Mute Swans on the Warwickshire Avon—a study of a decline

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Introduction

This paper deals with the size and distribution of the Mute Swan *Cygnus olor* population in South Warwickshire, England and in particular with a long-term decline in parts of the study area. Mortality factors, habitat changes, and breeding success are considered in some detail.

Description of study area

The study area originally covered 900 sq. km, in a block of 3 by 3 ten kilometre grid squares centred on Stratford-upon-Avon, Warwickshire. However, information was also collected from outside this area, and eventually, in 1974, the area was formally extended to include a further strip of 3 squares down the western boundary, increasing the study area to 1,200 sq. km (Figure 1). The study thus covers much of the terrain drained by the Warwickshire Avon and its feeder streams, mostly farmland less than 100 metres above sea level. The part of the Cotswold Hills lying within the southern boundary, and rising to about 250 m, provides little suitable swan habitat. The only extensive urban areas are Evesham, Stratford, the Warwick–Leamington Spa complex and in the extreme north-west corner of the study area, the major development of Redditch New Town. There is a marked increase in industrial land-use in Redditch, whereas formerly such activity was largely confined to Warwick and Leamington and never significantly affected this swan population.

Evesham formerly held a herd of swans but this had mostly disappeared by 1966. Stratford and Warwick–Leamington both

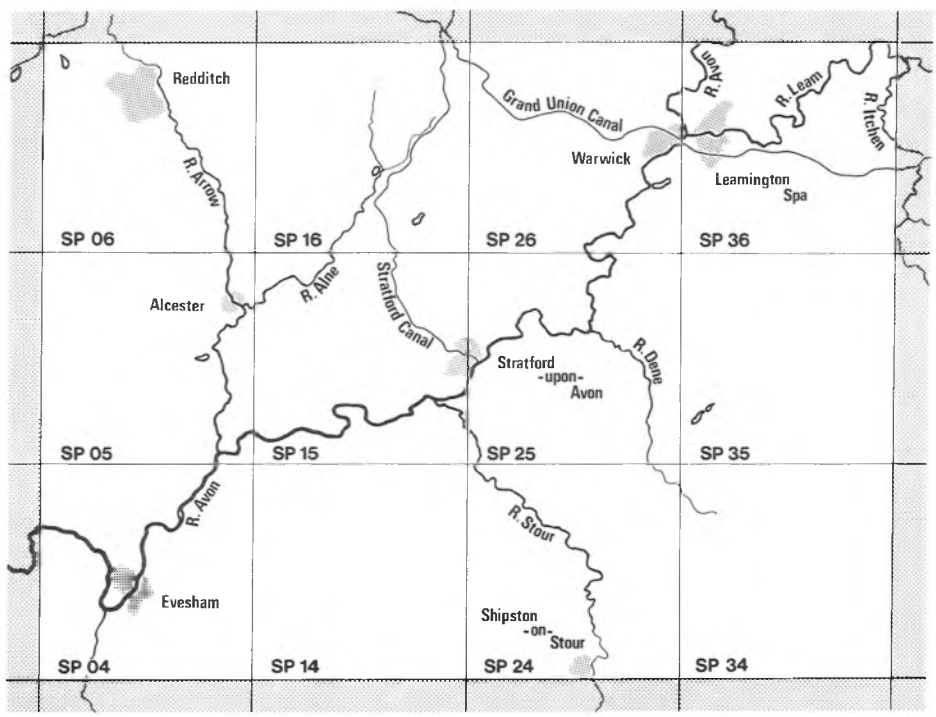

Figure 1. The study area.

Wildfowl 31 (1980): 29–36

held resident non-breeding swan herds in the study period, although the Warwick–Leamington group is of more recent origin and has, until very recently, been quite small. Places, close to, but outside, the area, which hold or have held swan herds include Worcester, Coventry, Leicester, Birmingham, and Draycote Water near Rugby. Other independent ringing studies of Mute Swans are those in Coventry, South Staffordshire and Oxfordshire. A varying amount of movement occurs between the present study area and each of these others, particularly Coventry, which has a common boundary with our own.

The main swan habitat is found on the River Avon and its tributaries, namely the rivers Leam, Itchen, Dene, Stour, Arrow and Alne. The total length of river in the study area is 157 km, varying greatly in size, condition and ecological quality. There are also 45 km of canal, comprising parts of the Grand Union and Stratford Canals, and an increasing number of small reservoirs and ornamental pools. There are no large reservoirs or natural lakes; the nearest are the Birmingham reservoirs in the North and Draycote Water just outside the eastern boundary.

With the Birmingham conurbation so close, it is not surprising that there is a heavy recreational demand for fishing sites. The demands of agriculture, horticulture and drainage also have a very significant influence on the river systems. An important new factor is the emergence of the Navigation Trusts which aim to restore derelict, and establish new, river and canal navigations, operating these for pleasure craft enthusiasts. This pastime is rapidly growing in popularity in the Midlands. The Avon from its confluence with the Severn at Tewkesbury up to Evesham (the Lower Avon) was made navigable by 1964. The Stratford Canal between Lapworth and Stratford was re-opened at that time, and the navigation between Evesham and Stratford (the Upper Avon) was completed in 1974. There is currently much local controversy over plans to establish a new navigation—the Higher Avon—between Stratford and Warwick–Leamington.

The Stratford non-breeding herd of swans is thought to have established itself early this century, probably coinciding with the growth of the town as a tourist centre and the development of the river frontage as a public park. In the first national Mute Swan census of 1955–1956, there were 40 non-breeders (Campbell 1960). In 1959, generally accepted as being the peak year of the national Mute Swan population (Ogilvie 1972a) the Borough Council was expressing concern at the herd's continued expansion, and it was then thought to number around a hundred. A proposal to reduce the herd size by 50% was abandoned after legal difficulties became apparent. However, the herd began to decline in numbers without direct interference and in the national census of 1961 there were 62 birds in the town (Eltringham 1963).

In 1959, efficient metal swan rings were developed by the British Trust for Ornithology and a number of ringers began to catch swans in Stratford. By 1961 J. A. H. was making regular ringing visits to the herd and the first detailed population counts date from that time. The first summer moult round-up was in 1964, and it was then that the study really began.

Study techniques

(a) Non-breeding population

Regular visits were made to obtain (i) counts of total numbers present, (ii) proportion of juveniles to adults, and (iii) observations of un-ringed or newly arrived outsiders. Wherever possible, unringed swans were caught and ringed, and birds carrying colour-rings indicating their origin in a different swan study area were caught and the ring number recorded. This ideal was usually achieved in the semi-tame Stratford herd though concentrations of swans elsewhere were often shy and less approachable, being less accustomed to bread-feeding. These visits were supplemented by reports from a wide network of observers.

Round-ups of the Stratford moulting herd were carried out every year between 1964 and 1973 inclusive. The birds caught were aged and the state of the wing-moult recorded. In 1974 we adopted the large 'Darvic' identification rings whose individual codes could be read, with binoculars, at a distance (Ogilvie 1972b). Then, by making several visits, recording all the 'Darviced' birds present on each occasion and observing the state of the wing feathers, the same information was obtained without the need to catch the birds. The use of 'Darvics' also gave rise to large numbers of sight records, particularly from the public, of birds both in the non-breeding groups and on territories.

(b) Breeding population

Swan nests were found by checking likely sites on pools, rivers and canals and our own results were supplemented with information from the public. The faithfulness of Mute Swans to particular traditional nest sites made coverage much easier. As the primary effort has been concentrated on the non-breeding herd, coverage of the breeding population has at times been incomplete, but only periods when full coverage was possible are included in this paper. Before the use of 'Darvic' rings, it was necessary each year to catch the pairs at the nest to identify them, but this is rarely needed nowadays and it is only necessary to disturb the female to count the eggs.

(c) Mortality

Dead Mute Swans are easy to see and consequently their recovery rate is high. A number of bird-watchers and the public have kept us informed of any dead or distressed birds. In addition, we enjoy a good liason with the local police and R.S.P.C.A. officials, and with the parks and amenities staff of the local authorities. We therefore receive, in most cases fairly quickly, a high proportion of the corpses recovered from the rivers. These are examined for obvious disease or injury, weighed and wing length measured. They are then dispatched to the Veterinary Investigation Centre at Sutton Bonington, in Nottinghamshire, where analyses of lead levels in the liver and kidneys of Mute Swans have been done, following a large number of Mute Swan deaths which occurred on the River Trent at Nottingham (Simpson *et al.* 1979). High levels of lead have similarly been found in a large proportion of River Avon swan corpses and the implications are discussed later.

(d) General

Swans found outside breeding territories or away from herds are ringed, if possible. Since 1974, all swans caught have been measured for wing length, and where possible, weighed as well. Juveniles are caught in the family group with their parents before they disperse from the breeding areas, though this is often not possible. Feather tissue samples are normally taken from all birds handled, for determination of their lead content.

Results

(a) Non-breeding herds

Table 1 gives results of counts of the Stratford herd from 1962 to 1978. For each winter, from September to the following March, a figure is given for the peak count and for the mean of all the counts taken.

Table 2 gives, for the years 1963 to 1978, the size of the July moulting herd at Stratford, and also the total yearly addition to the herd of young birds. The figures do not include 12 birds which were shipped to

Table 1. Winter counts of Stratford non-breeding herd.

	62–3	63–4	64–5	65–6	66–7	67–8	68–9	69–70	70–1	71–2	72–3	73–4	74–5	75–6	76–7	77–8	78–9
Winter peak	70	80	65	70	60	63	54	41	42	39	38	34	26	32	16	13	4
Winter mean	49	60	49	59	55	52	45	39	32	29	29	28	19	11	9	4	3

Counts between 1 October and 31 March are defined as winter.

Table 2. Summer moult population and input of juveniles into Stratford non-breeding herd.

	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Moulting herd size	—	55	57	69	68	54	48	35	23	22	37	31	31	30	20	2
Juveniles in herd after breeding season	46	51	53	30	26	34	10	15	17	15	9	11	18	10	1	2

No count was made of the moult herd in 1963.
The figure for juveniles includes all those joining the herd before July of the year following birth.

California in 1964, and 6 cygnets introduced from Northamptonshire in 1972.

Table 3 shows winter populations for the Warwick–Leamington area. Only in recent years have the scattered individuals there gradually merged together into a single group. In the last five years, the number of birds present has increased and several different focal points within the two towns have become apparent. The population quoted is the approximate average total of these different sites and is far more variable than the Stratford figure. From 1974 onwards, there have been a few records of swans moulting at other places: on the Grand Union Canal at Leamington Spa (12 and 5 in 1975 and 1977), at Emscote, Warwick (12 in 1978) and Welford-on-Avon (5 in 1978).

Table 3. Winter counts of non-breeders—Leamington/Warwick.

	1973–1974	1974–1975	1975–1976	1976–1977	1977–1978	1978–1979
Winter peak	17	7	22	39	26	33
Winter mean	13	7	7	13	4	10

Note: winter counts prior to 1973 were normally 5 birds or less.

(b) Breeding population

Complete coverage was achieved during the three years from 1964 to 1966, and for 1974 and subsequently the results are given in Table 4. The river groupings are defined as follows:

Upper Avon: The Avon between Evesham and Alveston. Upper Avon tributaries: the rivers Arrow, Alne and Stour, and pools lying immediately along the lines of these tributaries. Higher Avon: the River Avon from Alveston to the junction with the river Leam at Leamington Spa. Higher Avon tributaries: the rivers Dene, Leam, and Itchen and associated pools. Other sites: includes the Stratford and Grand Union Canals and isolated pools.

Table 4. Total number of breeding pairs in study area.

Period	1964–1966	1974–1975	1976	1977	1978
Upper Avon	9	5	3	2	3
Upper Avon tributaries	6	4	3	3	3
Higher Avon	3	5	4	5	5
Higher Avon tributaries	7	7	6	6	8
Other sites	5	5	3	2	3
Total	30	26	19	18	22

Table 5 is an attempt to depict the breeding performance. The population is classified on the same lines as in Table 4. The potential maximum number of pairs which we consider each river group to have been capable of sustaining in 1974 is multiplied by an index of success (x1) a pair holding territory, (x2) a nest, (x3) eggs, (x4) young, and (x5) young surviving into the following winter. This gives a crude 'maximum productivity index'.

For example, the Upper Avon was considered to be capable of carrying a population of 5 pairs of swans. If each of the five pairs had bred and produced cygnets, some of which survived into the winter, the maximum productivity of $(5 \times 5) = 25$ would be attained. In fact, as the table shows, the actual figure is generally much lower.

(c) Mortality

1975 was a year of unusually heavy mortality in the Stratford non-breeding herd. It

Table 5. Comparative breeding success 1974–1978.

Maximum productivity index	River group	1974	1975	1976	1977	1978
25	Upper Avon	22	11	10	6	7
20	Upper Avon tributaries	14	8	11	12	10
25	Higher Avon	17	20	13	19	13
35	Higher Avon tributaries	24	21	22	20	22
10	Canals	8	6	5	5	5
15	Pools	0	6	9	4	9
130	Total area	85	72	70	66	66

was also the first full year for which we had the benefit of post-mortem facilities. We may therefore take this year as a comparison with the period before and after it. This is done for the whole area in Table 6. It will be noticed that a combined percentage is given for the categories 'cause unknown' and 'lead poisoning' prior to 1975. Without post-mortem information it was not possible to recognize lead poisoning in swans found dead or dying without obvious cause. We believe, however, that the 'cause unknown' category has always included deaths due to lead poisoning and the reasons for this presumption will be discussed below.

As lead poisoning deaths features so strongly, and since a large number were in the Stratford area, a comparison between the annual number of birds dying in that area (January to December) and the July herd population is given in Table 7.

More precise post-mortem data exists for the period 1975–1978, and Table 8 breaks down the mortality into percentages for each cause of death. A broad comparison is made between the Upper Avon and tributaries around Stratford and the Higher Avon and tributaries around War-

Table 6. Causes of death expressed as percentages.

	Prior to 1975	1975	1976–1978
Lead poisoning)	63	76	43
Cause unknown)		16	20
Collisions (wires etc.)	19	—	16
Other accidents	9	4	9
Killed by predators	4	—	2
Oil	2	—	2
Fighting	2	—	4
Human action	1	4	4
Number of deaths	*127*	*25*	*45*

Table 7. Total mortality in Stratford herd as a percentage of number present in moult herd.

Year	Birds present in July moult herd	Birds recovered in Stratford during year	% mortality
1964	55	9	16
1965	57	7	12
1966	69	8	12
1967	68	3	4
1968	54	8	15
1969	48	2	4
1970	35	10	29
1971	23	4	17
1972	22	4	18
1973	37	4	11
1974	31	10	32
1975	31	20	65
1976	30	9	30
1977	20	5	25
1978	2	3	(150)

Table 8. Mortality causes in Upper and Higher Avon river groups 1975–1978.

Cause	Upper Avon and tributaries etc. Number	%	Higher Avon and tributaries etc. Number	%
Lead poisoning	35	74	1	5
Cause unknown	7	16	5	26
Collisions (wires etc.)	2	4	5	26
Other accidents	—	—	5	26
Oil	1	2	—	—
Disease	1	2	—	—
Human action	1	2	—	—
Fighting	—	—	2	12
Killed by predators	—	—	1	5
	47	100	19	100

wick and Leamington. The overall number of recoveries included is fairly small, but sufficient to show striking differences between the two areas.

Discussion

(a) The Stratford non-breeding herd

The Mute Swan population of lowland Britain has declined since its peak in the late 1950's, but this decline has been more severe in some areas than in others (Ogilvie, in press). Declines appear to be happening within several other study areas (Minton 1971) and for various reasons—pollution, general deterioration of habitat, and disturbance being among the more important. The results of our study show a growing imbalance between higher mortality levels and declining recruitment of young birds resulting in the gradual decline of the Stratford herd since the mid-60s. This was accelerated by spectacular mortality in 1974 and 1975, largely due to lead poisoning as a result of the ingestion of fishing weights.

The phenomenon of swans ingesting such weights has also been noted in other areas (Simpson *et al.* 1979). Despite the heavy reduction in the Stratford herd's size resulting from the 'lead-kill', there was a very encouraging recovery in the spring of 1976, with up to 32 swans in the herd, a high proportion being juveniles. Unhappily the number of birds at Stratford soon declined very sharply and has now fallen virtually to nil. There are certain puzzling features about the decline which make it difficult to accept lead poisoning as the whole and simple cause. In view of the efficient recovery of swan corpses in Stratford, the subsequent disappearance of most of the 32 birds present in spring 1976 after the main 'lead-kill' cannot have been due to death. They simply left the locality, and indeed a number of them have since been recorded in other places.

Prior to 1975, when no post-mortems were carried out, the major single category is that of 'cause unknown'. This includes birds found sick, moribund or dead, but with no obvious injury or other indication of the cause of death. The usual symptoms recorded in such cases closely resembled those diagnostic of lead poisoning (Simpson *et al.* 1979). They described an abnormal carriage of the bird's neck, with the lower third supported against the back, and reluctance or inability to stand. The birds eventually became paralysed, and in some cases were unable or unwilling to feed, apparently due to paralysis of the digestive tract. Since post-mortems on Stratford swans have been done, nearly all those with no other evident cause of death have subsequently been proved to contain lethal concentrations of lead, and probably most similar recoveries prior to 1975 would have shown this also. This mortality factor has therefore existed to an unspecified extent for a long period. It would be wrong to regard it as a new hazard to the population; certainly the 'lead-kills' which have occurred at Nottingham and Stratford are highly disturbing, and it is difficult to see why the problem should have suddenly increased in severity and extent.

There is no indication of a sudden change in the extent or methods of angling in Stratford in 1975. Low river levels in the dry summers of 1975 and 1976 may have rendered lost tackle entangled in the weed on the river bed more accessible to feeding swans; but while river levels in the 1977 and 1978 summers were normal, there has been no consequent reduction in the proportion of swans being killed by lead.

The only major change to the Avon at Stratford has been the opening of the navigation which has undoubtedly affected the habitat quality of the river. There is far less visible weed growth than in former years. In some areas, dredging was carried out and areas which were very shallow and carried luxuriant growths of macrophytic vegetation are now out of reach of feeding swans. It is questionable whether the same plant species will regenerate, and, at least in the short term, the available food supply has been reduced. Even where there has been no dredging there is less weed. The presence of large numbers of motor boats, discharging exhaust fumes into the river, may have an adverse effect on conditions for vegetation growth. Established weed beds can be uprooted by contact with propellers, and, once gone, will not be easily replaced.

A recent article (Blacksell 1978) refers to the severe deterioration of aquatic plants on the Norfolk Broads over the last twenty years, and blames as major factors the passage of motor cruisers causing water turbulence and turbidity, which excludes light necessary for plant growth. Much further investigation in a variety of habitats will be required before the problem is fully understood, but it is already evident that

motor-boats can affect the ecology of waterways in subtle and far-reaching ways. It is noteworthy that the pleasure boat operator in Stratford, had, in former years, to run a special weed-cutting boat up the river at the start of the summer season. This is no longer necessary.

The reduced food supply is particularly important during the moult period. In addition, the disturbance by boating activities interrupts feeding and upsets the birds at a period when they are physiologically vulnerable.

In these ways the opening of the navigation may have reduced Stratford's suitability as a centre for Mute Swan and, indeed, former Stratford birds have increasingly been reported in Leamington and Coventry. However, it would not have directly caused the death of the birds, though a reduction in the weed content of the river could have exacerbated the lead pollution problem. Firstly, hungry birds would exploit the limited available area of weed more thoroughly and be more likely to pick up weighted lines tangled in the weed. Secondly, swans in poor physical condition as a result of a drastically reduced food supply might be more susceptible to lead poisoning.

(b) Non-breeding herds elsewhere

A survey of aquatic habitats in Warwickshire carried out during 1977–1978 by Jackson *et al.* (1979), indicated that the ecological quality of the rivers Leam and Itchen was among the best in Warwickshire. The Leam is not navigable and in Leamington the amount of water weed and aquatic life is considerable. The abundant food supply is reflected in large clutch and brood size, and rapid growth and exceptional size of the cygnets reared on this stretch of river. Fishing is carried out to the same degree as in other parts of the study area, including Stratford.

Swans also use the nearby Grand Union Canal, especially in winter, and it was probably this site which first attracted a large group to Leamington in 1975, when they were fed regularly by residents on a new housing estate. Another commonly used site is the Avon-Leam junction at Emscote, which lies between two breeding territories and acts as an undisturbed gathering place for immatures in winter. In 1978 a small number moulted in this area. Numbers in each site vary, and movement between them is continual.

(c) The breeding population

There was a decline in the number of breeding pairs between the mid-1960s and the mid-1970s, and this trend has continued since.

Obviously, the 1975 'lead-kill' in Stratford had some effect. However, only birds breeding close to Stratford were involved and this did not significantly account for the more widespread decline which had in any case already occurred.

On the Upper Avon and its tributaries in the south west of the area re-colonization of sites falling vacant through mortality has not occurred. The decline of the non-breeding herd in Stratford has probably reduced the ease with which replacements can be supplied. It also appears that the vacant sites are no longer attractive to swans, and that where territories are occupied, breeding success has been extremely poor.

Prime nesting habitat for Mute Swans requires shallow water with good weed growth, and the former territories on the Upper Avon have nearly all, in the setting up of the Upper Avon navigation, received dredging treatment which has changed their character drastically. Approximately 60% of the river between Evesham and Stratford required dredging to permit boat passage, and in few places is the river sufficiently wide to allow the retention of the former shallows along side the main channel. In the mid 1960s the unnavigated Upper Avon carried three times as many pairs as the Higher Avon. Now, after dredging, it supports only about a half.

In addition to deepening the channel, the loss of islands where birds could rest safely, and spits and shallows where they could loaf and preen, and the grading of river banks where birds could formerly leave the water easily to graze, have further reduced the ecological value of the river. The likely indirect effects of boat traffic also apply to breeding territories, and while adult swans are often tolerant and even aggressive towards boats, they are less so while they have very small cygnets. A loss of nesting pairs has occurred on the River Arrow, which, while not navigated, has in recent years been much altered and canalized over much of its length by the Severn-Trent Water Authority, producing results similar to those occasioned by navigation work.

On the Higher Avon above Alveston, and on its tributaries the swan population

has increased. The swans occupy all the important areas of shallow water, which, if the Higher Avon Navigation proposals are approved, will be dredged to enable the passage of boats. It would then be difficult to foresee a future for more than the odd pair of swans on the Higher Avon in the 1980s.

(d) Other mortality factors

Reference to Table 8 shows that on the Higher Avon and Leam, lead poisoning forms a very insignificant part of the current mortality picture. In this area the major causes of death are flying accidents and conflict with dogs, other swans and vandals. It is tempting to regard the swan population in the north-east of the area as a healthy, vigorous one, much given to movement and occasionally losing birds through flying accidents, and the Stratford and south-west population, now largely defunct, as being ill-nourished and inactive, little inclined to movement, with most deaths due to lead poisoning.

Acknowledgements

In the early years, H. S. Helmsey-Hall, N. Henson and C. M. Reynolds kindly made their own ringing data available. From 1964 to 1973, the large round-ups of moulting birds would not have been possible without many helpers, and the efforts of C. D. T. Minton, G. H. Green, M. A. Ogilvie and Ann Hardman are particularly noteworthy. In recent years, the assistance of G. J. Ariss, R. J. Juckes, M. V. Tursner, G. Yates, C. H. Potter, E. J. Bradford, and Sarah Jane Hardman has been much appreciated.

The officials of the former Stratford-upon-Avon Borough Council and Stratford-on-Avon District Council have always been helpfully interested and in particular our thanks go to Bill Williams for retrieving so many dead and ailing swans. The co-operation of the local R.S.P.C.A. inspectors, especially Inspector D. W. Johnstone, has been most valuable.

The analysis of many corpses by Alan Hunt is acknowledged and would not have been possible without the weekly delivery service very kindly provided by J. C. Jackson from Wellesbourne to Sutton Bonington.

Summary

Continuous monitoring between 1962 and 1978 of the Mute Swan *Cygnus olor* population of the Warwickshire Avon has revealed a severe decline, involving the reduction of non-breeders by more than half and the complete loss of the Stratford herd. Breeding pairs dropped by a third and their breeding success by a quarter. Possible factors causing the decline are discussed.

For the last three years of the study, lead poisoning from ingested fishing weights was the cause of death of three-quarters of the birds. Prior to 1975 a similar proportion of swans died from an unknown cause, which in retrospect must have been due to lead. The reduced breeding success is thought to reflect a deterioration in habitat, following dredging for navigation and drainage. This and the increased boat traffic, have reduced the areas of macrophytic vegetation, causing a lack of food and an enhancement of the effect of the presence of lead fishing weights.

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