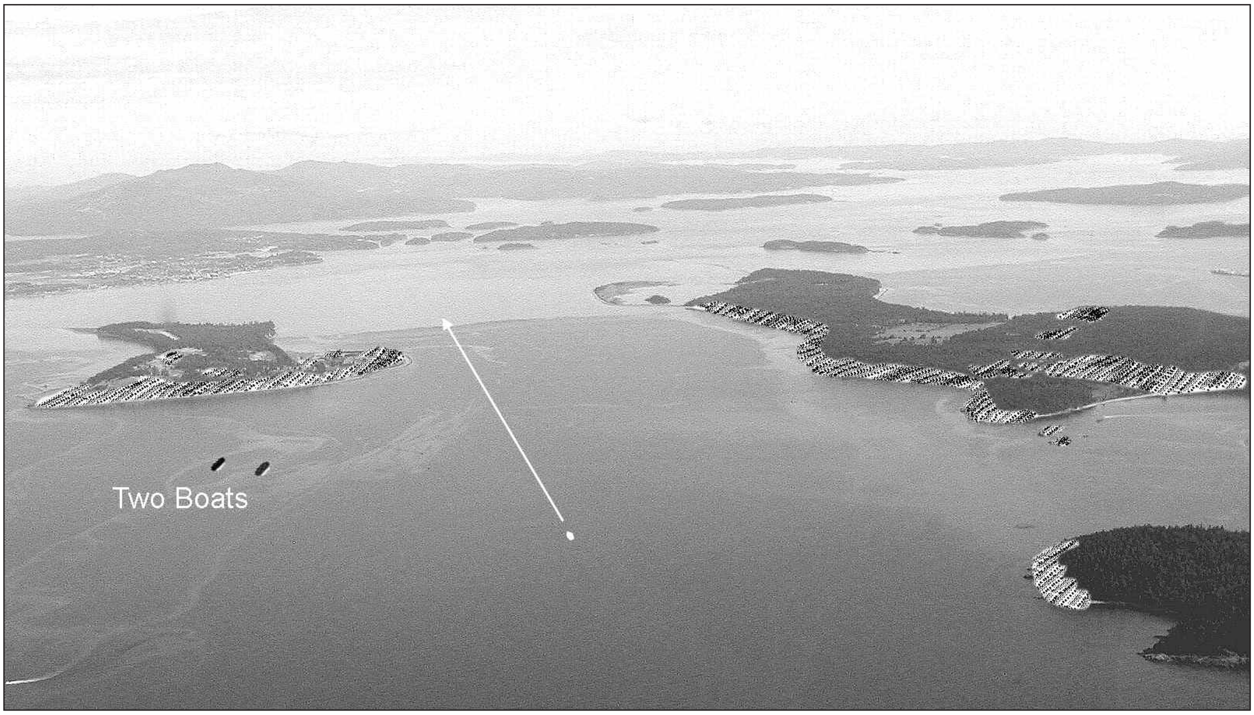
Objects or land areas that are hidden from your radar are said to be in a **Radar Shadow.** Consequently, only the land that is actually illuminated by the radar beam will appear on the radar display. The radar can see only those objects that are in direct line of sight.

To measure the distance of a target, the radar actually measures the time it takes for its beam to travel to an object and for the reflected **echo** to return to the antenna. Knowing the time taken, and the direction of the radar beam at the time, the radar determines the range and bearing to the object, and then projects a **pip** in the appropriate location on the display. In this manner it builds up a representation of every object it can see in the area. The result is an image that is presented in plan view, as if it were a map to be viewed from overhead. But this map view shows only those areas that are actually illuminated by the radar beam; areas in the radar shadow are missing from view.

