Some parameters of 'nonsense' orientation in Mallard

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Summary

Relay observers, connected by radio, were established on a north-west line to discover how long Mallard continued to fly in that direction after release. The observers provided positive data on 493 birds. Cross-fixes established the distances to which Mallard can be followed visually, and their straight line flying speeds.

After being lost to sight by the liberator the birds' flight became increasingly undirected and within four miles their general orientation had ceased to have any relation to that which they had initially. The great majority would have landed within twenty minutes. "Nonsense" orientation is thus a short-lived affair.

Introduction

Several populations of Mallard *Anas. p. platyrhynchos* have, on release away from the point of capture, been shown to fly off predominantly in one general direction (Matthews 1961, 1963a). This is north-westerly for Mallard bred in the areas around the Wildfowl Trust's duck Decoys at Slimbridge, Gloucestershire, and at Borough Fen, Peakirk, Northamptonshire. Progress has been made (Matthews 1963b and in preparation) in ascertaining the physical clues on which the orientation is based but its function remains obscure (hence the use, temporary it is to be hoped, of the adjective "nonsense"). It would clearly be most useful to know how long the orientation was maintained after the birds have passed out of sight of the liberator. This was the main objective of the present exercise.

From the beginning it had been clear that "nonsense" orientation was not continued indefinitely. Subsequent recoveries of Slimbridge birds were not all in Ireland. The one Peakirk Mallard used on orientation experiments and recovered in Alberta, Canada, can be described as exceptional. In our technological age the obvious answer would be to strap small radio transmitters on to the ducks and follow them by "cross-fixing" their position from receivers on the ground. If a range of more than about 20 miles is required the latter have to be in an aircraft. Such techniques are in fact in use in (naturally) the U.S.A. However, as transmitters would cost up to £30 apiece and be non-recoverable, receivers cost several hundred pounds, and running an aircraft is not cheap, it did not appear a practical proposition to use the technique here. Apart from financial considerations, there are severe governmental restrictions on the use of radio transmitters in Britain, because of interference with wireless programmes and other vital services. A rather more old-worldly technique was therefore employed.

Method

As the birds depart in a fairly tight fan out from the release point, it appeared worthwhile attempting a visual relay system by placing a series of observers along the axis of the scatter, i.e. to the north-west. The fenland of Lincolnshire offered prime locations where observers could be within unimpeded sight of each other. The site chosen was a point (National Grid reference TF 211174) near Deeping St. Nicholas. This had been used previously as a release point in orientation tests so a good deal of relevant data were already available. Including the present series, 1,495 Mallard have been released there in sunny conditions in July through October from 1960-66. These have given rise to 209 recoveries (mostly shot) and 42 returns to the point of capture (Borough Fen Decoy lies only six miles away, bearing 187°). We may use the 86 recoveries of birds which were both lost to sight still flying and recovered the same season (generally before the end of the following January) to illustrate the question we were seeking to answer, namely at what point does the generally north-west orientation (Fig. 1a) from the release point break down and lead to the random or (in this case) slighter south-easterly tendency (Fig. 1b) of the recoveries? There was absolutely no relation between the observed final bearings and the recovery bearings of the individual birds, the mean deviation of the latter from the former being ±96°. From Fig. 1a it will also be seen that birds eventually recaptured back at the Decoy had shown the usual predominantly north-west departures.

The countryside surrounding the Release Point is almost completely flat and divided into large rectangular arable fields by a complicated system of drainage ditches. Hedges are absent and there are relatively few trees. The main features are sketched in Fig. 2 and are, duckwise, the embanked Rivers Welland and Glen, about 40 feet wide, and the various major

