

VERSION 1.1
STANDARDIZED INVENTORY METHODOLOGIES
FOR COMPONENTS OF BRITISH COLUMBIA'S
BIODIVERSITY:

UPLAND GAMEBIRDS

GROUSE, QUAIL AND COLUMBIDS

Ministry of Environment, Lands and Parks
Resource Inventory Branch
Terrestrial Ecosystem Task Force
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PREFACE

This manual presents standardized methodologies for inventory of Upland Gamebirds in British Columbia at three levels of inventory intensity: presence/not detected (possible), relative abundance, and absolute abundance. The manual was compiled by the Elements Working Group of the Terrestrial Ecosystem Task Force, under the auspices of the Resources Inventory Committee (RIC). The objectives of the working group are to develop inventory methodologies that will lead to the collection of comparable, defensible, and useful inventory and monitoring data for the species component of biodiversity.

This manual is one of the Components of British Columbia's Biodiversity (CBCB) series which present standard protocols designed specifically for group of species with similar inventory requirements. The series includes an introductory manual (Introduction to RIC Wildlife Inventory) which describes the history and objectives of RIC, and outlines the general process of conducting a wildlife inventory according to RIC standards, including selection of inventory intensity, sampling design, sampling techniques, and statistical analysis. The Introduction to RIC Wildlife Inventory manual provides important background information and should be thoroughly reviewed before commencing with a RIC wildlife inventory. RIC standards are also available for animal capture and handling, and radio-telemetry. Field personnel should be thoroughly familiar with these standards before engaging in inventories which involve either of these activities.

Standardized data forms are required for all RIC wildlife inventory. This is important to ensure compatibility with provincial data systems, as all information must eventually be included in the Species Inventory Datasystem. The manuals and data forms are available from:

Superior Reproductions
#200 -1112 West Pender Street
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It is recognized that development of standardized methodologies is necessarily an ongoing process. The CBCB manuals are expected to evolve and improve very quickly over their initial years of use. Field testing is a vital component of this process and feedback is essential. Comments and suggestions can be forwarded to the Elements Working Group by contacting:

Wildlife Diversity Inventory Specialist
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ACKNOWLEDGEMENTS

The background information and protocols presented in this document are based on the unpublished draft manual, *Census methods for upland game birds in British Columbia*, prepared for the Inventory Resources Committee by Leslie A. Robb and Michael A. Schroeder. The draft manual was edited to its present form by Ann Eriksson, James Quayle and Leah Westereng. All decisions regarding protocols are the responsibility of the Resources Inventory Committee. Data forms and coding instructions for this manual were developed by Leah Westereng in consultation with the Elements Working Group.

1. INTRODUCTION

Upland gamebird species of grouse, quail, and columbids inhabit all ecoregions of North America from desert-like conditions to arctic tundra. In addition to such varied habitats, no group of birds exhibits a greater diversity of mating systems including monogamy, clumped polygyny (lekking), and dispersed polygyny species. Many of these species possess elaborate courtship displays that are unparalleled for their complexity and beauty making them popular subjects for 'birders' and photographers.

Interest in gamebird populations was initially generated by their hunting potential. When some species began to decline in number, legislation was introduced (as early as 1791 in the United States) to control market hunting. This legislation began a legacy of management efforts by provincial, state, and federal agencies. As a result, an extensive body of literature exists for upland gamebirds, much of which emphasizes demographic trends.

Historical and current land use practices (livestock grazing, timber management, crop production, and development) have resulted in the decline or extirpation of some species from their original range. Additionally, non-native species such as chukar, gray partridge, and ring-necked pheasant have been introduced in certain areas. The usefulness of accurate census information for such a diverse array of gamebird species cannot be over emphasized. Survey data can provide insight into distribution patterns and population trends, both of which are critical for effective management, especially for species that are hunted.

The overall objectives and questions addressed are fundamental considerations in determining the experimental design and survey techniques used. Appropriate sample sizes and statistical power in turn depend on survey design and methods. The purpose of this manual is to outline current survey techniques for upland gamebirds and provide an informative guideline for applying these methods.

2. INVENTORY GROUP

2.1 Spruce grouse, *Dendragapus canadensis*

Description

Small forest grouse (38-43 cm long). Sexes dimorphic; males have medium to blackish grey plumage with brilliant scarlet eye combs; females lighter in colour and more cinnamon than males. Subspecies distinct; body size and mass are greater for *D. c. canadensis* than *D. c. franklinii*; rectrices dark brownish and tipped with a broad rust band in *D. c. canadensis*, black with or without white tips in *D. c. franklinii*.

Distribution

Found throughout British Columbia except in coastal areas. *D. c. canadensis* inhabits northern ecoregions while *D. c. franklinii* has a more central and southern distribution.

Habitat

Resident of taiga and conifer forests, especially fire adapted forests. Typically found in young successional stands of dense jack (*Pinus banksiana*) and lodgepole pine (*P. contorta*), 7-14 m height, with a well developed middle story.

Movement

Migrant between breeding and winter territories (0-11 km). Females tend to migrate more frequently and over greater distances than males. Timing of migration varies between populations but in general birds depart winter range mid-February to mid-May, and breeding range mid-August to late December.

Behaviour

Polygynous. Solitary. Loose flocks of females with broods during late summer; flocks may form winter. Both sexes aggressively maintain breeding territories; 39-50% of yearling males do not maintain territories. Territorial males perform vertical flutter-flight displays in response to intruders. *D. c. franklinii* males also perform an audible wing-clap display (2 sharp claps about 1 second apart) that can be heard up to 150 m away. Territorial displays are most common during dawn and dusk. Females utter a "cantus" as a territorial display. Territorial behaviour peaks during the breeding season, however, some birds maintain territories year round.

Throughout their range, they forage primarily on pine needles (*Pinus banksiana* and *P. contorta*) during winter months and forbs, flowers and invertebrates in summer.

Status

Breeding densities range from 0-50 birds/100 ha for *D. c. franklinii* in Alberta, to 8-12 birds/100 ha for *D. c. canadensis* in Alaska. Sex ratio is 1:1 for most populations studied.

Selected references

Guiguet 1955; Johnsgard 1973; Robinson 1980; Boag and Schroeder 1992.

2.2 Blue Grouse, *Dendragapus obscurus*

Description

Large grouse (44-57 cm long). Sexes dimorphic; males larger than females (average of 1 273 g and 839 g, respectively). Males bluish to blackish grey with yellow to reddish eye combs; females brownish grey to brown. Blue grouse are divided into coastal and interior subspecies. Coastal birds have wide terminal greyish band on rectrices and yellow neck patches, interior subspecies narrow to no band and reddish neck patches.

Distribution

Inhabits mountainous areas of coastal and interior British Columbia except parts of the Taiga and Boreal Plains ecoregions.

Habitat

Interior subspecies found in shrub-steppe, alpine/subalpine, and forest habitats. Coastal subspecies resident of sea level to alpine/subalpine forest communities.

Movement

Migrant between low elevation breeding ranges to higher altitude winter sites. Birds depart winter range late-March to mid-April, and breeding range mid-June to late-October. In Washington State 50% (n = 30 recoveries) of movements were greater than 8 km; longest known movement 50 km. Males tend to migrate further and to higher elevations than females.

Behaviour

Polygynous. Terrestrial lifestyle, more arboreal during winter. Mostly solitary but broods may form loose flocks during late summer; small flocks may form during winter. Both sexes maintain breeding territories, no indication of winter territories. In general, few males and most females breed during their first breeding season following hatch. Territorial males perform short (1 m) flutter-flights from ground or in a tree. The song of male blue grouse, the "hoot", differs between coastal and interior subspecies. Coastal subspecies produce a loud hoot (heard > 300 m) usually from a tree or rock; interior subspecies produce a soft hoot (inaudible beyond 30 m) usually from the ground. During the breeding season females occasionally emit a "whinny" call. Size of territories maintained by males is highly variable, 0.2 to 5.2 ha.

Varied diet in summer (leaves, flowers, invertebrates); winter diet primarily consists of conifer needles.

Status

Breeding densities vary; interior subspecies 3-19 birds/km²; coastal subspecies 4-103 birds/km². Typical density 15-30 males/km². Sex ratio 1:1.

Selected references

Guiguet 1955; Johnsgard 1973; Campbell *et al.* 1990; Zwickel 1992.

2.3 Ruffed grouse, *Bonasa umbellus*

Description

Large forest grouse (41-48 cm long). Little sexual dimorphism in plumage colouration; birds generally reddish-brown with blackish neck ruff and distinctive crest, rectrices banded black, brown, and buff with a wider black band near the tips. Eye combs orange to reddish-orange in males, colourless in females. Two colour phases exist; the grey phase which is typical in northern populations and the reddish-brown phase common in southern populations. Eleven subspecies are recognized 6 of which are found in British Columbia, *B. u. yukonensis*, *B. u. umbelloides*, *B. u. affinis*, *B. u. phaia*, *B. u. sabini*, and *B. u. brunnescens*.

Distribution

Indigenous to all ecoregions of British Columbia. Absent on Queen Charlotte Islands and islands off northern mainland.

Habitat

Deciduous and mixed deciduous/conifer forest usually containing birch (*Betula* sp.) and poplar (*Populus* sp.). Common in fire serres, brushy stream courses, alder thickets, and brushy forest edges. Birds exhibit seasonal shifts in habitat use within their home range; during winter they tend to use brushy areas, while in summer they use areas that are more open.

Movement

Sedentary, occupies same territory year round. Juveniles can disperse as far as 19 km.

Behaviour

Terrestrial habits, more arboreal during winter. Not gregarious. May form loose flocks in winter. Males perform drumming displays on their territories commencing mid-February to early April, peaking during early May. Drumming sites are usually logs often used repeatedly between years. Drumming displays most common during crepuscular periods. Although drumming displays peak during the breeding season, autumn displays are common. As many as 38% of the males in a population may be classed as 'nondrummers', such birds are usually yearling males.

Diet items in summer include berries, fruits, herbaceous material; winter diet primarily comprised of buds, catkins and twigs of deciduous trees/shrubs such as birch (*Betula* sp.) and aspen (*Populus* sp.).

Status

In central British Columbia densities of 4.4-10.5 drumming males/km². Populations exhibit ten year "cycles" in abundance. Sex ratio assumed to be 1:1.

Selected references

Bump *et al.* 1947; Edminster 1947; Aldrich and Duvall 1955; Brewer 1980; Johnsgard 1983; Davies and Bergerud 1988; Campbell *et al.* 1990.

2.4 Willow ptarmigan, *Lagopus lagopus*

Description

Small grouse (35.5-43 cm long). Males larger than females. During the breeding season males are rusty chestnut with dark barring, have scarlet eye combs, and dark brown rectrices; females greyish brown and more heavily barred, rectrices dark brown. Both sexes have feathered tarsi and white plumage in winter.

Distribution

Resident of alpine and subalpine habitat in the mountainous areas of western British Columbia. Absent from Northeast Pacific, Georgia Depression, Taiga Plains and Boreal Plains ecoregions.

Habitat

Alpine and subalpine communities at or near treeline, 600-1980 m elevation. Frequents the shrub zone of tundra where willow (*Salix* sp.), birch (*Betula* sp.), and shrubby cinquefoil (*Potentilla fruticosa*) form the overstory. Wet sedge meadows, sedge-willow marshes, streams and lake edges are commonly used.

Movement

Birds may move considerable distances between breeding and winter sites; in northern British Columbia confirmed movements of 100 km. Records of willow ptarmigan moving as far as northern Minnesota during some years. Females move further than males. Depart breeding grounds when snow accumulation has covered vegetation, usually by December. Arrive on breeding territories mid-March to mid-April. Males arrive on breeding range 2-3 weeks before females.

Behaviour

Walking is primary mode of locomotion during breeding season. Forms flocks of 20-200 birds in autumn. Both sexes aggressively defend breeding territories; birds usually form monogamous pair bonds and members of the same monogamous pair share a territory. Some males are polygynous. Territorial males are extremely vigilant and often sit on a prominent 'lookout'. Males perform "flight call" display; bird flies in a loop upward to 30 feet then lands, on ascent utters barking aa, on descent ka-ka-ka-ka, and upon landing utters kohwa-kohwa-kohwa. Males actively defend nests and broods.

Diet is varied during summer (leaves, berries, seeds, invertebrates), willow buds and stems are primary diet items during winter.

Status

Breeding densities 0.4-4.0 pairs/km²; rarely 78 territorial males/km². Sex ratio assumed to be 1:1. Populations cycle at intervals of 8 or 9 years.

Selected references

Weeden 1965; Johnsgard 1983; Mossop 1988; Campbell *et al.* 1990; Gruys 1991.

2.5 Rock ptarmigan, *Lagopus mutus*

Description

Small tundra grouse (32.5-39 cm long). Both sexes have feathered tarsi and white plumage in winter, rectrices black in all seasons. Males and most females have black loreal streak most noticeable in winter plumage. Eye combs orange to scarlet in males, females have paler ones. Males retain white plumage until incubation then molt to brownish-grey. During breeding season females have brownish-black with tawny barring.

Distribution

Uncommon resident of mountainous areas of British Columbia. Most abundant in the northeastern part of the Northern Boreal Mountains ecoregion.

Habitat

Arctic and alpine tundra interspersed with rocky outcrops, 915-2450 m elevation. Hummocky, well-drained willow and birch dominated communities; sedge-meadows. Habitat tends to be higher in elevation than that occupied by willow ptarmigan. In areas where both species are indigenous there is little to no overlap in local distribution.

Movement

Migratory between winter and breeding areas. Birds depart breeding range in late August to late October, and winter range mid-April to late March. Males arrive on breeding areas 2-3 weeks earlier than females.

Behaviour

Flocks numbering several hundred birds form during migration and winter. Territorial during breeding season; birds form monogamous pair bonds and members of a pair share the same territory. Territorial males perform "flight song" display; bird flies 2-80 m above the ground then soars upward until reaches stalling speed, swells neck and descends on bowed wings while uttering loud staccato call. Females do not defend territories. Male remains with female until time of hatch then usually abandons territory, few males provide parental care.

Diet items vary by season and availability; birch and willow buds and leaves eaten in all seasons.

Status

Breeding densities variable; 2.3-9.2 territorial males/km². Average population density 1-4 birds/km². Sex ratio (male:female) may vary between years and populations; 1:1, 1:1.2, 1:1.3, 1.2:1.

Selected references

Weeden 1965; MacDonald 1970; McGowan 1975; Johnsgard 1983; Campbell *et al.* 1990; Holder and Montgomerie 1993.

2.6 White-tailed ptarmigan, *Lagopus leucurus*

Description

The smallest North American grouse (30-34 cm long). Only grouse with white rectrices. Both sexes have feathered tarsi and white plumage in winter. In breeding season males have 'necklace' of barred brown and black breast feathers; females brown and black with yellow barring.

Distribution

Resident of mountainous regions throughout the province. Absent from Queen Charlotte Islands, subspecies *L. l. saxatilis* found on Vancouver Island.

Habitat

Alpine regions 1280-2650 m elevation. Mostly rocky, moist vegetation near snowfields, willow dominated plant communities, Carex-Geum rock meadows.

Movement

Local populations migrate altitudinally between winter (low elevation) and breeding (higher elevation) ranges. Females tend to move further than males. Arrive on breeding areas early April to early June; depart breeding areas for winter sites in late September to mid-November.

Behaviour

Birds establish territories in breeding season. Males arrive on breeding range before females and defend territories by ground and aerial displays. Most conspicuous display by territorial males is 'flight scream'; aerial component ku-ku-KIII-KIIEER, after landing utters duk-duk-DAAK-duk-duk. Birds usually form monogamous pair bonds but some males are polygynous; members of the same pair share a territory. