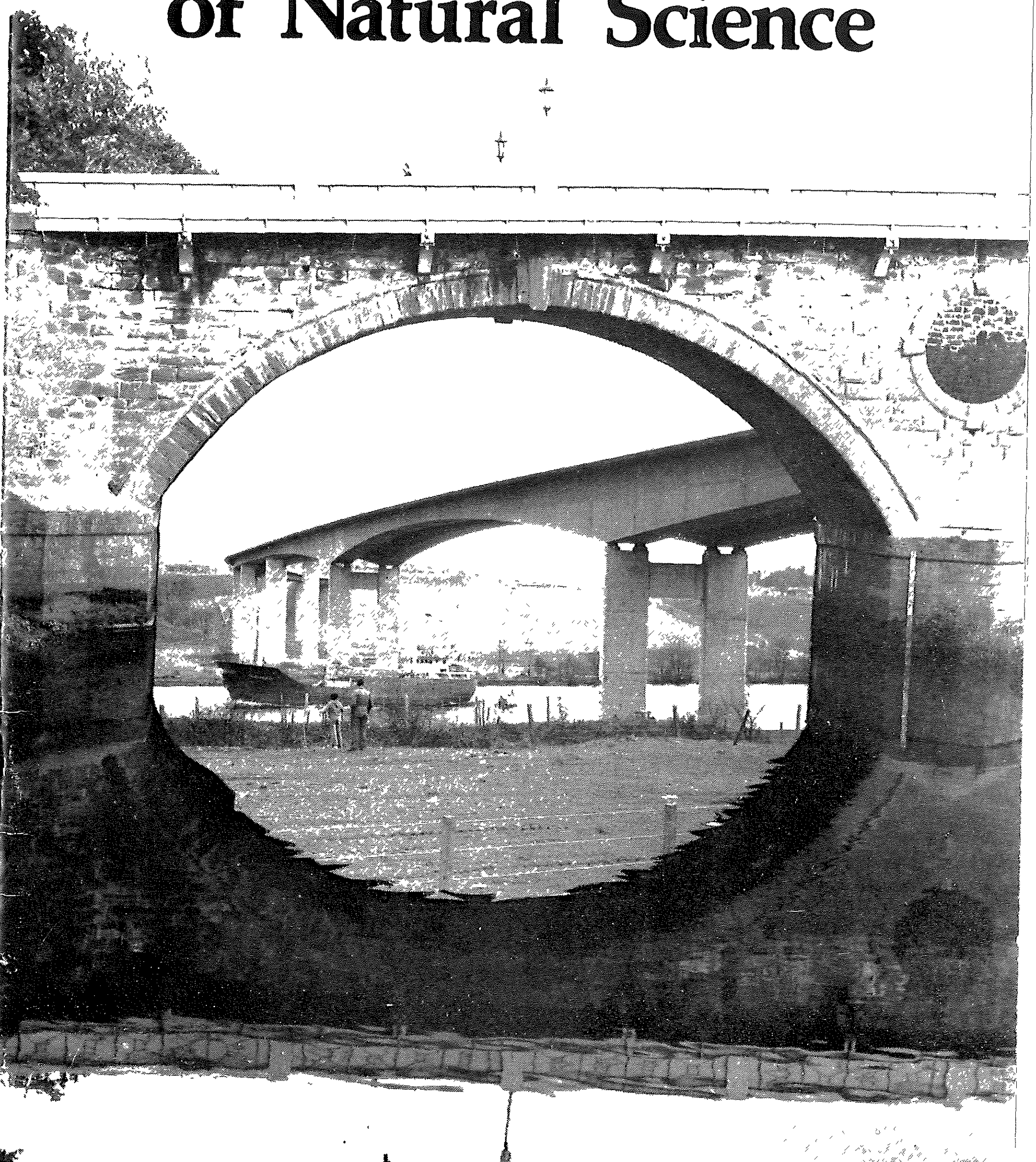
Transactions of Perthshire Society of Natural Science



Transactions of Perthshire Society of Natural Science

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Contents

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Introduction

In 1887 The Society published Volume I of its Transactions and proceedings which was offered to Members at the price of one shilling. Since then the Transactions have appeared at regular, and sometimes irregular, intervals and at increasing costs. With this issue we produce Volume XIII with a more modern format and closer co-operation with the production facilities of Perth Museum. The papers contributed reflect some of the recent changes in our environment and natural resources and maintain the scientific interest and value for which the Society exists. We are grateful to all our contributors, and appreciate their labours and erudition.

Perhaps the most striking changes in our local environment over the last few years has been the improvements and remaking of the main roads in the County, and the bridges over the River Tay. The Society has been concerned over the damage and loss of some of the more unusual flora along the river banks. It is good to record that the Society's representations in this aspect have received full and sympathetic appreciation from the Engineers and Contractors concerned. At Friarton Bridge and Rotmel Island, higher up the river, construction plans were modified to avoid the loss of rare plants.

Mr H G Binnie, Resident Engineer at the Friarton Bridge, delivered a lecture to the Society on The Design and Construction of Friarton Bridge. This was received with great interest and we are pleased to be able to publish his lecture. The construction of the new A9 road beyond Dunkeld required the alteration of the river course round Rotmel Island. Mr Robson's paper describes this and the steps the Botanical Section took to preserve the flora on the Island. The Botanical Section will be watching the present construction work on the extension of the A9 to by-pass Pitlochry.

Of great interest to us today, and perhaps of greater value to the future is Mr Nicholas Bogdan's contribution in his paper on the excavations in Perth High Street during the last two years. Mr

Bogdan was Director of the excavations and among his work force were members of our Archaeological and Historical Section. This is a valuable article which will be of significant interest to historians in the future.

Ornithologists and others will be interested in two papers from members of the Ornithological Section. Miss Thom and Mr Cameron contribute a valuable account of the Great Crested Grebe and its breeding incidence in Perthshire. Mr Maurice Drummond, who is Warden of the Loch of The Lowes Reserve, brings us up to date with the return of the Osprey to Perthshire.

The Editor expresses his great appreciation of the guidance and help he has received from the Director of Perth Museum and his Staff in compiling this issue of the Transactions. Their interest and suggestions have been invaluable to one who is inexperienced in such a task.

Finally, the Society is once again grateful for the skill and expertise of our Printers without whom this issue could not be produced.