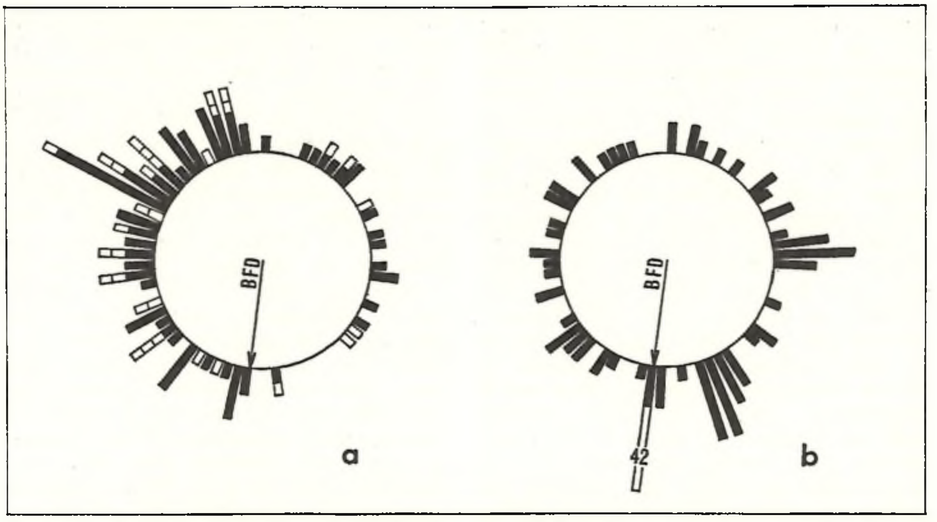

Figure 1. Initial orientation of Mallard versus their subsequent recovery. In (a) are shown the bearings on which 86 Mallard were lost to sight from the release point. The same birds were subsequently recaptured (□) at Borough Fen Decoy (B.F.D.) or recovered (■) elsewhere, in directions shown in (b). Length of spoke is proportional to number of bearings. North at top.

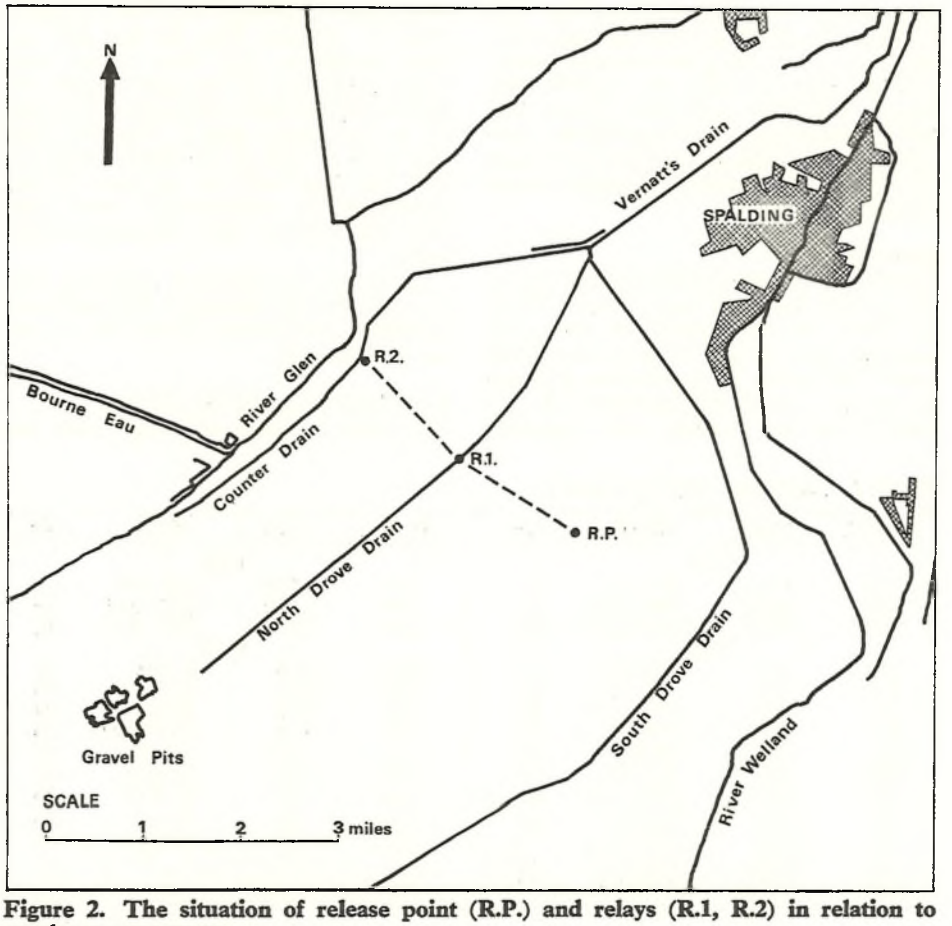

Figure 2. The situation of release point (R.P.) and relays (R.1, R.2) in relation to nearby watercourses.

Drains of half that size. Fig. 2 also shows that the Release Point is situated rather centrally to the nearest Rivers and Drains and that they do not in themselves provide the explanation for the north-westerly direction tendency of the released birds.

