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HOME RANGE AND HABITAT USE BY THE ENDANGERED GREY PARTRIDGE (*Perdix perdix*) IN THE IRISH MIDLANDS

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ABSTRACT

O'GORMAN, E.C., KAVANAGH, B. and ROCHFORD,J.: HOME RANGE AND HABITAT USE BY THE ENDANGERED GREY PARTRIDGE (*Perdix perdix*) IN THE IRISH MIDLANDS: The last potentially viable population of native Irish Grey Partridge (*Perdix perdix*) is located over a 25 km^2 area at Boora bog, Co. Offaly, in the Irish midlands. The habitat is a mosaic of cutaway bogland, coniferous forestry, newly created farmland and wetlands. Since 1996 a combination of predation control and the provision of habitat strips has been the focus of conservation efforts in Boora in an attempt to increase partridge numbers in the short-term. The aim of this study is to provide baseline information on partridge movements and habitat use in the conservation site. The result of two years fieldwork is presented. An area of 18 km^2 was mapped during the course of fielwork. Nine male birds were radio-tracked. The biological time periods (B.T.P.) calculated for breeding pairs were Exploration, Prelay, Lay, Incubation, Brood rearing, Primary and Secondqary covey movements. The home range varied in size and location from one B.T.P. to the next. This was linked to habitat availability. Breeding attempts occurred in young forestry plantations and newly created habitat strips within the cutaway bog area. The coveys left the cutaway bog area in late summer to feed on nerby pasture. A second movement in late Autumn was made to utilise winter stubbles on adjacent farmland. Birds returned to breeding sites in the cutaway bog area the following spring. The practical applications of the findings to the conservation effort are discussed.

1. INTRODUCTION

The Grey Partridge (*Perdix perdix*) is currently listed as an „endangered" species in Ireland (WHILDE, 1993). The partridge is now limited to two populations in the Irish Midlands (KAVANAGH, 1997). Both populations, one in Lullymore, co. Kildare, the other in Boora, Co. Offaly are associated with areas of citaway bogland.

A radio-tracking study was conducted from 1992-94 in Lullymore to give a greater understanding of the role played by cutaway bogland in partridge ecology (HEARSHAW, 1996). During this study the local partridge population did not increase despite management measures and the national population continued to decline (KAVANAGH, 1995). It became clear that the species was at risk of extinction. A project was initiated in 1996 in an attempt to

preserve the species from further decline (KAVANAGH, 1998). The conservation effort focused on the larger population in Boora with a combination of predation control and habitat management.

The present radio-tracking study began in March 1997. The objective was to monitor the movement patterns and habitat use of birds within the conservation site. Most partridge radio-tracking studies have used time periods based on pre-determined calender dates. These dates are chosen by the researcher rather than being influenced by changes in the requirements of individual partridge. Examples include 1-2 month intervals (MCCROW, 1977; SMITH *ET AL*, 1982), seasonal, ie. winter and spring (CHURCH, K.E., 1990) and spring & summer (BIRKAN et al, 1992; CHURCH, 1995) time periods. Other radio-tracking studies have focused only on particular times of the year such as the breeding season (CARROLL *ET AL*, 1990; CHURCH, 1994; ENCK, 1990; RANDS, 1986a) or other specific time periods (CHURCH *ET AL*, 1980; KAISER, 1995; REITZ and MAYOT, 1998; THOMAIDES *ET AL*, 1995). In this study an attempt was made to follow birds through an entire year.

2. STUDY AREA, MATERIALS AND METHODS

Much of the study area (**Figure 1**) was once covered in raised bog (BELLAMY, 1986). Peat harvesting of the raised bog was carried out on a large scale by the semistate body „Bord na Mona" since the 1940's. Once the layers of peat have been removed the resulting area is termed cutaway bog. Some of this cutaway bog has been left idle for up to 25 years, and natural recolonisation by a widw variety of flora and fauna has taken place (KAVANAGH, 1990).