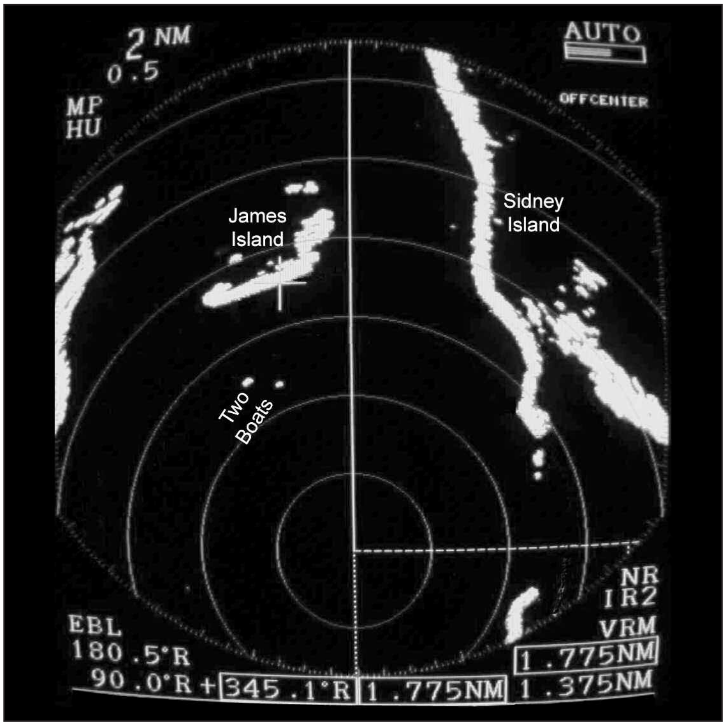
This type of display, showing the ***position*** of radar visible targets in plan view is known as a **Plan Position Indicator (PPI)**. Every radar set uses a PPI display; and understanding the PPI view is fundamental to interpreting the wealth of information your radar can provide.

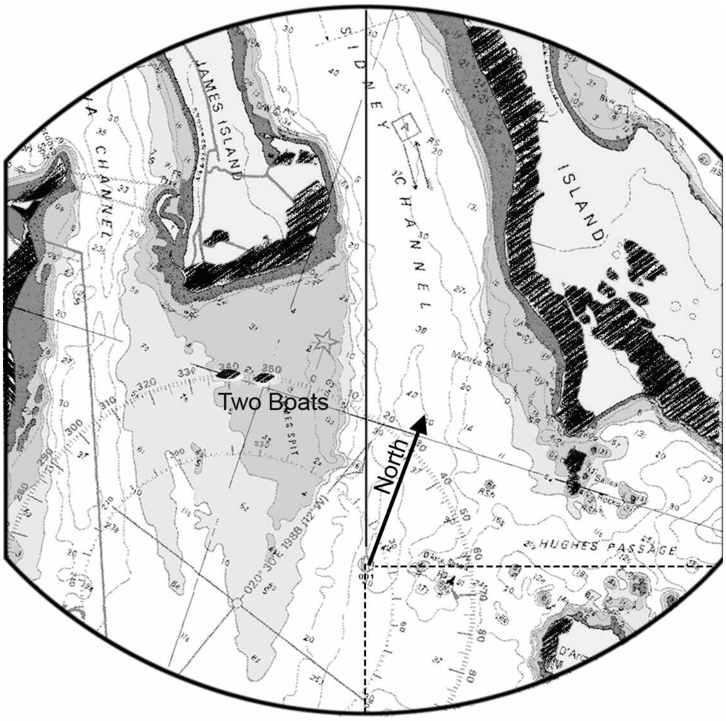


▲ **Fig. 1-1**
Imagine that your radar is a very powerful searchlight illuminating the land around you.



▲ **Fig. 1-2**
When your radar illuminates the land around you, some areas remain in shadow. As the highlighted surfaces in the photograph indicate, only the land that is actually in the direct line of sight of the radar beam will be illuminated, and only those areas will show up on the display.





◄ Fig. 1-3 The Plan Position Indicator The Plan Position Indicator (PPI) displays in plan view (as if from above) only what is in your line of sight. Radar shadow areas do not appear on the display.