The two relay points were on the Drains to the north-west of the Release Point, taking advantage of the slight elevation afforded by their embankments. Relay 1 (TF 192186) was 1.4 miles, 304° from the Release Point. Relay 2 (TF 177202) was 1.4 miles, 315° from Relay 1 (exactly the same line of sight could not be used because of farm buildings). A system of simple flag semaphoring and a stereotyped release procedure ensured that the observer at Relay 1 (R.1) was usually able, through binoculars (16 × 40), to sight and follow the bird from the moment of release. The observer at Relay 2 (R.2) had a much more difficult task in that he could not see the release directly and when the bird came into his ken it was generally well up in the sky. To monitor him on to the bird, recourse was had to a walkie-talkie radio link between R.1 and R.2. This worked tolerably well. Each bird was released singly and the next bird was not released until signals indicated that both Relays had lost its predecessor. In a successful follow through this might be a quarter hour later, the whole release taking up to eight hours to complete.

Material

Twenty-six releases were carried out in 1964, 1965 and 1966 as set out in Table I. They were confined to the early autumn since it had been shown (Matthews 1963a) that the north-west tendency is obscured in Peakirk-trapped Mallard from November onwards, due, probably, to the arrival of Continental immigrants with contrary " nonsense " tendencies. All the Mallard in the present series were Peakirk-trapped save for 100 introduced from Slimbridge and released in M.281 and, alternating with Peakirk birds, in M.282-4. These reinforcements were brought in since the decline in the north-west tendency among the Peakirk birds had set in unusually early. Slimbridge Mallard are consistent, season-through, in their orientation, but there are obvious logistic difficulties in bringing large numbers across England to the eastern flatlands. The majority of the Peakirk birds were fresh-caught, early autumn being the main catching season at Borough Fen Decoy, which catches 2-3,000 duck a year. A substantial minority were kept in a spacious aviary for a few days to make up lean catches to a worthwhile release.

All releases were with the sun visible and with visibility in excess of three miles, generally five to ten miles. As these were away-from-base experiments they were sometimes carried out in stronger winds than desirable, i.e. over Beaufort Force 3. Mallard then fly low and are more prone to drop into ditches over which they pass. If the wind is from the north-west the birds become more spread out as they battle into it. The unseasonably wide scatter of the birds caught in 1965 has been referred to above. Other tiresomenesses encountered were heat haze and smoke from burning stubble fields.

All in all it is perhaps surprising that as many as 493 individual birds afforded substantial additional information as set out in Table II.

The visual radius of the observer

The cases in which the flying bird was

Table I. The series of relay releases.

M. Ref.	*Date*	*Wind*	*No.*	*M. Ref.*	*Date*	*Wind*	*No.*
	1964				1965		
250	10.10	W 2/0	35	283	17.10	SW 0/1	48
251	12.10	NW 2/0	38	284	19.10	ESE 2/3	39
252	13.10	NW 2/3	34	285	20.10	ESE 3/2	12
	1965				1966		
271	2.9	NNE 4	31	310	26.8	E 2/4	37
272	4.9	SW 4/3	30	311	28.8	ESE 2/4	40
273	5.9	SSW 0/2	38	312	29.8	SE 3/4	22
274	6.9	NW 1	38	313	31.8	NNW 2/4	40
275	7.9	W 0/2	40	315	2.9	S 2/3	27
276	9.9	W 4/5	6	316	3.9	W 4/2	45
277	11.9	NW 1/2	38	317	5.9	W 3/2	40
278	12.9	W 0/2	46	318	6.9	W 4/3	60
280	22.9	SSW 2/3	21	319	7.9	W 2/1	46
281	15.10	W 3/1	17				
282	16.10	NNW 1	52	Total for 26 releases			920

lost near-simultaneously by both the R.P. and R.1 provide some necessary data on the distance at which Mallard are normally lost to sight. This was obviously over one and a half miles but previous information was scanty and based on scattered observations of birds passing behind known, distant landmarks.

The bearings from R.P. and R.1, taken at vanishing, intersect to give a cross-fix line. The observer at R.1 could only be expected to relay birds which the liberator lost 70° to right or left of the line between them; R.2 was limited to ± 40°. Using the two mile radius, when a bird vanishes from the sight of one observer its position relative to the next observer can be plotted, and also the bearing on which it will vanish from *his* sight if it continues in a straight line.

Table II. The additional information provided by the Relays.

Note. A positive relay was one in which the Relay observer had the bird in view for at least half a minute longer than the Release Point.