Farmland is found on „mineral islands", areas of calcium rich moraine deposits, such as eskers, at an elevation slightly above that of the surrounding bog. In recent years there has been significant reclaimation of cutaway bog in Boora. Wetlands, conifer plantations and commercial grassland have been created depending on local conditions (MACNALLY, 1998). Trapping of partridge began in March 1997. A farm-reared partridge was used as a decoy to trap wild birds in a funnel entranced cage trap. Several birds were caught at night with a net and lamp as they roosted on the ground. Using a tape recording of a jeep on approach resulted in a 100% attempt/catch ratio (W. KAISER pers. comm.). Only male birds were fitted with radio-transmitters. Leg rings were attached to female birds caught. Birds were weighed and in several cases feather and blood samples taken for future DNA analysis.

Figure 1: Map of the Grey Partridge study area in Boora, Co. Offaly, 1997-1998.

The transmitter was attached to the bird around the neck with a cord. A knot was tied in the cord at the required fit and super-glue applied to this knot. The transmitter sits snugly against the feathers of the upper chest and the whip antennae extwnds behind the bird's head. This necklace desing has been used in previous partridge studies (BIRKAN *ET AL*, 1992; BRO *ET AL*, 1998; HEARSHAW, 1996; KAISER, 1995) and on other ganebirds (MARCSTROM *ET AL*, 1989; WILLEBRAND *ET AL*, 1990). Biotrack Ltd., U.K supplied the 10g TW-3 radio-transmitter. It has a ground-ground range of 1-3 km and a transmitting life of 7-9 months. The signal was recived on a mariner 57 receiver and hand-held Yagi 3-element aerial

Radio-tagged birds were located 1-2 times daily with radio-fixes at least 5 hours apart. At each radio-fix the date, time, weather, habitat type, location and other relevant details were recorded. In many cases visual observation of birds was possible. When the accuracy of a fix was undetermined between two habitat types, triangulation was used or the

area was searched for droppings after the bird had left. During the breeding season care was taken to minimize disturbance due to the risk of observerinitiated corvid predation (HAMMOND and FORWARD, 1956; KAVANAGH, 1995; MACINNES and MISRA, 1972). All rado-fixes were calculated by triangulation during this time.

3. DATA ANALYSIS

The concept of a home range has been defined and refined by several authors (BURT, 1943; MOHR, 1947; JEWEL, 1966; BAKER, 1978). A home-range consists of a restricted area within which an animal moves when performing its normal activities. Stating the time period over wich a home-range is measured should be fundamental to the definition of a home-range (MORRIS, 1980).

Home range and habitat use for each time priod were calculated using Ranges V (KENWARD, 1996). Habitat preferences were analysed using Compositional Analysis (AEBISCHER and ROBERTSON, 1992; AEBISCHER *ET AL*, 1993).

In this study an attempt was made to monitor the movements of birds through a complete year. During the course of fieldwork a number of distinct time periods became evident. These have been coined „Biological Time Periods' (B.T.P.) as they are based on breeding behaviour and movement patterns of the birds being followed as opposed to simple calender periods.

The biological time periods calculated for breeding pairs in this study were exploration, habituation, lay, incubation, brood-rearing, primary and secondary covey movements.

Exploration: first described by CHURCH *ET AL*. 1980, when radio-tracking pre-nesting pairs in Wisconsin, U.S.A. A similar movement pattern was discovered in the previous Irish study (HEARSHAW, 1996) and in this study. This involved large movements across the study area by the newly formed pair with no obvious center of activity.

Prelay: began when movements of the pair became more restricted to an area in which the eventual nest site was initiated. Similar movements were described by CHURCH et al. 1980, as habituation and was termed prelay in the HEARSHAW study.

Lay: this was the time period during which the hen was laying eggs in the nest. At this time the hen is only present at the nest for 2% of the time all visits being during the day (FANT, 1953). An average of one egg is laid every 1.4 days (POTTS, 1986).

Incubation: this time period referred to the duration the hen was incubating the clutch of eggs. At this time the hen is present at the nest for 90% of the time, all absences being during the day (FANT, 1953).

Brood-rearing: begins when the chicks hatch. The movements of the parents and brood were restricted in this study until the chicks reached 5-7 weeks. A number of sudies have investigated movements during brood-rearing (CARROLL *ET AL*, 1990; CHURCH, 1980; GREEN, 1984; RANDS, 1986a).

Primary covey movements: this time period began with a sudden movement by the covey out of the brood rearing area in the late summer. This time period was first described in this study and may be unique to Irish partridge behaviour.

Secondary covey movements: a sudden movement out of the previous home range in autumn to an new area in which the civey remained through the winter.

Within each B.T.P. home ranges were calculated using Multiple Convex Polgon (MCP), Harmonic mean analysis (HM) and cluster analysis (CL). A full review of these and other techniques is given in HARRIS *ET AL* 1990 and KENWARD 1996. The habitat type at cach radio-fix was recorded during fieldwork. The percentage habitat use was indicated by the proportion of radio-fixes occuring in each habitat type in a given B.T.P.

Habitat preferences were calculated by comparing habitat use with habitat availability. There have been many publications on analysis techniques (BYERS *ET AL*, 1984; FREIDMAN, 1937; JOHNSON, 1980; NEU *ET AL*, 1974). The advantages and limitations of these are discussed in ALDRIDGE and RATTI 1986, 1992. This study used the technique of Compositional Analysis (AEBISCHER and ROBERTSON, 1992; AEBISCHER *ET AL*, 1993). The habitat proportions are transformed into log ratios, thus rendering each proportion independent from the rest. The analysis of data produces a ranking system from most preferred to last preferred habitats.

Two levels of analysis were used to define habitat preferences within a biological time period

1. **MCP Vs STUDY.** The proportion of habitat types contained within the home range (MCP) are compared with the availability of each habitat type in the study area.

2. **USE Vs MCP.** The proportion of radio-fixes in each habitat type compared with the proportion of habitat types available within the home range (MCP).

4. RESULTS

Fieldwork was conducted continously from March 1997-October 1998. Nine male birds were captured and fitted with radio-transmitters, five in 1997 and four in 1998. Sufficient data for detailed analysis was obtained of movements and habitat use of three birds. The three birds, two paired (one pair in each year) and one unpaired male, were tracked for a period of between 8-10 months each.

An area of 18 km^2 was mapped during the tracking period with thirteen main habitat types identified. The size of these habitats varied greatly with grassland, tall forestry and cutaway bog being the three largest (**Table 1, Figure 1**).

The majority of the grassland consists of cattle and sheep pasture, with many fields taking silage or hay in the summer. Forestry refers to conifer plantations and naturally regenerated mixed willow (*Salix* spp.) and birch (*Betula* spp.) woods on cutaway bog. Tall forestry in classified when the average height is over 2m and the canopy has become closed with no ground vegetation except rushes (*Juncus effusus*). In contrast young forestry (<2m) areas contain an open canopy with a diversity of herbaceous plants and grasses. Edge refers to roads, railways (for transporting peat) and the ungrazed/unploughed portions of agricultural land. Tillage contains spring sown oats and barley with stubbles left over the winter and various root crops. The habitat strips were planted in the central cutaway bog area in the study area (**Figure 1**) adjacent to railway lines. Nesting and brood rearing cover were provided with seed mixes recommended by the Game Conservancy.

Table 1: Habitat availability (decreasing order) in the Grey Partridge study area in Boora, Co. Offay, 1997-1998.