The Editor

The Design and Construction of Friarton Bridge

H G Binnie

Design

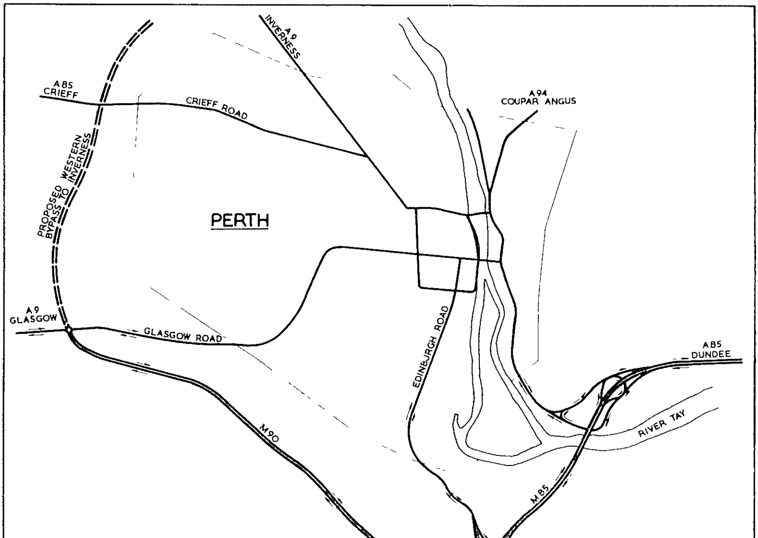
Once the basic decision to build a bridge has been made, a number of important decisions must follow fairly rapidly. The first of these is the site of the bridge. The site chosen depends on a number of different factors. For large bridges, the narrowest point of any crossing is always chosen to reduce the sheer cost of the bridge, and all the secondary matters—the approach roads and existing buildings etc must take second place. For smaller bridges however, these other secondary points have a significant effect on the total cost and must therefore be taken into account. In the case of Friarton Bridge, the factors to be taken into account were the position of the Craigend Interchange to the south, Kinnoull Hill cliff immediately to the north of the river, the position of the Perth to Dundee railway line and, not least, the Salmon Fishing Bothy at Lairwell. Considering all these points and the economics of different decisions the final crossing point was chosen.

Having done this the next step was to decide upon the span of the bridge, that is whether the river should be cleared in one complete span or in a number of spans with piers in the river. In order to consider this decision sensibly it was necessary to look at the types of vessels using the river. There are a number of small dredgers which use the river daily and there are also fairly large cargo vessels which use Perth Harbour. These are fairly common throughout the year but in September up to 50 in the month use the Harbour to transport grain to the Low Countries. Generally the cost of any bridge is directly related to the length of the main span, the longer the main span the more expensive the bridge. In this case, however, considering the size of the cargo vessels and the narrow river it was decided to cross the river in one span to avoid the possibility of collisions with the piers.

Consideration of the height of the biggest of the cargo ships likely to use the river determines the required clearance from high water level to the lowest point of the bridge over the river.

The site of the bridge, the size of the main span and the height above the water are thus determined. The loading produced by heavy vehicles is known, the loading produced by wind etc can be calculated so that all the information required to design the bridge has been obtained.

Before the bridge design is finalised many different alternatives are considered in order to obtain the most economical solution. Building materials of steel or concrete or a combination of steel and concrete can be used together with different types of bridges; an arch or cantilevered bridge or suspension bridge and so on. Preliminary calculations are carried out using different materials and based on different types of bridge. Usually from these preliminary calculations one type of bridge fairly rapidly shows itself as being the most economic and suitable for any one crossing. In this case, however, for various reasons, it was not possible to show clearly that either a steel or concrete bridge would be the cheapest so two final designs were made, one for a steel bridge, which in fact is the bridge under construction, and the other for a concrete bridge. This concrete bridge required more columns, 14 as opposed to the 8 of the steel bridge, and required cable stays



Plan of Perth By-Pass scheme.

to support the river span. This would be done by constructing towers on top of the river piers and supporting stays from these towers out to the centre of the span and anchor stays going back towards the land to balance these loads. As it happened this one turned out to be some 10% more expensive than the steel bridge and therefore the steel bridge was adopted for construction.

The steel bridge under construction consists of twin continuous steel box girders side by side, each girder carries a reinforced concrete deck and each deck carries one carriageway of the new road. The girders are 14′ 3″ wide and 10′ deep increasing to 25′ deep over the river piers where the stress is greatest. Each girder is supported on reinforced concrete columns and these columns are supported in pairs on large reinforced concrete base slabs. These slabs are founded on good material where this is near the surface and on groups of reinforced concrete piles where the good material is much deeper.

Construction

The construction procedure can be conveniently divided into three separate stages. Construction of the foundations and the columns; erection of the steel box girders and construction of the reinforced concrete deck which forms the roadway proper.

The first operation to be carried out was the excavation for the foundations of the columns. The ground in the vicinity of the river is flat and not much higher than the water level in the river at high tide. This means that when holes are excavated into the ground they rapidly fill with water to the level of the river making it necessary to form coffer-dams for the excavations near the river. These are formed from interlocking steel sheet piles which are driven into the ground to form a closed rectangle. The earth is then excavated from within this closed rectangle to form the excavation for the bases. Once this is done small pumps are installed and these easily control the water which seeps in and foundations can then be constructed in the dry.

The bases, which each support a pair of reinforced concrete columns, are generally $60' \times 30' \times 10'$ thick. These were founded on sound material where this was near the surface, mainly at each end of the bridge as the ground rises away from the river but as the columns reach towards the river the good material is much deeper and piles in these instances were driven through the soft material. These reinforced concrete piles were driven using a 4-ton hammer falling through 2′ and they were driven through the ground until they founded on bedrock below. At the first base to be piled, which was furthest from the river—the piles were driven about 30′ into the ground before they hit rock. At each base approaching the river the piles became deeper until at the river pier on the north side of the river the piles went to a depth of 150′ before they hit bedrock.

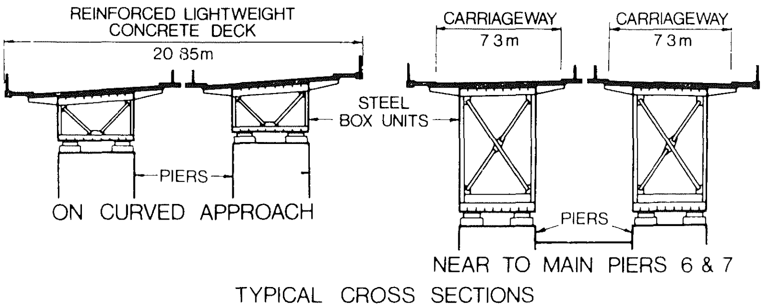
The number of piles at each foundation depends upon the load on the columns, at the large river piers which take the biggest loads there are 120 piles below the base. Each pile is designed to carry a maximum of 80 tons and to ensure that the piles would carry this load at least one pile at each foundation was tested to a load of 120 tons to give a safety factor of 50% on the load. Once the piles had been driven in and tested then the ends were cut off to a uniform level and the large base cast on top.

When the bases had been cast then the next operation was to construct the concrete columns on top. This was done using two specially made metal formers. These formers were 20′ high and each column was concreted in a series of 20′ lifts. The columns are approximately 100′ high giving five lifts in each column. Each pair of columns was constructed in tandem and the two shutters concreted all the columns throughout the job.

Whilst all this work on foundations and columns was in progress on site, fabrication of the box girders was in progress in the works. A box girder is simply a rectangular hollow steel tube and the bridge consists of two of these side by side. Each girder is fixed to concrete abutments at each end and temperature movements are allowed for at an expansion joint at approximately the mid-point of the bridge and this caters for movements up to 2′ 6″. The box girders were fabricated in the works in lengths of approximately 60′ and these were then welded together end to end on the site to form the continuous girders required in the design. Each unit was made up in the works completely finished including three of the five coats of paint. This reduced the work on site and avoided the expense of erecting on site a semi-permanent workshop.

The construction of a bridge of this nature nowadays is fairly straightforward, the use of modern large cranes and heavy lifting gear making the erection of 60′ long, 50 ton box girders relatively simple. The biggest difficulty with a steel box girder bridge is the sheer accuracy required in construction. The bridge consists of two steel box girders each ½ mile long constructed from separate units 60′ long. Construction started at each end of the bridge and the units were lifted into the air and welded together end to end. Any inaccuracies in any joint would rapidly be magnified as more units were erected and the accuracy required to ensure that the completed girders approaching the mid-point from each end actually met at the correct point in space was very high.

The individual box girder units are built in a series of straights even though the bridge is curved. The girders could be constructed on a curve but this would be very expensive and it is not necessary. The scale of the bridge is such that one cannot see the box girders are in a series of straights and in any case the concrete deck on top is built in a smooth curve which disguises the straights below. In order that the box units fitted together and formed the correct curve it was necessary to cut the end of each box unit in a horizontal direction to an accurate angle so that when these units were welded together end to end, they formed the correct chords of the correct horizontal circle. If this was not done accurately then the bridge would not land exactly on the concrete piers and it would of course completely miss the girder coming to approach it when it reached the mid-point of the bridge.



Cross-section of bridge construction.

Similarly, box girders were built in an upward vertical curve between concrete piers. This is because when the concrete deck is later cast on to the girders, the weight of the concrete causes the box girders to deflect. If the steel box girders were built straight between piers then the weight of the concrete would cause the girder to deflect and sag and although this would not affect the strength of the bridge it would look unsightly. So the amount the steel girders would deflect under the weight of the concrete was calculated and the girder was constructed upwards by this amount in a vertical curve so that after deflection the correct profile would be achieved. This vertical curve was made in the same way as the horizontal curve—the end of each box unit was cut accurately in the vertical direction so that the box girders, when welded together end to end, formed the correct chords of the correct vertical circle.

Also, as the bridge goes round the curve of the roadway the top of the box girder is super-elevated. This super-elevation changes around the curve and this also has to be catered for by a further accurate angle at the end of each box unit. So the ends of each separate box unit must be cut to a very accurate angle to cater for horizontal curvature, vertical curvature and super-elevation producing a complex problem in three dimensional geometry.

Unfortunately, as soon as a girder is erected and a joint welded a problem arises caused by weld shrinkage. When two pieces of metal are welded together end to end shrinkage occurs. This shrinkage can be calculated and in this case was in the region of ¼″ for each joint. Each box girder unit therefore was constructed ¼″ oversize so that after welding, the length of the bridge was correct. Unfortunately, this shrinkage, which is caused by the very high temperatures involved in welding, is not always consistant. So notwithstanding the tremendous accuracy in calculating and constructing the ends of the box units, errors do arise as soon as these units are welded. Consequently, after the erection of each girder unit, it was necessary to do a survey to see in which direction the box girder was pointing. If excessive shrinkage occurred on one side of the box girder for example then the whole box girder was pulled out of line in that direction and it was necessary to correct this error when erecting the next box girder unit. So the erection procedure tends to be a constant series of corrections in order to stay on or as near to the correct line as possible.

Here another problem arises. Surveys were carried out using optical surveying instruments—theodolites and so on—but unfortunately this could not be done during the hours of daylight. When the sun shines it shines on one side of the steel box girder—this automatically puts the other side in shadow—and one side of the box girder is therefore much warmer than the other side and this side therefore expands more than the other. This differential expansion causes the box girder to bend in a curve. We have surveyed box girders on this site on sunny days and found the end of the girder to be deflected 8″ off to one side, due entirely to the sunshine. So, obviously, it is impossible to do accurate surveying in this manner and we overcame this problem by doing surveys at dawn so that the box girder unit had all night to reach an equilibrium temperature. There was enough daylight to see by but not enough heat in the sun to cause the box girder to deviate and true directions could be determined.

In this way, by accurately constructing the box units to start with and by constantly correcting when errors occurred during erection, the correct shape and position for the completed girder was achieved.

Temperature causes further problems with steel bridges of this size. The box girders are each ½ mile long with a joint at mid-way and of course this length of steel expands and contracts a considerable amount. Any bridge is designed to work within a fixed temperature range. From the Meteorological Office Records a reasonable average yearly temperature is determined for the area in which the bridge will be built and this is used as the basic design temperature. From the records the highest summer and the lowest winter temperatures which are likely to be attained in the life of the bridge are obtained thus giving a working temperature range. From these temperatures the range of expansion and contraction the bridge will experience is calculated and everything is designed to work within these limits.

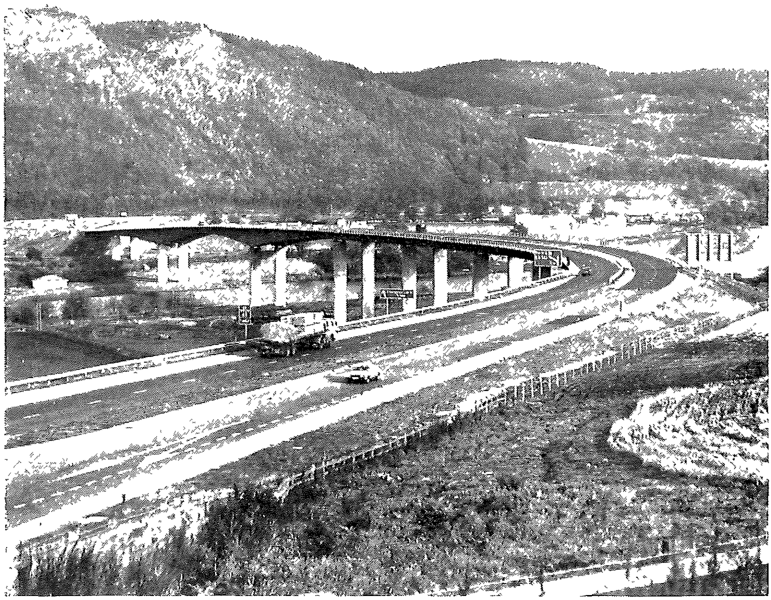
In the case of Friarton the steel girder is attached to the top of the concrete columns. As the girder expands or contracts the columns bend and the maximum movement of this is ± 15″ ie 15″ each side of the vertical. The columns are designed to be vertical at the design temperature and they will bend 15″ one way in winter and 15″ the other way in summer. The bridge is designed to work in this manner and once construction is finished then it will work as designed. However, during construction this is another factor which has to be taken into account. As the box girders are welded together end to end temperature is ignored until a pier is approached. When the box girder unit which will actually land on a concrete pier is lifted the temperature of the box girder is measured. The column is standing vertically as no forces are acting upon it and if the steel box girder is at the design temperature then all is fine and the box girder can be landed directly on to the pier. But if the temperature of the girder is not the design temperature then it is necessary to calculate its expansion or contraction from the design and then bend over the pier by that amount. The box girder can then be landed on to the pier and made fast. When the temperature next reaches the design temperature the column will become vertical again. It is most important that this is done correctly so that the columns do act as they have been designed, that is they are vertical at the design temperature and they bend one way in winter and the other way in summer by the prescribed amount.

The erection of the girders of Friarton Bridge was done in two parts—over the land a large crane, seated on the ground, lifted up the units and landed them on to temporary props which supported the weight whilst the welded joints were made. This, of course, could not be carried out over the river and here special lifting beams were used. These beams were supported on top of the partially completed bridge and they, by means of winches, lifted up completed box units from a barge floating in the water. The beam lifted up the girder unit and held it until the joint was welded. Once the joint was welded then the whole beam moved forward to the new end of the bridge in order to lift up the next unit, and in this way the whole of the box units over the river were erected and welded together.

All the welds were X-rayed in order to ensure that there were not inherent weaknesses in the welds.

After the box girders had been erected and welded small steel outriggers were bolted at 10′ centres along both sides of each girder. These were used to support the concrete deck. The main box girder is the spine of the bridge—on each side are bolted these small outriggers and over the whole is a reinforced concrete deck.

The concrete of this deck was formed of lightweight aggregate made from the residual ash from power stations. This gives a concrete which is as strong as ordinary concrete but only two-thirds of the weight. In this way economies can be made in the construction. If the reinforced concrete deck is lighter then the steel box girder does not have to support such a weight. Therefore it can also be lighter and if both the steel girder and the concrete deck are lighter then the columns need not be so strong and the foundations need not be so large. This saving in weight of the



View of the completed bridge from the South taken 8.11.78.

concrete deck is reflected throughout the whole structure and does provide a considerable economy.

The concrete deck is then waterproofed with hand-laid mastic asphalt which helps to prevent corrosion of the reinforcement in the concrete deck by prohibiting the ingress of water. On top of this mastic asphalt are placed kerbs and the roadway running surface of normal roadway bituminous material. A safety barrier along the central reserve and a parapet along the outer edge of each carriageway both of which are designed to withstand impact loading from highway vehicles complete the structure.

Acknowledgements

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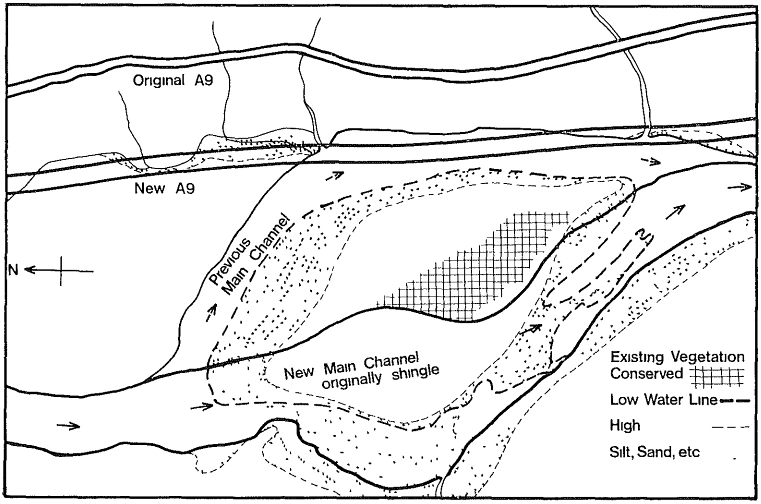
Botanical Conservation Work at Rotmel Island

A W Robson

The shingle habitats of a fast-flowing river like the Tay, particularly in its highland reaches, are complex in their substrata and plant communities, and consequently rich in species. Rivers, being seasonally varying volumes of water carrying stones, sand, silt and organic detritus, living and dead, and moving at different velocities at different times, are restless creators and modifiers of the lowest levels of valleys initiated during the Ice Ages. The materials they bear or roll along are deposited when the speed slackens, and secondarily removed to be re-deposited elsewhere downstream. Flooding, currents hastening over rapids, the deposition of large objects such as tree trunks, the exposure of belts of hard rocks etc all play their part. New channels therefore are constantly being gouged out as former ones are banked up or become silted back-waters. It is this element of continuous change which provides terrain of scientific value to the botanist. It is not generally appreciated that it is the natural stratification combined with the physico-chemical nature of the deposits that determine which species grow and where they grow. The range may be from single plants tolerating open, high and dry shingle-banks to those which fringe the quiet marshy hollows open to the skies or associated with willow and alder scrub. Deep sand deposits overlying the stony layers may ultimately carry natural forest, the most advanced of plant communities. Man has altered the natural picture moderately in the past and early efforts at containment are seen in the levees which, where not removed or breached, are still in evidence.

Rotmel Island (Nat Grid Ref 37/003463 OS Map 49) was first designated an SSSI (Site of Special Scientific Interest) by the Nature Conservancy in 1955 along with other similar sites on the Tay. I have endeavoured to illustrate the main motivation for these conservation measures above.

When the plans for the new A9 Dunkeld By-Pass were intimated to the Nature Conservancy Council the Assistant Regional Officer, Dr R A H Smith, notified me, and the Botanical Section thus became involved in a programme designed to offset potential damage to the SSSI. The topography at this point brought the projected line of the road well below the existing roadway and close to where the river's main channel cut east of the island. Inevitably a major containment became essential to ensure that the road foundations would not be undermined. Measures requiring a new channel to be driven through the island would dramatically modify the double bend formed by the river's own forces. In botanical terms, these would seem to indicate a diminution of the variety of habitats, a man-controlled re-laying of the shingle and almost certainly the loss of some interesting species.



Rotmel Island: Position of new A9 and new river channel superimposed on 1955 map of SSSI indicating former river beds and backwaters at low and floodwater levels.

From the beginning, co-operation between the NCC and the Scottish Development Department, the Contractor, and the PSNS was achieved. It was found possible to conserve intact a small but typical area of original shingle scrub which could thus act as a reservoir for natural regeneration of the "landscaped" area when operations were completed. This undisturbed vegetation was studied and listed for its constituent species in June 1975. It had been resolved between the NCC and Derek Lovejoy & Partners, the Contractors, before the excavation of the new river-bed, to remove the top shingle and retain it in a heap to be spread out evenly over the new riverbank, giving at least a chance for any viable seeds or plant fragments to survive and grow. A programme of seed collection was undertaken in August and September 1975 at Dowally Island, about a mile upstream, a similar habitat complex. Seeds selected were mainly of Nootka Lupin, Sea Campion, Field Mouse-ear Chickweed, but Northern Bedstraw, Wood Cranesbill, Burnet Saxifrage, Restharrow, and six other attractive species were included in a mixture. They were held in dry conditions until, over one and two winters, they could be sown in appropriate locations. The whole scheme was as carefully controlled as possible under the circumstances, some seeds being sown within the conserved area, while the bulldozers were still at work, and some on the relaid areas after the standard contractual sowing of Rye-grass and White Clover to "fix" the shingle, the whole to be allowed to return naturally and gradually to something resembling the original character of the SSSI.

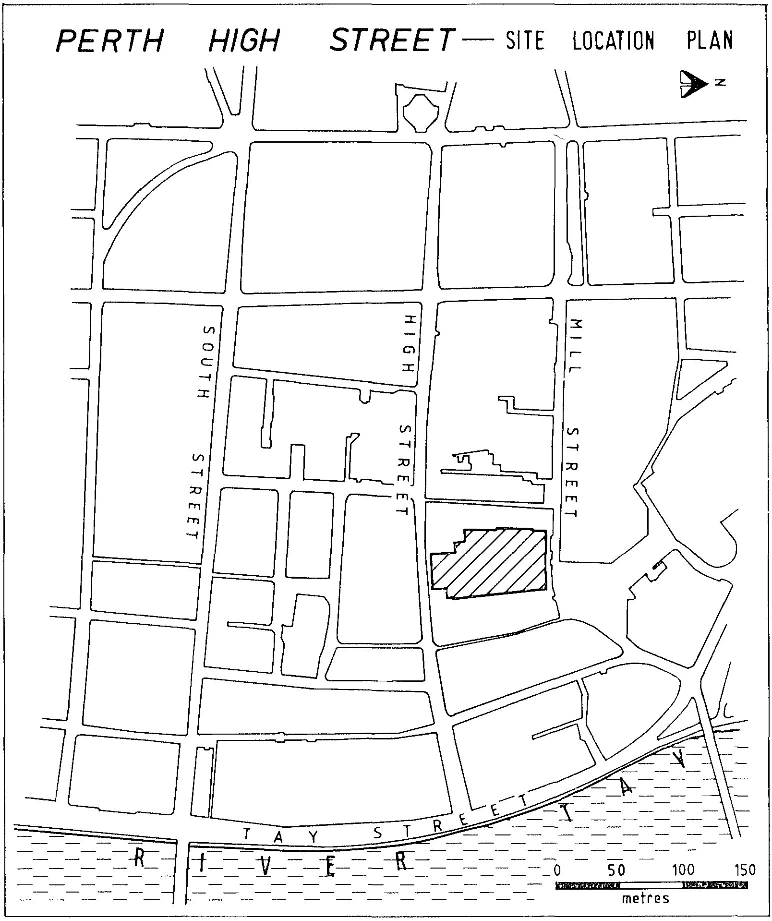
At the time of writing it must be said that the seasons 1978 and 1979 would have been too early to properly evaluate results. It will be many years before there is a complete recovery of the desired character; nevertheless an excursion in 1980 would provide an informative exercise in assessing the speed of recovery and the identification of the potential range of habitats which might develop naturally. The whole co-operative exercise has been immensely satisfying and demonstrates how, if conservation is built in to necessary progress of this kind at the outset, change and improvement may take place without loss of amenity or the extinction of our heritage of wild flowers, ferns, mosses and lichens or the places where they can flourish undisturbed.

The Perth High Street Excavation 1975-77

Nicholas Bogdan

Since the war, as a result of new building techniques and the use of plant, the mediaeval deposits of Perth have been increasingly destroyed during the course of urban redevelopment. In 1968, perhaps the first rescue excavation to be mounted in a Scottish burgh was carried out in George Street by the Perthshire Society of Natural Science (Archaeological and Historical Section). Unfortunately it was not until early 1975 that this was to be followed up. Then, largely because of increased interest in Perth's historical heritage, Miss Thoms of Dundee Museum directed an exploratory excavation at St Ann's Lane; substantial amounts of mediaeval pottery and organic material being recovered, confirming that in places at least Perth's mediaeval deposits remained intact to a remarkable degree. Meanwhile through the work of the Perth Archaeological Survey (which culminated in the publication in 1975 of an implications report "It will soon be too late"), it had become clear that a number of major sites were threatened. It was also realised that the size of the problem was such that it would require a full-time archaeological team. The Perth High Street Excavation Committee was consequently formed in 1975, with a brief to organise and administer a large-scale excavation on a site which Marks and Spencer Ltd were about to redevelop on the High Street.

Originally it was intended that this excavation should last for three months and be carried out by a team of twenty, but the advent of the Government's Job Creation Programme was eventually to allow the first season to be extended by ten months, and for a second season of six months. The expansion of the full-time workforce was commensurate, for it peaked during the spring of 1976 at sixty. Nevertheless the excavation would not have been extended had it not been for a delay in the redevelopment plans and the discovery that this site too was noteworthy for its deeply stratified mediaeval deposits and anaerobic soil conditions, which were to result in the recovery of considerable amounts of organic material. At first it had been expected that it would only be possible to trench parts of the large site. As things transpired it was possible to open up much larger areas, albeit only on a scale commensurate with the complexity of the site and the initial experience of many of the excavators.

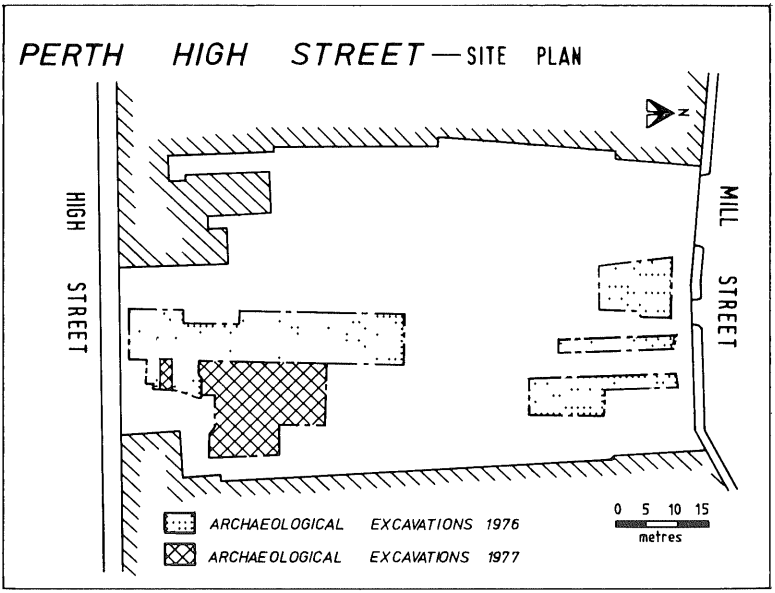


Site location plan.

As the demolition of the standing structures was not carried out until October 1975, it was decided to carry out a detailed architectural survey for although the buildings mainly dated from the eighteenth and nineteenth centuries, and were largely in a derelict condition, it was realised that they, like the archaeological deposits, formed an important part of Perth's historical heritage. Almost immediately the survey revealed that incorporated within the Masonic Hall, which had been built in the centre of the site in 1818, were substantial remains of the 'Old Parliament House', a typical example of a late sixteenth century L-plan townhouse. It had traditionally been associated with a meeting of the Scottish Parliament, possibly that which met in Perth in 1606. During the seventeenth century it had belonged to the Conquerors, perhaps the richest family then in Perth. In 1812, during the demolition of its south wing, John Duncan, a young chemist who was later to become famous as a pioneer in the production of anaesthetics, discovered an early fourteenth century hoard of approximately fifteen hundred silver coins. Unfortunately he illicitly converted most into bullion before using the proceeds to further his business interests. Perhaps surprisingly, during the course of the excavation only one mediaeval coin, a silver penny of William the Lion (1165-1214) was recovered. This lack seems to be a feature which the High Street shares with other urban excavations in Scotland. There is, however, modern and late mediaeval evidence that barter was particularly prevalent in Scotland, and it is possible that during the Middle Ages coins tended to be reserved for foreign trade. An interesting example of a trade token, decorated on one side with two stylised confronted 'peacocks' was also found. Similar tokens have been found during recent excavations at Ludgershall (Wiltshire), London and Dublin; and it has been suggested that they were intended for circulation by inn-keepers during the period immediately preceding the introduction of the farthing in England in 1279. During the second season, a fine example of a balance, which could, presumably, have been used for weighing coins and bullion, was discovered.

Although as much as two metres of archaeological deposits had been destroyed by nineteenth century cellars on both the High Street and Mill Street frontages, it soon became clear that even there, between one and two metres remained. On average the deposits were found to be about 3.5 metres deep, and dated in the main from c1140 until the mid-fourteenth century; only in places did later mediaeval layers survive intact. Even by the standards of York this seems an exceptionally rapid build up and it seems probable that during these first centuries a conscious effort was made to raise the burgh above flood levels. Perth has always been threatened by floods; in 1209 the bridge and royal castle were badly damaged, seagoing ships sailed in the streets and the elderly King of the Scots had to make a hazardous escape with a few courtiers in a small boat. During the excavation, evidence of Perth's seafaring traditions was forthcoming. Apart from the recovery of iron nails of a type used in ship and boat-building, timbers from a clinker-built boat had been re-used on one of the structures. In 1621 the recently constructed stone bridge was swept away with disastrous results on the burgh's economy for it was not replaced until 1772; in the intervening period the Tay could only be crossed by ferry.

Initially it was only possible to excavate in the north sector, but almost immediately a hitherto unsuspected ditch and robbed-out town wall (2.5m thick) were detected lying about 23 metres to the south of the known (but no longer visible) defences. The wall had been slighted, apparently only a short time after it had been constructed, and it had been extensively robbed, probably also in the fourteenth century. In the circumstances, it seems probable that this wall should be identified with that which Edward I was building in Perth in 1304. During both Wars of Independence the English used Perth as a forward supply base as Berwick upon Tweed, their main base, was too far south. While parts of Berwick's Edwardian defences still stand, no trace had hitherto been found of the wall with which Walter of Hereford, one of Edward's most senior master masons, surrounded Perth. Walter had previously spent a number of years working on the castle and town walls of Caernarvon.



Site plan.

Unlike most Scottish burghs, Perth appears to have had some defences by the twelfth century. No archaeological evidence of them was found, and it is probable that all trace had been destroyed during the construction of this newly-detected wall and ditch. In January 1313, King Robert (Bruce) personally stormed the town, massacring a number of the inhabitants and ordering the stone walls to be slighted. Nevertheless he later visited Perth, and during the last years of his life leased houses in the town not only for his doctor but also for his pet lion. In 1332 the town fell to Edward Balliol and the 'Disinherited' Anglo-Scottish lords, after they had defeated David Bruce's supporters at Dupplin. Although Balliol temporarily re-fortified the town with planks etc it was not until four years later that Edward III ordered the local monasteries to pay for the reconstruction of the walls in ashlar. It seems likely that the robbing of the newly-discovered wall belongs to this period, and that the original footings were not re-utilised because they were already being under-cut by the waters of the lade or town ditch. There was no evidence of a berm.

The wall had cut a number of thirteenth century features, including a stone-lined pit and an oven, which had partially subsided into another pit—possibly a well, that had been infilled with a considerable amount of animal hair, probably the waste product of the local skinners. An adjacent street is still called the Skinnergate, although during the twelfth century it had been called the Castlegate for it then led to the royal castle.

The recovery of more than five thousand leather fragments, many of them soles, indicates that the site probably included a cobbler's workshop. The leather finds also included garment pieces, belts and straps and a number of knife-sheaths, some of which were decorated.

Numerous wooden artifacts were found as a result of the exceptional soil conditions. These included an assemblage of turned wooden bowls and platters, and the staves of a number of bowls, barrels and buckets. In one place, a large barrel had been re-used to line a wall. Other notable finds included a well-used mason's mall, mallets, spades, a complete ladle, gaming pieces and even part of a vessel decorated with a face mask. The latter is perhaps unique, although it is noteworthy that a number of rather similar ceramic face masks were recovered. Although wooden vessels only rarely survive, in the Middle Ages they evidently were in everyday use. Even more exciting was the recovery of part of a stringed musical instrument—possibly a harp. Musical instruments have occasionally been found during English excavations, but this was still a most unusual discovery. During the early Middle Ages, the Scots were noted as harpists. A particularly pleasing discovery was a little round box complete with lid. Although it was empty, it may perhaps have been used as a money-box.

The recovery of parts of about thirty structures was one of the most important results of the excavation, for unlike England, very little was known, hitherto, about early burghal buildings. As it is believed that no existing Scottish townhouse dates from earlier than the fifteenth century, the evidence recovered from the site was particularly important, especially for the light it threw on the relationship between Scottish and English vernacular architecture. It now seems possible that the two traditions only diverged after, and possibly as a result of the political and social isolation resulting from the Wars of Independence. Certainly the structures examined which mainly dated from the twelfth and thirteenth centuries, were not unlike contemporary building from south of the Border, which is perhaps not surprising if one remembers that towns were an Anglo-Norman introduction into Scotland; Perth being one of the earliest as well as one of the most important.

The great majority of the structures were post and wattle buildings, which appear to have been aligned at right angles to the High Street and by the early thirteenth century extended at least 45 metres back, access to them being provided by a series of gravel paths. Comparatively little remained of the main structures on the street frontage. The flimsy ancillary buildings had evidently been used as workshops, storehouses, byres and stockpens of the type which can still occasionally be seen in mediaeval illuminated manuscripts and paintings. Only rarely were internal posts discovered, and it would seem that the hurdling, and sometimes planks, served merely as a screen wall against a load-bearing skeleton frame. Recently traces of similar buildings have been discovered in Aberdeen, and on the other side of the North Sea in Lund (Sweden) and Hedeby (W Germany).

From at least the thirteenth century the Scots had close contact with Scandinavia and the Baltic. In 1297 Wallace wrote to the Hanse Towns informing them that the Scottish ports were again open for trade. During the second season a grooved sill-beam of c14 metres length was discovered. Although vertical planks had been socketed into it, it too had belonged to a timber-framed structure. All that remained externally of one of the more recent structures, although it probably dated from the second quarter of the fourteenth century, was the low stone groundwall, which also would formerly have supported a timber-framed house. Contemporary buildings of this type are known from recent excavations in Dublin, Winchester, and York; and still occasionally survive intact in England. Even more surprising was the discovery of part of the foundations of an early fourteenth century stone house which had fronted onto High Street. Although no early houses appear to have survived above ground level in any of the Scottish burghs, there is documentary evidence for a contemporary stone house in Aberdeen. The excavation's historians discovered that Roger de Quincy, Earl of Winchester and Constable of Scotland (1195-1273), had a '*domus lapidea*' a stone house, in Perth during the reign of Alexader II (1214-1249). It now seems that stone, or at

Work on the site during the second season. The paving in the top left hand corner is the level of Bunch's Vennel, later Parliament Close, dating from c1300.

least partially stone, buildings were occasionally built in Scottish burghs from at least the early thirteenth century, although it was probably not until the late fifteenth century or even later that they became common.

Even with the more flimsy structures, a persistent problem had been subsidence which resulted from the large number of rubbish pits of various types and sizes that had been dug all over the site. More than 140 were discovered during the two seasons. So serious a problem did they pose, that in one place it had become necessary in c1150 to lay a 16 metre long section of horizontal hurdling as a path. Timber pathways are known from the low-lying excavations in Dublin (Eire) and Novgorod (USSR). During the Middle Ages wattling had a wide variety of uses. In places, as in Dublin, it had sometimes been used as flooring, particularly in areas which were subject to subsidence or undue wear.

It was, however, not only because of the structures that the High Street excavation was of note. The quantity, richness, and variety of the finds provided a unique and yet remarkably full picture of domestic and commercial life in an early Scottish burgh.

Clearly, the site had been occupied by the rich and important for many of the finds were exceptional; indeed the documentary evidence indicated that, from the mid fifteenth century at least, the site had included a number of Provosts and Bailies amongst its inhabitants. As usual the most numerous finds were sherds of pottery; over 57,500 were recovered. Most of it had been made locally, but it did include imported wares from SW France, E Yorkshire, Flanders, the Rhineland, N France, Germany and SE England. The detailed study of this, perhaps the largest corpus of mediaeval pottery so far to be recovered in Scotland, will inevitably be important for much of it comes from stratified occupation layers and pits. Most unusually a few of the approximately 3,500 contexts, excavated during the two seasons, can be precisely dated by resorting to documentary and dendrochronological (tree ring) evidence. A surprising result of the excavation was the discovery that the sequence of tree rings of oak from the site was similar to those from Northern Ireland studied by the Queen's University of Belfast; an indication, no doubt, that Perth and Ulster were subject to similar climatic fluctuations. Further information on the local climate is likely to be forthcoming from the abundant environmental evidence from the site. This forms the basis of an integrated research programme which it is anticipated will result in a great increase in our knowledge of Perth's palaeo-habitat. The botanic evidence is being studied at the University of Glasgow; while the entomology which may well provide additional information on the use to which different parts of the site were put, is being studied at the University of York. Research is also being carried out on the animal hair and bones. The latter, which are nearly as numerous as the pottery, are already providing most interesting new evidence on mediaeval dietary preference, animal husbandry, butchery practice, hunting and the natural environment. A feature of the site was the particularly large numbers of goat horn cores, which may indicate the presence of a horner. Rather more unusual was the recovery of samples of eggshell, including two unbroken eggs, and even feathers. The excavation of considerable amounts of animal hair, mainly cattle, were interesting especially as these can be supplemented by the yarn from the textiles found. Most of these were wool, although they also included instances of cultivated silk and goat hair. During the two seasons, approximately 300 samples of textile were discovered; thus forming one of the largest bodies of material to be excavated in Britain. It is fortunate that this corpus ranges from fine felted and dyed woollens to coarse open examples which may have been mats, blankets or something of this sort. Especially noteworthy was the recovery of three examples of lacis netting (a form of simple lace), dating from c1300. While contemporary examples are known from illuminated manuscripts and from burials in Burgos (Spain) and Marburg (W Germany), these from Perth appear to be the first examples to be excavated in Britain. One appears to be a hair-net while the others were probably furnishings.

The anaerobic soil conditions preserved a number of worked bone artifacts, which included examples of both double and single-sided combs. Perhaps the most remarkable find from the excavation was one of the bone knife handles; for it had been fashioned to portray a cloaked figure with leaf decoration around the head. Almost certainly it represents a 'Green Man' or 'Jack in the Green', a folklore figure associated with Spring. The carving of this beautiful, if rather sinister, piece invites comparison with the finest contemporary stone sculpture. Indeed the 'Green Man' motif is occasionally met with in ecclesiastical architecture. The handle, which had lost its blade, was found in what was possibly a metal-worker's workshop.

Although the site was marshy, nearly 2000 pieces of metalwork were recovered; much of it in surprisingly good condition. They included everyday objects such as examples of nails, buckles, barrel padlocks, keys of various types, shears, scythe and spade blades, horseshoes and even a curry-comb; a number of knives, some with their wooden handles still intact, also survived. Items of personal adornment included brooches, buttons, decorated pins, rings, strap buckles and even a pair of tweezers. Weapons were also found including fine examples of a battle-axe, a spearhead, arrowheads of various types and the handle of a sword. Fragments of chain-mail also remained. During both seasons a prick spur was recovered;

the earlier, which is of a transitional type that must date from c1150, being a fine example of romanesque metalwork. The other spur dates from c1300; perhaps appropriately the closest parallel being the spurs on the tomb effigy of Aymer de Valence, Earl of Pembroke, who of course took a prominent part in the first War of Independence. Indeed it was he who surprised and defeated Bruce at Methven in 1306. The most elaborate pieces of metalwork recovered were probably two ampullae or holy water flasks which must have been brought back from pilgrimages; one from Canterbury probably within fifty years of Beckett's death in 1171. St Thomas became so popular a saint north of the Border that the Scots besought his aid as well as that of St Andrew before the battle of Bannockburn. The other ampulla, which was recovered during the second season, is shaped like a church, but it has not yet been possible to determine its source. A pilgrim badge depicting the crucifixion of St Andrew was also found; it had presumably been brought back from St Andrews, the metropolitan church of Scotland.

The 'Canterbury Ampulla' showing the mitred figure of Thomas Beckett. It probably dates from the late twelfth century, shortly after Beckett's death in 1171.

The 'Second Ampulla'. Although its source is not known, it appears to show the coronation of the Virgin Mary and may have come from Walsingham.

One of the rarest types of find were two small 'purse' shaped tokens; one of which was decorated with the Paschal Lamb, a sign perhaps significantly associated with St John the Baptist, Perth's patron saint. During the last century, tokens like these were recovered from the River Seine; they seem to have been sold as souvenirs at mediaeval trade fairs.

The 'St Andrew Pilgrim Badge'. St Andrews was the metropolitan church of Scotland and Perth lay within the diocese of St Andrews.

An overriding impression stemming from the excavation was that some at least of the early townspeople had been remarkably cosmopolitan, and yet conversely they had also pursued in some ways a rural economy in an urban context. Nevertheless the richness and variety of the finds did much to confirm that in many respects Perth had been the *de facto* capital of Scotland during the early Middle Ages. Indeed it is interesting to compare it and Scone's position and role with that of the City of London and Westminster in mediaeval England.

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The Spread of the Great Crested Grebe *(Podiceps cristatus)* as a Breeding Species in Perthshire

Valerie M Thom
Euan D Cameron

The first recorded breeding of the Great Crested Grebe in Scotland occurred at Loch of Lowes, Dunkeld, in 1877. Since then the species has colonised most Scottish counties from Aberdeenshire and Argyll southwards. In Perthshire, which holds nearly one third of the Scottish population, it is now found on almost all the lochs which fulfil its ecological requirements. These appear to be basically a depth of 10-15 feet or less, in at least part of the available water area; an adequate food supply, which is almost certain to be present in a loch of this depth; and reed-beds, or other suitable cover, for nesting. At the first census of Great Crested Grebes in 1931, the county population was assessed at 30-32 adults. By 1965, when the census was repeated, the estimated population—65-84 adult birds on 20 different waters—had more than doubled. However, a further census in 1975 showed that numbers in Perthshire had hardly increased at all over the intervening ten years.

Breeding records now exist for 26 waters, and birds have been noted during the breeding season on a further six. These waters are listed in the Table, together with the date of the first known breeding and the number of pairs present in 1931, 1965 and 1975. Nearly half of these lochs are less than 250 feet above sea level, and most of the remainder lie between 250 and 500 feet. The highest altitude at which breeding has occurred in Perthshire is at 900 feet on Loch Ordie (where the species no longer occurs), while two other lochs, Redmyre and Laird's Loch, are over 700 feet up. Apparently suitable waters on which grebes have not yet been recorded, but where they may well appear in the future, include King's Myre, White Moss, Loch Voil and Dunalastair.

The 1965 census was carried out largely because relatively high residues or organochlorine insecticides had been found in Great Crested Grebes. The census results showed that, contrary to what might have been expected, the grebe population had increased substantially in both Scotland and England. It has been suggested that the increase in England is associated with the creation of many new reservoirs and gravel pits, but this explanation is not, of course, applicable to Perthshire.