	No. of birds	*Average time in sight*
Near simultaneous cross fixes R.P./R.1		*min:sec*
a) on birds seen to land	87	2:41
b) on birds lost flying	50	3:26
Positive relay by R.1 only		
a) bird seen to land	72	5:04
b) bird lost flying	233	5:37
Positive relay by R.2		
a) bird seen to land	10	8:03
b) bird lost flying	41	7:55
Total	493	

on the bird's position. If the intersection is very oblique the position is doubtful. In some cases the bird had clearly been lost prematurely, having gone low, passed through stubble smoke, etc. Omitting such unsatisfactory cases, we are left with 70 measured distances, ranging from 1.5 to 2.9 miles and with a mean (and median) of 2.1 miles from the observer. Obviously the value varied with the clarity of the atmosphere, the attitude of the bird relative to the observer and so on. But is is clearly justifiable to use a circle of two miles radius to describe the visual field of the observers.

The observational situation can then be represented by three overlapping circles as in Fig. 3. The Relay observers thus had additional crescentic fields of view not available to their predecessors down the

The directness of the flight paths

(a) In sight of liberator

The cross-fixes on flying birds (which naturally occur around the overlap of the visual circles) and also on birds seen to land by two observers, provide definite measures of the distance they had flown in a known time and hence their (straight-line) ground speed. This in turn gives a measure of the directness or otherwise of their flight.

Scattered references in the literature and personal observations indicate that Mallard flying straight will average around 45-50 m.p.h. From Table III we see that only those birds, still flying, which were lost to sight in less than two and a half minutes were maintaining an essentially straight track away from the R.P. There-

Table III. Straight-line ground speeds of cross-fixed Mallard.

Time from release (minutes)	*Still Flying*		*Landed*	
	No.	*Av. m.p.h.*	*No.*	*Av. m.p.h.*
1 — 1½	—	—	20	34.5
— 2½	20	40.3	29	24.6
— 3½	16	31.9	19	18.9
— 4½	15	28.3	11	14.0
over	9	17.7	8	19.0
	50		87	

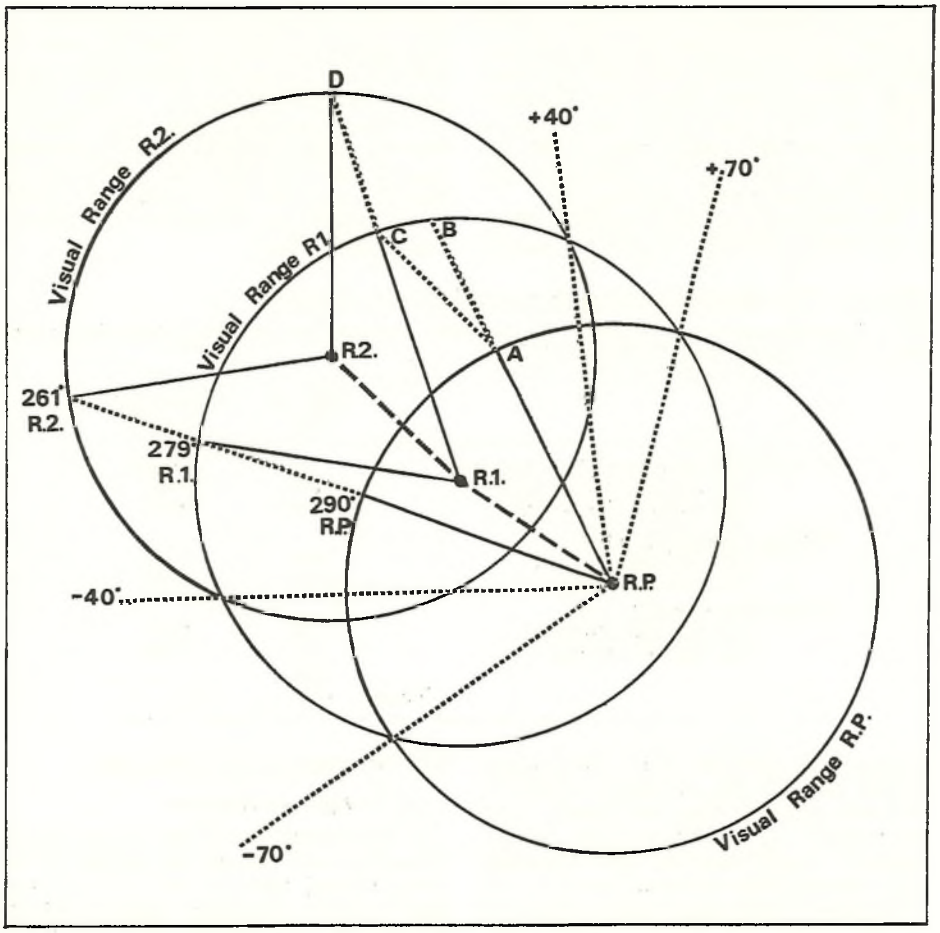

Figure 3. The visual fields of the observers at the release point (R.P.) and relays (R.1 and R.2). The circles are of two miles radius. For other explanation see text.

after their speed declined as their deviations from the straight line increased. The same is true of the birds that landed within sight of the liberator. We leave out of account here birds that landed within a minute of release. They were generally flying low and seldom gave a good cross-fix and their intentions were obvious from the start. Those which flew for longer than a minute before landing showed an increased tendency to wander the longer they were in sight. But, in each time interval, their speeds were slower than those of the birds which flew out of sight. This suggests that they had less inclination to fly in the "nonsense" direction and were from early on seeking a suitable ditch in which to land.

We have made it standard practice in all our investigations of free-flying orientation to record the bearing at 30 seconds after release and to use the relation of this to the final bearing as a measure of the directness of the birds' flight. The present observations provided an opportunity to test the validity of this measurement. The speed of cross-fixed birds is set, in Table IV, against the difference between their 30 second and Final Bearings. There is a good correlation, giving confidence in the simpler method of measuring the directness of flight.

The directness of the flight paths

(b) After relay

Birds which remain a long time in the sight of the liberator must, *ipso facto*, be deviating a good deal from the straight line away from him. The decline in "speed" with time in sight shown in Table III does not, in itself, indicate that there is a progressive increase in meandering. To see if this really is the case we must compare directness of flight shown before and after leaving the liberator's field of view.

Each bird which was subsequently relayed is considered to have been lost to the liberator on his two mile circle. Time in sight thus gives an estimated speed in covering the straight line, R.P. to A in Fig. 3. Using this speed, we calculate how long it would have taken the bird to fly on from the liberator's two mile circle to the point on Relay 1's two mile circle reached by the extrapolation of the liberator's Final Bearing, e.g. the distance AB on Fig. 3. This is the Expected time that Relay 1 should have had the bird in sight if there were no increase in meandering. It is then compared with the actual time he followed it (in both cases additional to the time the liberator had it in sight). Excluding birds vanishing from the liberator in under two minutes (60 m.p.h.) as premature losses, and those which vanished on bearings too near the overlap of the visual circles to give a measurable AB, 206 relays are available, as in Table V.

From this it will be seen that while the bird passed through the additional crescent of view covered by Relay 1 its meandering doubled overall. Those birds which flew the most directly from release showed the greatest proportionate increase in such meandering.

The investigation can be extended to the directness of flight after the birds pass into the crescent of view covered only by R.2. For this, the speed while in R.1's crescent is calculated from the time taken to cover the straight line between the final bearing on the liberator's circle and the actual final bearing on R.1's circle (AC in Fig. 3). This speed is then used to calculate how long the bird should have taken to continue on the latter bearing to reach R.2's two mile circle (CD in Fig. 3). Nearly half the birds received by R.2 gave no measurable value for CD since they did not continue on through, as we shall see below. The 22 birds for which the ratio between expected and actual time in R.2's crescent of view can be calculated, gave a mean of 2.27, i.e. the rate of meandering again doubled. It is obvious that the originally rather direct flight away from the point of release had become very undecided. The next point to be investigated is whether the flight continued in the same general direction or whether there was a change or breakdown in orientation.

Variation in orientation with distance

A bird flying straight from the release

Table IV. Correlation between speed and angular deviation measurements within sight of the Release point.

Calculated speed (m.p.h.)	*Deviation of Final from 30 seconds Bearing* — *Flying < 1 mile* *No.*	*Average*	*Flying > 1 mile* *No.*	*Average*
0 — 10	13	± 50°	—	—
11 — 20	13	± 37°	12	± 85°
21 — 30	9	± 20°	28	± 60°
31 — 40	5	± 16°	13	± 40°
41 — 50	—	—	14	± 21°
51 — 60	—	—	7	± 20°

Table V. The increased meandering of Mallard which had passed out of sight of the liberator.

Time in sight from release point (minutes)	*No. of birds*	*Additional time in sight by Relay 1 Actual/Expected ratio*
2 — 2½	58	2.86
— 3	34	2.00
— 3½	44	1.76
— 4	28	1.35
— 4½	15	1.09
over	27	1.63
	206	1.99

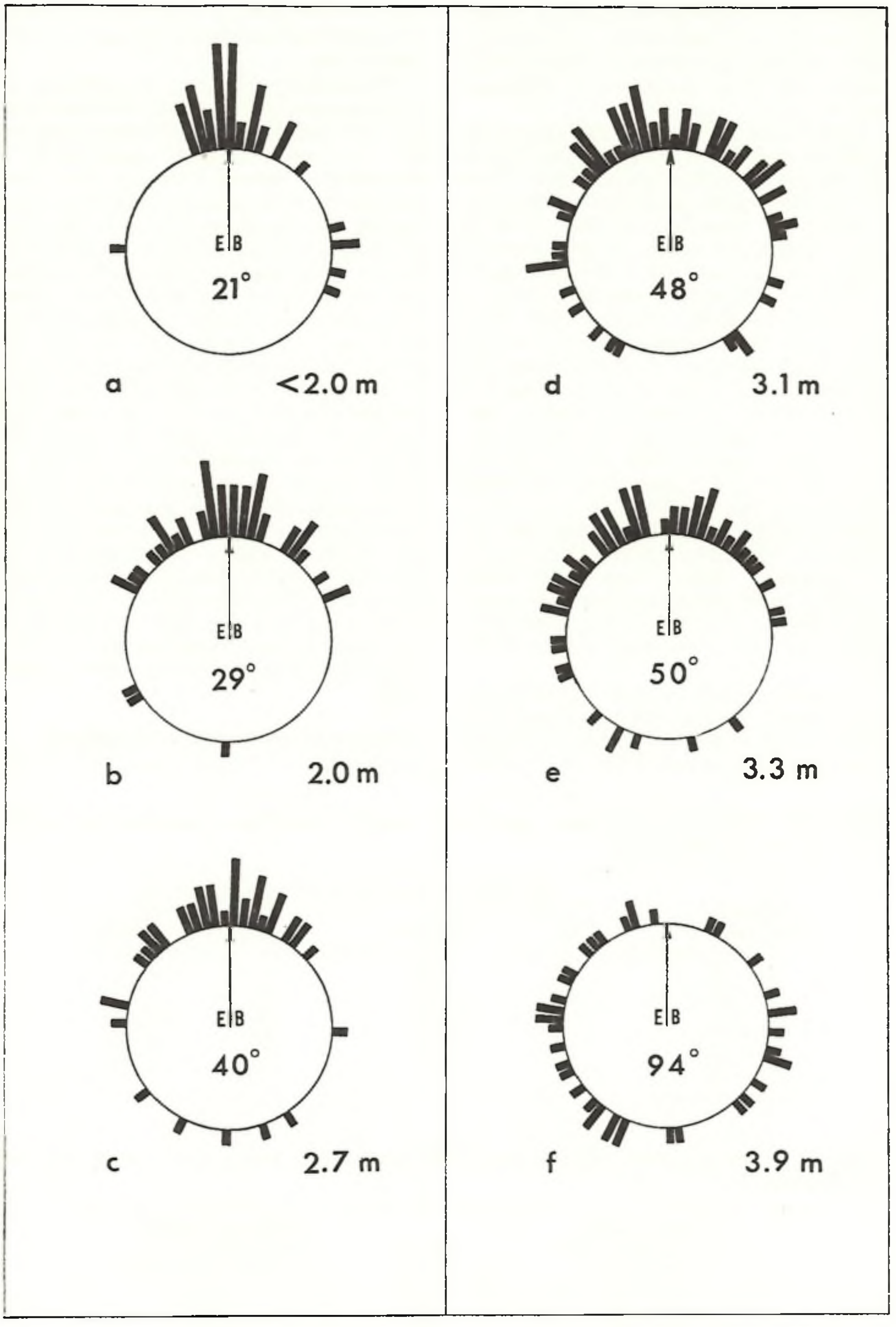

Figure 4. Increasing deviation from expected bearings with distance from release point. The vertical arrow (EB) shows the expected bearing on which birds would be lost to R.1 (a—e) and R.2 (f) if they had maintained that on which they were lost to the R.P. The mean deviations of the actual bearings are shown, grouped according to the minimum distance in miles expected to be covered in sight of the relays. See Table VI and text.

point and on over Relay 1 will have the same final bearing for both observers. More usually the bird will pass to one side or the other of the connecting line and the extrapolation of its final bearing with regard to the liberator will give rise to a different final bearing with regard to R.1 and yet another with regard to R.2. These Expected Bearings are found by drawing on a scale plan. Thus in Fig. 3 Final Bearing (R.P.) 290° gives rise to an Expected FB (R.1) of 279° and an Expected FB (R.2) of 261°. Comparison with the Actual Bearings at which the birds were lost from the Relay Points will then give a measure of the deviation from the initial orientation as the bird proceeds away from the release point. Now, a bird lost by the liberator on a bearing close to the relay axis should be under observation by R.1 for a longer stretch than one near to 70° left or right (1.4 miles down to zero). If there were a progressive breakdown in orientation with distance, it should show up more strongly in the former case than in the latter. The deviation of Final Bearings (R.1) from Expected have therefore been grouped in Table VI according to divergencies from the relay line of the FB (R.P.) which gave rise to them. Fig. 4 (a-f) shows the deviations of the individual vanishing points. from the relay axis. No difference appears in the two categories and we can therefore state that by the time the birds had gone four miles from the Release Point the original directional tendency had disappeared, the distribution of final bearings being quite random with respect to that orientation.

In passing, it should be noted that the proportion of relays achieved by R.2 is not so low as would at first appear. R.2 was not introduced until the releases in 1964 had indicated its desirability. In six other releases it was not possible to operate an R.2. In the rest, 87 birds picked up by R.1 passed within ± 40° of the relay axis. R.2, which picked up 51 birds (including ten seen to land), was thus successful with three-fifths of those which (see Fig. 3) were possibilities. This shows, incidentally, that further relay observers would have been unproductive.

The rate of landing

In our investigations of the meaning and basis of "nonsense" orientation those birds, usually about 20%, which land within sight of the liberator have been excluded from consideration. In the present series the percentage landing was rather higher, 26%, probably because of

Table VI. Deviation from initial orientation in relation to distance from Release Point. For explanation see text. Fig. 4 refers.

	Relation F.B. (R.P.) to relay line	*No. of bearings*	*Minimum expected miles*	*Mean deviation F.B. (Relay) from expected*
Relay 1				
	Over ± 70°	47	ca. 2.0	21°
	Under ± 70°	51	2.0	29°
	Under ± 45°	46	2.7	40°
	Under ± 30°	73	3.1	48°
	Under ± 10°	62	3.3	50°
Relay 2				
	Over ± 10°	21	3.9	94°
	Up to ± 10°	20	4.7	94°

As expected, those birds lost near the overlap of the R.P. and R.1's visual circles had made but little change in direction by the time they were lost to the latter. Those leaving the R.P's sight close to the relay axis did, however, show greater deviations, particularly by the time they had travelled at least three miles direct. The Relay 2 results are split into only two categories, partly because of the smaller numbers available, partly because only five were more than ± 30° (the value used to determine mileage in Table VI) the wind effects discussed earlier. As the initial act of orientation can be considered to have terminated when the bird lands, the rate at which this occurs, out of sight of the liberator, is of obvious importance.

Both R.1 and R.2 observed a further 20% of the birds that they relayed from their predecessor landing in *their* sight (respectively 72 out of 357 and 10 out of 51). Each Relay extended the range for which the bird was followed by around a mile. This would indicate that, if this rate of "fall out" continued, 90% of the birds would have landed within ten miles or so from the Release Point.

Another approach is to consider the data on a time basis, lumping together observations by R.P., R.1 and R.2 and finding the percentage of birds seen to be flying at the start of each minute which had landed by the end of that minute. This is done in Table VII. From this it will be seen that the rate of "fall out" after release was high, about 10%, for the first two minutes, then fell somewhat before increasing towards the end of the observations. If the rate observed in the 14th and 15th minutes was maintained then we would expect 90% of the birds to have landed within about 20 minutes of release. This accords well with the mileage estimates above.

Table VII. The decline with time of the proportion of birds under observation, and the rate of landing.

Minutes from release	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Seen flying at start	920	831	685	530	391	267	172	109	77	55	32	23		14		2		920
Lost flying	7	63	108	107	95	83	53	30	16	16	6	7		8		2		601
Seen landing	82	83	47	32	29	12	10	2	6	7	3	2		4		—		319
% Landing	9	10	7	6	7	5	6	2	8	13	9	9		29		—		35