	Boora in 1997		**Boora in 1998**	
Habitat	**Hectares**	**%**	**Hectares**	**%**
Grassland	492	27,0	489	26,8
Tall Forestry	371	20,3	371	20,3
Cutaway Bog	364	20,2	364	20,0
Edge	112	6,1	112,44	6,2
Handcut Bog	97,4	5,3	97,4	5,3
Tillage	91,6	5,0	94,1	5,2
Drains	83,01	4,6	83,01	4,6
Heather Top	66,2	3,6	66,2	3,6
Young Forestry	60	3,3	60	3,3
Hedgerows	36,5	2,0	36,5	2,0
Lakes	21,99	1,2	21,99	1,2
Habitat strips	19,7	1,1	19,7	1,1
Buildings	7,87	0,4	7,87	0,4
Total	**1823,27**	**100**	**1823,27**	**100**

Home range calculation

A summary of the biological time periods (B.T.P.) with various details and home range calculations is given in **Table 2** for a breeding pair in 1997 and 1998. No home ranges could be calculated for exploration as both birds were captured at the end of this B.T.P. The early stage of the „secondary covey movements" time period in 1998 was similar to 1997 but was not completed due to predation. A visual representation using 90% Harmonic Mean Analysis is given (**Figure 2**.) to illustate the successive locations of home ranges in each B.T.P. in 1997. A similar pattern was evident for pair m6 in 1998.

Figure 2: Home range calculated during each Biological Time Period using 90% Harmonic Mean Analysis for a pair of Grey Partridge in Boora, Co. Offaly in 1997.

Habitat use

The precentage habitat use was indicated by the proportion of radio-fixes occuring in each habitat type in a given B.T.P. (**Table 3**.). Changes in the size and location of home ranges from one B.T.P. to the next are linked to changes in habitat use. Birds used a high proportion of cutaway bog and young forestry during prelay. Young forestry predominated during lay, incubation and brood rearing in 1997. In 1998 a combination of young forestry, cutaway bog and habitat strips were used. Once the covey moves away from the brood rearing area (primary covey movements) a switch to open pasture is evident with less time spent in young forestry, cutaway and handcut bog than in the prelay. The covey moves again to exploit winter stubbles (tillage) as they become available. This is during the secondary covey movements B.T.P. in late autumn and winter. A similar proportion of pasture is used as before. Individual birds return to the cutaway areas during covey break-up the following Spring.

Table 2: Summary of radio-tracking data collected for a pair of Grey Partridge in Boora, Co. Offaly in 1997-1998.

	Start date	**Finish date**	**No. days**	**Fixes**	**MCP**	**HM 85*, 90**	**CL 90*, 95**
Prelay							
1997	16-Apr-97	15-May-97	30	27	80,7	57,8	6,9*
1998	24-Mar-98	3-May-98	41	35	19,5	10,9	9,8
Lay							
1997	16-May-97	5-Jun-97	21	21	8,2	2,5	1,4
1998	4-May-98	25-May-98	21	17	20,4	14,2	5
Incubation							
1997	6-Jun-97	30-Jun-97	25	26	5,5	3,1	0,8
1998	26-May-98	19-Jun-98	25	25	6,7	3,2	3,4
Brood rearing							
1997	1-Jul-97	19-Aug-97	50	41	5,1	5,6	3*
1998	20-Jun-98	26-Jul-98	37	31	13	5,8	1,1
Primary covey movements							
1997	20-Aug-97	6-Nov-97	79	50	77,4	68	16,8*
1998	27-Jul-98	27-Sept-98	63	67	68,1	41,9	32,3*
Secondary covey movements							
1997	7-Nov-97	22-Jan-98	77	28	91,9	63,8	14,4*

KEY: Fixes = number of radio-fixes recorded during B.T.P.
MCP = Home range size calculated using Multiple Convex Polygon
HM = Home range size calculated using 85 or 90% Harmonic Mean Analysis
CL = Home range size calculated using 90 or 95% Cluster Analysis.

Table 3: Percentage of radio-fixes recorded in each habitat type for all B.T.P.s for a Grey Partridge pair in Boora, Co. Offaly in 1997-1998.

	Prelay		**Lay**		**Incub.**		**Br. Rear.**		**Pr. Cov.**		**Sec. Cov.**	
YEAR	**97**	**98**	**97**	**98**	**97**	**98**	**97**	**98**	**97**	**98**	**97**	**98**
Cutaway bog	29,6	32,6		29,4		88		25,8	10	22,4	3,6	
Handcut Bog	3,7	4,7							18		3,6	
Heather Top	3,7											
Tall Forestry												
Young Forestry	63	41,9	95,2	64,7	92,3		100	67,7	16	16,4		
Grassland		9,3			7,7				48	44,8	46,4	
Tillage											42,9	
Habitat strips		4,7		5,9		12		6,5		6		
Edge		7	4,8						8	10,4	3,6	

Table 4: Ranking of habitat preferences in all B.T.P.s for a Grey Partridge pair in Boora, Co. Offaly 1997-1998.

	MCP Vs TOTAL	USE Vs MCP	MCP Vs TOTAL	USE Vs MCP
	1997	1998	1997	1998
Prelay	YF, C, Hab	YF, HB, HT	YF, C, D	Hab, YF, C
Lay	YF, G, D	E, YF	YF, C, Hab	YF, Hab, C
Incubation	YF, G, D	YF, G	Hab,C, YF	Hab, C
Brood rearing	YF	YF	YF, Hab, C	YF, Hab, C
Pr. Cov. Mov.	YF, G, HB	E, HB, YF	YF, G, C	Hab, E, YF
Sec. Cov. Mov.	T, HB, G	C, T, E		

KEY: YF = Young Forestry C = Cutaway Bog Hab = Habitat strips
G = Grassland D = Drain HB = Handcut Bog
T = Tillage E = Edge

Habitat preferences

Habitat preferences were calculated by comparing habitat use with habitat availability as described in the Data Analysis section. The most preferred habitats are presented in ranking system in **Table 4** fot both MCP Vs. STUDY AREA and USE Vs. MCP. Where greater than there habitat types were involved only the top three ranks are shown. Young forestry, habitat strips and road edge were the most frquently preferred habitats during B.T.P.s up to primary covey movements. A preference was shown for winter stubble fields in the secondary covey movements B.T.P. in 1997.

5. DISCUSION

A pattern of home range and habitat use by partridge became evident during this study. Following a period of exploration and habituation (CHURCH *ET AL*, 1980) the pair selected a nest site within the cutaway bog one in young forestry, the other in habitat strips. Once a nest site was chosen there was a contraction in home range size corresponding to laying, incubation and brood rearing.

After several weeks of brood rearing the covey suddenly expanded the home range to explore new areas containing open pasture. A second movement then occured incorporating areas of winter stubbles away from the cutaway bog. In late winter coveys returned to the cutaway area where pair formation occured.

The biological time periods used in this study to examine the changes in home range and habitat use over the year for each individual have been more informative than if calender dates were chosen instead. Calender dates can mask stuble changes in habitat use. It is recommended that future radio-travking studies should investigate the possibility of also applying this technique to their radio-tracking data.

It is the reduction of suitable nesting and brood rearing cover on modern farmland that has contributed to the decline of the partridge population in England (POTTS, 1980; 1986). Residual cover within the cutaway bog area has provided breeding habitat in this and the previous Irish study (HEARSHAW, 1996). The remaining two populations of wild partridge in Ireland occur in areas containing large areas of cutaway bog (KAVANAGH and AEBISCHER, 1997). In the Lullymore study (HEARSHAW, 1996) recolonised areas within the cutaway bog were selected as nesting sites while the birds followed in this study preferred the cover

provided by young forestry and habitat strips planted on cutaway areas. In Hungary partridge have also chosen forestry belts as nest sites (FARAGÓ, 1995). However, young forestry only provides a good breeding habitat in the first few years of growht after which it is avoided when the canopy closes.

CHURCH 1984a and KUGELSCHAFER et al. 1995 provided data indicating that birds prefer to breed in locations used the previous year. Our data also indicated That birds returned to breeding areas. These occured in cutaway bog areas. It is vital Therefore onsure suitable breeding habitat is available in these traditional nesting areas. It is disturbing that large areas of cutaway bog in the conservation site are being reclaimed as commercial grassland, forestry and wetlands. The traditional breeding areas identified during the radio-tracking study should be protected from reclaimation to allow the partridge population to recover. Additional habitat strips should also be provided in these areas.

The movement away from the cutaway bog in late autumn (secondary covey movements) appeared to be linked to the availability of winter stubbles which has been identified as a preferred winter habitat for partridge in other studies (CHURCH and PORTER, 1990; KAISER, 1995; MCCROW, 1977; SCHULZ, 1980). In this study birds moved over 1.5 km from the cutaway to suitable stubbles. The provision of winter stubbles on the cutaway bog may prevent this autumn movement off the conservation site.

Thus, the examination of radio-tracking data based on biological time periods can provide important information for the conservation of the remaining Irish partridge population.

REFERENCES

AEBISCHER, N.J. and ROBERTSON, P.A. (1992): Practical aspest of compositional analysis as applied to pheasant habitat utilisation. In: *Wildlife Telemetry*: Remote Monitoring and Tracking of animals, edited by Priede, I.G. and Swift, S.M. p. 285-293. Ellis Horwood, London.

AEBISCHER, N.J., ROBERTSON, P.A. and KENWARD, R.E. (1993): Compositional Analysis of habitat use from radio-tracking data. Ecol. **74**:1315-1325.

ALDRIDGE, J.R. and RATTI, J.T. (1986): Comparison of some statistical techniques for analysis of resource selection. *J. Wildl. Manage*. **50**: 15-165.

ALDRIDGE, J.R. and RATTI, J.T. (1992): Further comparison of some statistical techniques for analysis of resource selection. *J. Wildl. Manage*. **65**:1-9.

BAKER, R.R. (1978): The Evolutionary Ecology of Animal Migration. Hodder and Stoughton, London.

BELLAMY, D. (1986): The Wild Boglands, Bellamy's Ireland. Country House, Dublin.

BIRKAN, M., SERRE, D., SKIBNIENSKI, S., PELARD, F. (1992): Spring-Summer home range, habitat use and survival of grey partridge in a semi-open habitat. In: Perdix VI, First International symposium of partridges, quails and francolins, edited by Birkan, M., Potts, G.R., Aebischer, N.J. and Dowel, S.D. Gibier Faune Sauvage 9. Pp.431-442.

BRO, E., REITZ, F., MAYOT, P. and MIGOT, P. (in press): Diagnosing the environmental causes of the grey partridge decline in France: a comparative approach, In: Perdix VIII. International symposium on Partridges, Quails and Pheasants in the Western Palearctic and Nearctic. Sopron, Hungary 26-29 October 1998.

BURT, W.H. (1943): Territoriality and home range concepts as applied to mammals. *Journal of Mammology*. **24**:346-352.

BYERS, C.R., STEINIORST, R.K. and KRAUSMAN, P.R. (1984): Clarification of a technique for analysis of utilisation availability data. *J. Wildl. Manage*. **50**:157-165.

CARROLL, J.P. (1990): Winter and spring survival of radio-tagged gray partridge in North Dakota. *J. Wildl. Manage*. **54(4):**657-662.

CARROLL, J.P., CRAWFORD, R.D., SCHULZ, J.W. (1990): Nesting and brood-rearing ecology of gray partridge in North Dakota, In: Perdix V: Gray Partridge and Ring-necked Pheasant Workshop. Kans. Dep. Wildl. Parks, Emporia, Kansas. p. 272-294.

CHURCH, K.E. (1980): Gray Partridge (*Perdix perdix*) nesting success and brood survival in east-central Wisconsin. M.E.A.S. Thesis, Univ. Wisconsin, Green Bay. p.81.