Note the **range scale** is indicated in the upper left corner of the display, as is the interval between **range rings**. Also note that the image has been shifted so that the point representing the vessel's location has been shifted toward the bottom of the display, thus bringing the shore of Sidney Island onto the display.

If you superimpose the radar image over a chart of the area, it is easy to see how the radar image coincides with geographic features on the chart. The cliffs on Sidney Island and James Island are clearly illuminated and return strong images. Behind the cliffs, the flat areas of the island do not appear on the radar display, but the hills beyond the cliffs are visible because they project upwards out of the radar shadow and into the radar beam. [See Fig. 1-1]

The Look of the Display

The next thing you will notice is that each echo slightly changes every couple of **seconds**, and that the images undergo this subtle change in regular clockwise sequence. This rotating zone of change represents the sweep of the radar beam in the real world. ***If you think of the front edge of this rotating zone of change as updating the latest radar image on the display, you may find it easier to understand.***

For reasons we will discuss later, this rotating line of updated information is known as the **time base**. The center of the PPI, around which the time base rotates is known as the **sweep origin** or **time base origin** and represents the position of your own vessel.

Some echoes wink in and out of existence. They may be the echoes of birds or they may simply be transient electronic noise; generally they do not last beyond a single revolution of the time base. Larger images on the display which are usually the echoes of landmasses, do not change significantly with each revolution of the time base.

Whenever the time base rotates through the straight up position, it appears to *paint* a vertical line originating at the center of the display. This is the **heading flash** and it indicates the direction the bow is pointing (the vessel's heading). This type of display is known as a **Head-up** presentation. (There are other ways to view a radar image, which we will discuss later.)

Understanding the Radar Display

Of course, the image on your display will remain static only as long as your vessel remains in the same place and headed in the same direction. ***Once on the move, you must deal with a dynamic situation.***

When your vessel is in motion the radar displays a dynamic, changing image, centered on your own position. It stands to reason that in order to understand what landforms are being displayed by the radar, you must simultaneously figure out where you are in relation to those landforms. This task is made more complex by the nature of the radar image, which displays only the land surfaces that are illuminated by the rotating beam. As you move in relation to the land, the images change significantly.

Let's imagine you are behind the wheel in your boat. In spite of its being a bright sunny day

Ranges and Range Rings

In Chapter 2 we discuss how to set up your radar. When you have set the radar up properly, the image will resemble Fig. 1-3.

Notice that the range scale is indicated in the upper left corner of the figure. The range scale indication on your radar may be located elsewhere, but international standards require that it be displayed prominently. Your user manual will tell you where to look on your particular set.

The range scale is the distance from the center of the display to its edge (whether or not the sweep origin is offset). In Fig. 1-3, the range scale is 2.0 **nautical mile (Nm)**.

Also note, there is another number below the range scale indication. In Fig. 1-3 0.5 Nm represents the distance between the range rings. You can use the range rings to roughly estimate distances.

Range rings can be turned off in most radars, but it is normally best to leave them on, until you have developed a good facility with the radar. Range rings provide a rough indication of distance, and the different range ring patterns on each range **scale** provide a hint as to the scale in use.

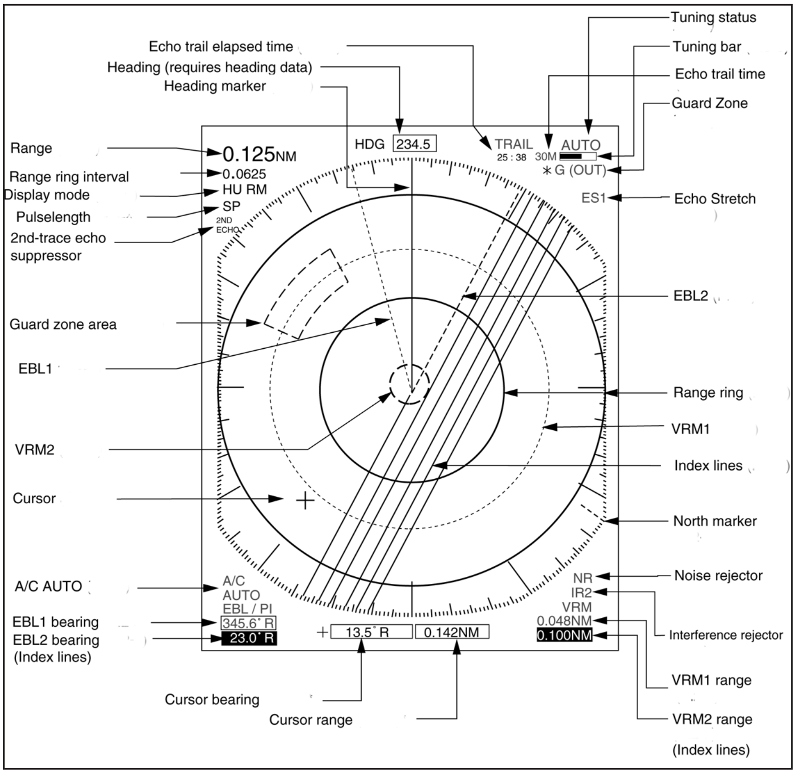
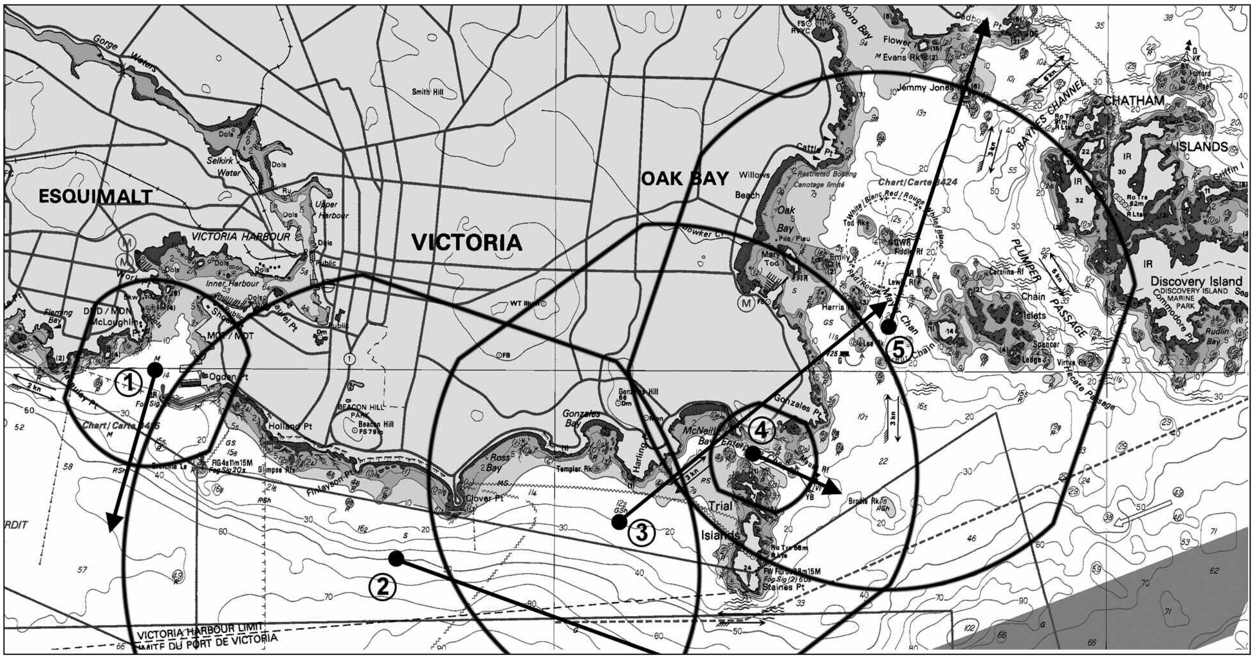


Fig. 1-4 ►
Display Indications for the Furuno FR7062
This is the model used to capture many of the images in this book.



▲ Fig. 1-5
The Voyage of the MV *Baidarka*
As you proceed out of Victoria Harbour toward Sidney, you collect a series of screencaptures of your radar display. (See pages 11 to 21) The chart in this figure and in Fig. 1-6 shows the areas covered by the screencaptures, and the direction of travel at the time.

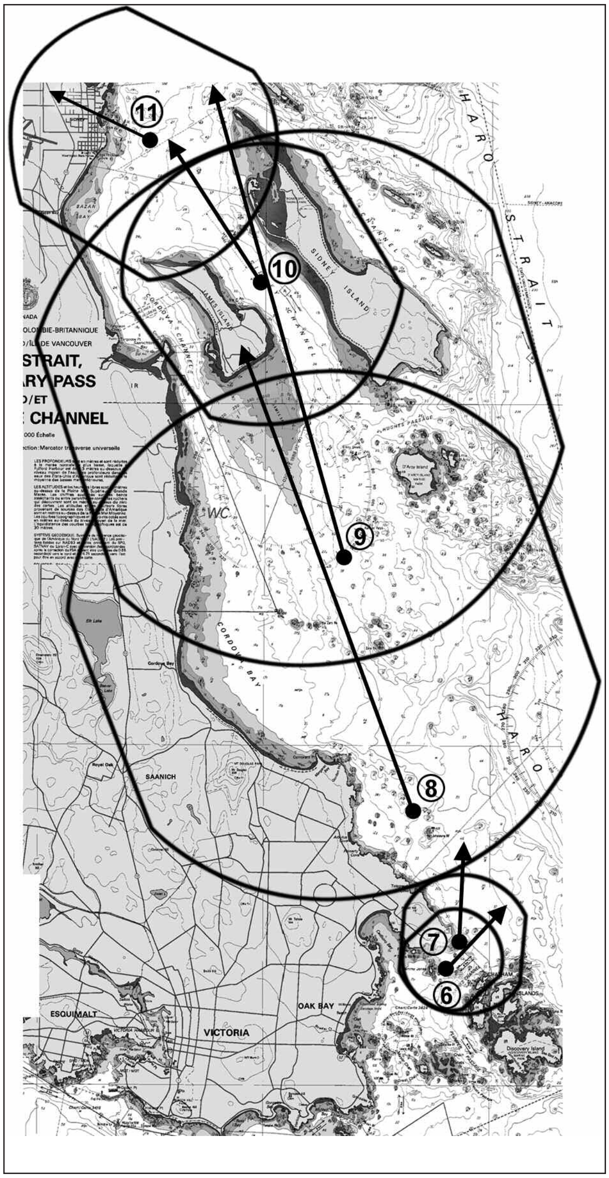
you have decided to start your radar operating so you can become familiar with its operation. This turns out to be a wise choice because, as you leave the harbour breakwater and turn the corner to head up the channel, you find that a fog is blanketing the entire area.

You have a couple of choices—either turn around and wait for the fog to clear, or go ahead and navigate using your radar. You decide to go ahead, using your new radar. After all, what is the point in spending several thousand dollars, if you are not going to use the radar when you need it.

Your radar is about to become a new set of eyes, peering through the fog to help you navigate and to show you what vessels and other hazards lie ahead. Let's watch the radar image as you navigate through these waters.

(continued on page 25)

A large-scale chart covers a small area.
A small-scale chart covers a large area.



◄ **Fig. 1-6**
The Voyage of the MV *Baidarka* (*continued*)
In the following figures, note that the position of the vessel in relation to the contours of the land determines the shape of the radar images. Also note that though the shapes of the illuminated areas change dramatically, certain features continue to be recognizable so long as they are in sight.