As mentioned above, the 1975 census indicated that, in Perthshire, numbers had remained almost static. Four waters occupied in 1965 had been abandoned, but four new ones colonized. It is interesting to note that the two lochs holding most pairs in 1965—Lake of Menteith and Butterstone Loch—had both lost most of their breeding pairs by 1975, and both have come under increased pressure from angling and general recreational use; furthermore, of the four waters colonized between those years, Loch Freuchie, Butterstone Mill Dam and Glenfarg Reservoir, are less easy of access to the general public and are also at altitudes of over 500 feet. This indicates that the Perthshire breeding population of Great Crested Grebes may have stabilized its numbers, but is having to readjust its distribution to avoid human disturbance during the breeding season.

Because of worries that the Great Crested Grebes dying as a result of oil spillage in the Firth of Forth in early 1978 may have been Scottish breeding birds, the Scottish Ornithologists Club organised a breeding season survey for this year. The results of this for Perthshire indicate that local birds were not involved in this pollution disaster.

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Perthshire Lochs for which Records of Breeding Great Crested Grebes exist

Loch	First recorded breeding	Number of pairs present 1931	1965	1975
Lowes	1877	nil	4	5
Menteith	1896	1	7	3
Dupplin	1903	2	3	4
Clunie	1904	1	3	5
Drummond	pre-1905	no data	1	1
Watston	1906	no data	1	nil
Butterstone	1910	nil	5+	1
Ochtertyre	c1911	1	1	nil
Craiglush	pre-1912	nil	2	2
Redmyre	1912	nil	One bird	nil
Marlee	1912	2	2	1
Lubnaig	1912	1	nil	no data
Ordie	1920	no data	nil	no data
Doine	1927	no data	nil	no data
Methven	1931	1	nil	no data
Rae	1931	1	1	one bird
Stormont	1931	2-3	1	8
Rusky	1931	1	nil	no data
Balloch	1965		1	1
Fingask	1965		1	nil
Stare Dam	1965		1	2
Laird's Loch	1965		1	nil
White Loch Blairgowrie	1975			1
Freuchie	1975			1
Butterstone Mill Dam	1975			1
Glenfarg Reservoir	1975			1

Summering, but no breeding records, also exist for Monk Myre, Mahaick, Carsebreck, Seamaw, Old England, Glack and Abercairney.

The History of Ospreys in Perthshire

Maurice Drummond

There is no doubt that in past times Ospreys were present and breeding in Scotland in abundance. Reliable and accurate records of their presence and breeding sites are few until last century. By that time the Highland Clearances had changed the use of the countryside and led to the formation of large 'sporting' estates and extensive sheep farming. Ospreys were shot as a sporting achievement and their nests were systematically robbed of their eggs by collectors. The result was the extermination of the Osprey in Scotland by the end of last century.

Macgillivray writing in his History of British Birds in 1840 says that Loch Tay was 'a residence of the Osprey'. Jardine in 1841 says the Osprey used to breed on the Isle of Inchmahone in the Lake of Menteith until scared by repeated plunder of their nests they deserted the Lake. Harvie-Brown writing in 1906 says the Osprey was known to breed in the Rannoch area. The same writer records that a pair of Ospreys attempted to breed on Loch Ordie in 1886 but the female was shot, and in 1887 another was shot in that area.

The Loch Ordie Ospreys were both shot by an Atholl gamekeeper. The 1887 bird was stuffed and is in Blair Castle. The eyrie was taken down and given to Perth Museum, where it can still be seen. One of the men who helped to cut down the eyrie was a young forester who later became an Atholl gamekeeper whose beat covered Butterstone and Craiglush and the Loch of the Lowes. It was in the late 1960's that Ospreys began to appear again over these Lochs. This is ideal Osprey country with shallow lochs containing pike and perch, and suitable Scots pine trees for nesting, with dead pines near by for perching on.

In the first week in April 1969 a male Osprey appeared, a month after the Loch of the Lowes had become a reserve of the Scottish Wildlife Trust. He was joined in early May by a female, and during that summer they built an eyrie on a slender 90 feet pine tree at the west end of the Loch. The nesting tree swung in the wind and it was feared that the eyrie could easily fall or the eggs roll out of the nest. To prevent this the tree was secured with four guy-ropes in the early spring of 1970. The birds returned in April 1970 and laid two eggs. In spite of the guy-ropes one end of the eyrie was blown down in a gale and the eggs were lost. That pair of Ospreys built only one 'frustration' eyrie during the summer, on a much more sturdy pine tree at the south-west corner of Craiglush Loch.

In the following Spring, before the return of the Ospreys in 1971, a device was erected to foil egg collectors. This was a steel collar round the tree some 18 feet from the ground. From this collar were attached five downward sloping five feet long steel bars, interlaced with barbed wire. The Ospreys returned that year and successfully bred two young. In 1972 the birds again returned to the same eyrie and there was another successful breeding.

In 1973 a female Osprey arrived first and instead of using the eyrie of previous years she carried sticks and began to build a new nest on a small Pine between Craiglush Loch and the Loch of The Lowes. She was joined by a male. Again eggs were laid and successfully hatched. A pair of Ospreys hatched two young in the same eyrie in 1974. In 1975 a pair of Ospreys were present throughout the summer but did not breed. The weather in April and May was very cold. The birds were in poor condition and showed no interest in nest building until August when they carried sticks to the eyrie.

In the first week of April 1976 two Ospreys arrived and began repairing the eyrie. The male was an unusually shy bird, and as a result of being disturbed by a man with sheep among the trees at the west end of the loch, he disappeared. Another male took over and was joined by a second female. For the next eight weeks there were two females and one male at the site. The females took turns at incubating and often sat side by side on the eyrie. The male would bring in a fish, give it to one of the females who would then feed the incubating female. It was expected that the eggs would be infertile as no mating appeared to have taken place. The birds left the eyrie after seven weeks of trying to incubate the eggs. Two days later the nest was inspected and no eggs found. They had probably been taken by crows. The birds disappeared in July and did not build frustration eyries in the Loch of the Lowes area.

In 1977 there was another very cold Spring. Although birds were present in the area and often seen, no nesting occurred.

In 1978 the first bird did not arrive until 19 April. The eyrie was rebuilt and the female was seen to be carrying moss to it. It looked as if she was going to lay but on 7 May she disappeared. It is not known what happened to her. On 2 June a new pair of birds arrived and remained until 6 September carrying sticks to the eyrie.

In 1979 the same pair of birds arrived and the eyrie was rebuilt by the end of April. The female was a young bird and did not lay eggs until 12 May. Two young Ospreys were successfully hatched. All the previous Loch of the Lowes young birds flew for the first time 52 days after hatching. The 1979 birds first flew together on the 57th day from hatching and did not leave for Africa until 20 September. They were ringed before they left.

The Loch of the Lowes Ospreys are looked after by the Perthshire Branch of the Scottish Wildlife Trust, assisted by members of the Perthshire Society of Natural Science who act as part-time Voluntary Wardens. During the nesting and incubating period the tree is guarded 24 hours a day. The young birds are ringed with the assistance of the Highland Officer of the Royal Society for the Protection of Birds, whose advice is available on problems of management that may arise. In 1979 some 20 breeding pairs of Ospreys were recorded in Scotland, but for the protection of the birds the only sites publicised are the Loch of the Lowes and Loch Garten in Inverness-shire. The Osprey is now a protected bird in this country but its eggs are still sought by unscrupulous collectors for financial gain, hence the need for secrecy of the nesting sites. The Scottish Wildlife Trust's observation hide at the Loch of the Lowes allows a clear view of the present and past eyries. It was built in 1970 and since then 400,000 visitors have visited the hide and the Visitors' Centre, most of them to see the Ospreys.

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