CHURCH, K.E., HARRIS, H.T. and STIEL, R.B. (1980): Habitat utilisation by gray partridge (*Perdix perdix*) pre-nesting pairs in East Central Wisconsin, In: Proccedings of Perdix II Grey Partridge Workshop. Edited by PETERSON, R. and NELSON, L. University of Idaho, Moscow. p.9-20.

CHURCH, K.E. (1984a): Nesting biology of Gray Partridge in east-central Wisconsin. Pp. 46-53 in Perdix III: Gray Partridge and Ring-necked Pheasant Workshop, Wis. Dep. Nat. Resour., Madison, Wisconsin. CHURCH, K.E. and PORTER, W.F. 1990. Winter and Spring habitat use by grey partridge in New York. *J. Wildl. Manage*. **54(4)**: 653-657.

CHURCH, K.E. (1994): Summer habitat use and home range of translocated grey partridge (*Perdix perdix*) in New York State, U.S.A. *Gibier Faune Sauvage* **11**:145-153.

BYERS, C.R., STEINHORST, R.K. and KRAUSMAN, P.R. (1984): Clarification of a technoque for analysis of utilisation availability data. *J. Wildl. Manage*. **50**:157-165.

ENCK, J.W. (1990): Roost site characteristics of gray partridge broods, In: Perdix V: Gray Partridge and Ring-necked Pheasant Workshop. p.214-222.

FANT, R.J. (1953): A nest recording device. *J. Anim. Ecol*. **22**:323-327.

FARAGÓ, S. (in press): Habitat selection of partridges (*Perdix perdix*) covered by the Lajta project (Western Hungary), In: Perdix VII. Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

FREIDMAN, M. (1937) The use of ranks to avoid the assumption of normality implicit in the analysis of variance. *Journal of the American Statistical Association*. **32**:675-701.

GOACHE, C. and REITZ, F. (in press): Grey Partridge (*Perdix perdix*) reproduction in the chalk country of champagne, In: Perdix VII, Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

GREEN, R.E. (1984): The feeding ecology and survival of partridge chicks (*Alectoris rufa* and *Perdix perdix*) on arable farmland in east Anglia. *J. Appl. Ecol*. **21**:817-830.

HAMMOND, M.C. and FORWARD, W.R. (1956): Experiments on causes of duck nest predation. *J. Wildl. Manage*. **20**:243-247.

HARRIS, S., CRESSWELL, W.J., FORDE, P.G., TREWHWLLA, W.J., WOOLLARD, T. and WRAY, S. (1990): Home-range analysis using radio-tracking data: a review of problems and techniques particularly as applied to the study of mammals. *Mamm. Rev*. **20(2/3):**97-123.

HERSHAW, J. (1996): The ecology of the grey partridge (*Perdix perdix*) in the Irish Midlands. M.Sc. thesis, University College Dublin, p.129.

JEWELL, P.A. (1966): The concept of home range in mammals. Symposium of the Zoological Society of London. **18**:85-109.

JOHNSON, S.R. (1980): The comparison of utilisation and availability measurements for evalueting resource preference. Ecol. **61**:65-71.

KAISER, W. (in press): Habitat use of radio-tagged grey partridges (*Perdix perdix*) in North Bavaria, In: Perdix VII, Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

KAVANAGH, B. (1990): Baseline ecological survey of Turran cutaway bog, Co. NOffaly. Unpub. *Report to Bord na Mona*, p.31.

KAVANAGH, B. and AEBISCHER, N.J. (1997): Grey Partridge (*Perdix perdix*), In: The EBCC Atlas of European Breeding Birds: teheir distribution and abundanc, Eds. Hagemeier, W. and Blair, M. Poyser, London.

