How to use marine radar for bird watching

A simple and inexpensive method for using a widely available type of radar

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FOR MORE than two decades radar has been an important tool in ornithology. Radar detects the movements of birds at night or in clouds or fog, and displays the birds' position on a map-like screen that gives a more accurate location than is possible by means of visual observation with binoculars even under excellent visibility conditions (see Eastwood 1967).

Many different sorts of radar have been used for studying bird migration: airport radars, weather radars, and even satellite tracking radars. In contrast to these complex instruments, which require several trained operators, the common and easily operated small-boat marine radar has largely been ignored by ornithologists. These radars are rugged, dependable instruments with fewer controls than a stereo radio receiver. In my experience a high school graduate can learn to use them for observing birds in about one hour. The low power radiation of these instruments poses little or no hazard, and thus they can easily be moved from one location to another without the need of obtaining government approval. This mobility usually more than compensates for the relatively short range at which these instruments can detect birds, about one kilometer. Marine radars are designed for high resolution work; the entire display can be set to cover only two kilometers. At this resolution, V's of geese, flocks of blackbirds, and single passerine migrants are clearly recognizable on a marine radar (Williams and Klonowski 1974), but would all appear as a single dot on the display of a larger radar set at its minimum range of 10 to 50 kilometers. Marine radars closely approximate an observer with binoculars in their ability to detect birds (range about one kilometer, altitude, ground level to about 200 meters, see Cohen and Williams 1980, for altitude estimation). Thus, it is often possible to identify radar echoes by visual means during the day and then compare these echoes with those seen at night. Such identification is difficult or impossible with large instruments (Williams and Williams 1980).

Marine radars are by far the most common type of radar, and usually it is not difficult to obtain the owner's permission to use one. There is no need to modify the radar or change its calibrations; and, as the radar can detect large numbers of birds in a few minutes, the time needed for bird study is very small compared with the normal operation of the radar. For these reasons many boat owners are amenable to naturalists using their radars for ornithological observations.

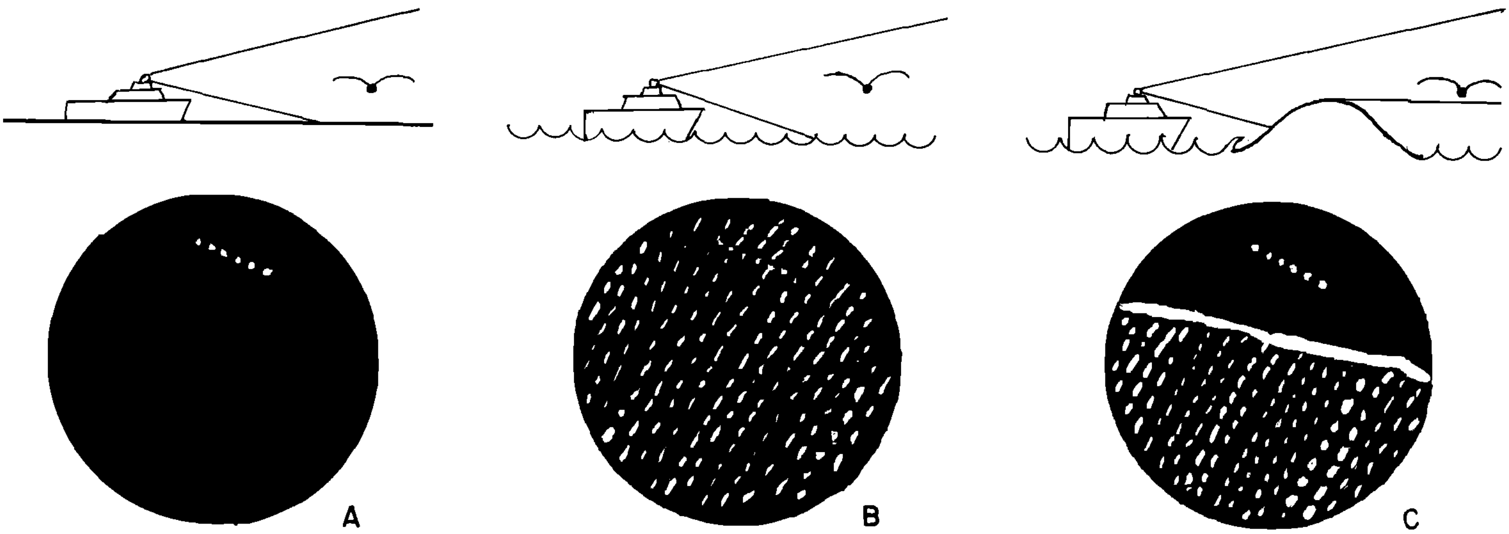
INSTRUCTIONS

FIRST ONE must learn to recognize birds on the radar display. I suggest a calm day when several large birds, such as waterfowl or gulls, are moving over the water about 100 to 300 meters from the radar.

1) Turn on the radar and let it warm up.
2) Set range at ½ nautical mile or one kilometer.
3) Set all anti-rain and anti-sea return controls to minimum.
4) Set receiver gain to maximum. The screen should now be very bright, almost all white.
5) Turn down the brightness or video gain until you can just see the carpet of background random noise on the screen.

There should be several large, bright echoes on the radar screen, which will be refreshed by each sweep of the courser as it moves around the display and which do not change position on the screen. These are echoes from stationary objects such as docks, islands, or buoys, and one has to learn to ignore them. Echoes that do change position with each sweep of the courser are moving objects such as birds or boats. Birds are easily distinguished by their speed. On a six-inch radar screen set at ½ nautical mile range, echoes from birds will move about $^1/_{10}$ of an inch between successive sweeps (about 30 mph). This is sufficient for each successive image on the radar screen to be separated clearly from the previous one. Echoes from boats are usually much larger than those from birds, and move more slowly, so that the successive images are not separated. Aircraft appear as large echoes at successive intervals of a half an inch or more. Once presumed bird echoes are detected, they may be verified by checking with a pair of binoculars at the distance and direction indicated by the radar.

There are several methods of recording radar data. The simplest is to observe the radar screen directly and record the speed, direction, and location of bird echoes on the radar screen. I find this is most easily done with a clear plastic ruler placed parallel to the line of dots marking a bird track on the radar display. At night or if the radar is in a dark room, these dots will persist for several revolutions of the



A radar fence allows a marine radar to detect birds over waves or land areas. Each of the three parts of this figure shows a diagram of a boat with a radar under different conditions. The beam of the radar is shown just as it sweeps past the front of the boat. The circle below each diagram shows the screen of the radar as it would appear in that situation after several rotations of the radar beam. The radar display reads like a map, with the boat at the center, objects in front of the boat toward the top of the screen, and objects behind the boat toward the bottom of the screen. ***A.*** *The radar easily detects a bird flying over calm water; the track of the bird is shown as a series of dots on the radar screen.* ***B.*** *The boat is surrounded by waves and the radar echoes from these waves (the lines of dots on the screen) obscure the track of the bird.* ***C.*** *The boat is positioned behind a long sandbar, which acts as a radar fence, eliminating echoes from waves beyond the bar. The sandbar produces a long, white echo on the radar screen, and echoes from waves can still be seen in the lower half of the screen, but beyond the sandbar the screen is clear and the track of the bird is easily detected*

radar courser. The direction of travel relative to the boat is read directly from the compass rose on the circumference of the radar screen. Speed is calculated from distance traveled in four or more revolutions of the courser, the revolutions per minute being constant. With this method it is difficult to follow more than two birds at a time. A more complete record may be obtained by making time-lapse cine films of the radar screen. A detailed comparison between a time-lapse film analysis and notes made directly from the radar screen has shown that the two methods are in excellent agreement and that for most purposes direct observation of the radar will yield sufficient accuracy (Williams *et al.* 1981). During heavy nocturnal migration it is usual to have five to ten birds on the radar screen at one time Ten minutes of visual observation would yield more than 50 tracks, usually enough for a reliable estimate of the mean direction and speed of migration.

The instructions above are adequate when the water is calm, but this is rarely the case, and the use of a radar fence, which permits observation under windy conditions or over land areas, must be discussed. Any object that reflects sufficient radar energy will show as an echo on the radar screen; this includes waves, land areas, and docks. These strong echoes will obscure the much fainter echoes of birds if they are located in the same area of the screen. Since we are only interested in birds, we can cut off echoes from terrestrial objects by reducing the sensitivity of the radar to objects at ground level. This is easily done by positioning the radar close to a low building, a sand dune, or other radar-opaque object that cuts off that portion of the radar beam parallel to the ground, leaving only the portion of the beam which is angled upward toward the sky. This results in a strong echo from the radar fence (the nearby object), but a clear radar screen beyond the radar fence. Avoid using vertical cliffs or high walls as a radar fence as they reflect too much energy back to the radar and reduce sensitivity. Trees in leaf, sand dunes, or sloping roofs are all excellent.

Another problem is motion of the boat. Since most radar displays show echoes relative to the boat, a moving boat will cause even stationary objects to move on the radar screen. This is eliminated, of course, if the boat is securely anchored in a protected location or tied up at a dock.

Marine radars will be most useful for ornithological studies in which it is important to compare diurnal and nocturnal activity, to examine local movements of birds, or to examine migratory patterns in remote areas. In my opinion the longer range of more powerful radar installations is over-rated; estimates of migratory direction and speed with marine radars do not seem to be any more variable than those taken with surveillance radars having 100 times more range (Williams *et al.* 1981). The principal advantage of greater range seems to be detecting birds flying at greater altitudes. On those unusual nights when birds at different altitudes would show different migratory behavior, then the marine radars give a less complete sample.

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