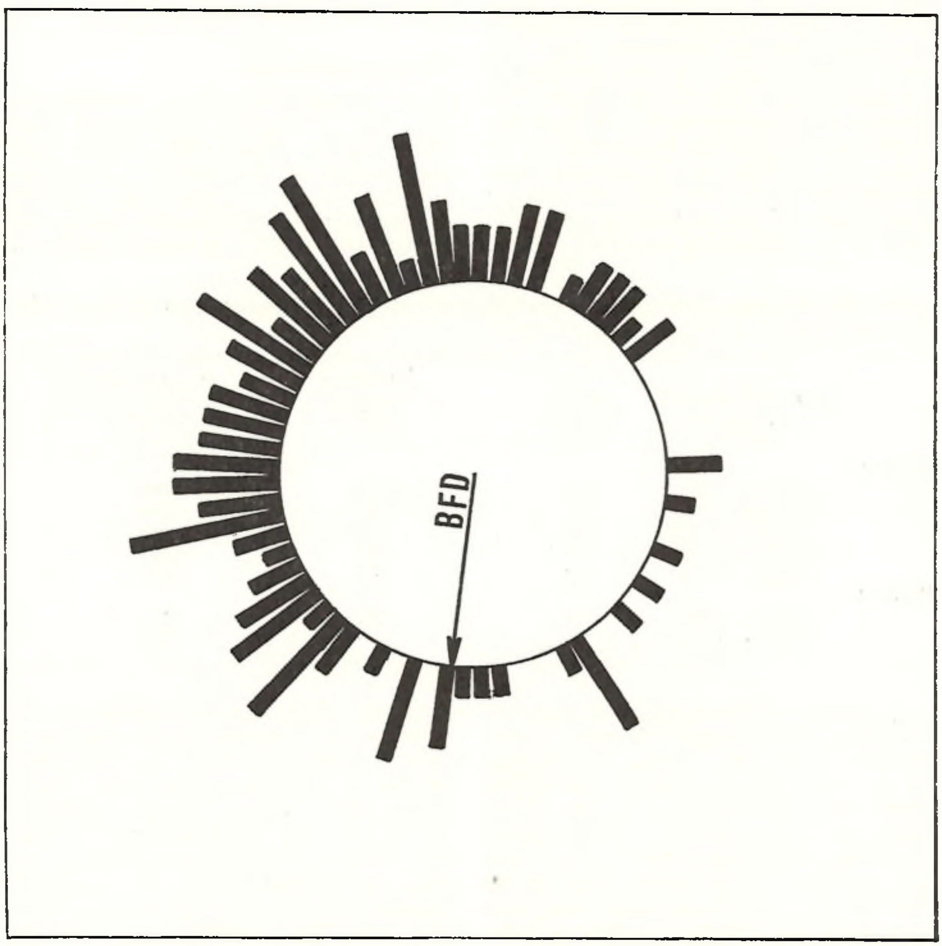

Figure 5. Final bearings from Relay 1 (Figure 4, d and e) plotted as compass directions. North to top.

The effect of local topography

Although the parameters we have been able to describe probably have general application to the "nonsense" orientation of Mallard, the details must surely have been influenced by local topography. Thus of the 87 relayed birds that R.1 saw land, 28 (39%) came down in the North Drove Drain on which the observer was stationed. Had this watercourse not been there the birds concerned might well have flown farther. On the other hand, at another site other temptations would arise.

It was noticeable that even when the watercourses did not seduce the birds to land they often influenced them to change course. However, the influence of these major landscape features was often only temporary, and minor features such as roads also acted as "leading-lines." We may examine the matter by replotting those R.1 Final Bearings (Fig. 4d and e) which derive from R.P. Final Bearings within ± 30° of the relay axis. These central bearings would not, as viewed from R.1, have a strong bias imported by their origin. In Fig. 5 they are shown as actual compass bearings, i.e. with north at the top of the diagram. It will be seen that there was a generalised spread about the relay axis, not a strong concentration in particular sectors, as there would be if, for instance, many birds had flown SW or NE between the Drains.

Each landscape will have its own effects on the precise way in which "nonsense" orientation breaks down; the important thing is that it *does* break down.

Conclusions

After Mallard were lost to sight from the Release Point, their flight became increasingly undirected. Within three or four miles their general orientation had ceased to have any relation to the "nonsense" direction in which they had departed. The great majority would have landed within ten miles or twenty minutes. In other words, "nonsense" orientation is a short lived affair.

This might be thought to strengthen suggestions that it is essentially an escape-reaction. On the other hand, it can plausibly be argued that it would be advantageous for a bird to fly on one general course for a short time while making more subtle measurements whereby it appreciates its position relative to home. The present experiments do not distinguish between these possibilities. They do show, however, that an understanding of "nonsense" orientation will be found by investigations of the behaviour visible to the liberator armed with binoculars. There is no need to launch into expensive technology in this case.

Acknowledgements

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