KAVANAGH, B. (in press): Can the Irish Grey Partridge (*Perdix perdix*) population be saved? A National Conservation Strategy for the Future, In: Perdix VII, Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

KAVANAGH, B. (in press): The Irish Partridge (*Perdix perdix*) Conservation Strategy: an update, In: Perdix VIII, Internationale symposium on Partridges, Quails and Pheasants in the Western Palearctic and Nearctic. Sopron, Hungary 26-29 October 1998.

KENWARD, R.E. and RANGES, V. (1996): An analysis system for biological data. Institute of Terrestrial Ecology, Natural Environmental Research Council, Wareham, Dorset.

KUGELSCHAFTER, K., BERNSHAUSEN, F., DORING, V., KORN, M. and RICHARZ, K. (in press): How do partridges (*Perdix perdix*) find a suitable place for breeding: traditions vs preferences for specific structures, In: Perdix VII, Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

MACINNESS, C.D. and MISRA, R.K. (1972) Predation on Canada goose nests at McConel River, Northwest Territories. *J. Wildl. Manage*. **36**:414-422.

MACNALLY, G. (1998): Optimising the return to Bord na Mona. In: The Future Use of Cutaway Bogs: proceedings from the first comprehensive conference on cutaway bogland rehabilitation. *Kilcomoc Development Association*, Co. Offaly pp. 13-16.

MARCSTROM, V., KENWARD, R.E. and KARLBOUM, M. (1989): Survival of ring-necked pheasants with backpacks, necklaces and leg bands. *J. Wildl. Manage*. **53**:808-810.

MCCROW, V.P. (1977): Movements and habitat use of grey partridge in North Central Iowa, In: Perdix I. Hungarian Partridge Workshop, N. Dakota Game Fish Dep., Dickinson. p.89-98.

MOHR, C.O. Table of equivalent populations of North American small mammals. *American Midland Naturalist* **37**:223-249.

MORRIS, P. (1980): An elementary guide to practical aspects of radio-tracking mammals, In: A handbook on Biotelemetry and Radio-tracking. AMLANER, C.J. and MACDONALD, D.W., eds. *Pergamon Press*, Oxford. p.161-168.

NEU, C. W., BYERS, C.R. and PEEK, J.M. (1974): A technique for the analysis of utilisation-availability data. *J. Wildl. Manage*. **38**:541-545.

POTTS, G. R. (1980): The effects of modern agriculture, nest predation and game management on the population ecology of partridges (*Perdix perdix* and *Alectoris rufa*). *Avances in Ecological Research*. **11**:2-79.

POTTS, G. R. (1986): The Partridge, Pesticides, Predation and Conservation. Collins, London.

RANDS, M.R.W. (1986a): The survival of gamebird chicks in relation to pesticide use on cereals. Ibis. **128**:57-64.

REITZ, F. and MAYOT, P. (in press): Characteristics of grey partridge movements from the end of summer to the next spring: a comparative study, In: Perdix VIII. International Symposium on Partridges, Quails and Pheasant in the Western Palearctic and Nearctic. Sopron, Hungary 26-29 October 1998.

SCHULZ, J.W. (1980): Gray Partridge winter movements and habitat use in North Dakota. *The Praire Naturalist*. **12(2)**: 37-42.

SMITH, L.M., HUPP, J.W. and RATTI, J.T. (1982): Habitat use and home range of grey partridge in Eastern South Dakota. *J. Wildl. Manage*. **46(3):**580-587.

THOMAIDES, C., PAPAGEORGIOU, N., CHARALAMBIDES, A. and VILLA, R. (in press): Grey Partridge (Perdix perdix) breeding and habitat use in northern Greece, In: Perdix VII. Symposium International sur les Perdix, les Cailles et les Faisons. Dourdan, France 9-13 October 1995.

WHILDE, A. (1993): Threatend Mammals, Birds, Amphibians and Fish in Ireland. Irish Red Data Book 2: Vertebrates. H.M.S.O. Belfast. Northern Ireland.

WILLEBRAND, T. (1990): Demography and Ecology of a black grouse (*Tetrao tetrix*) population.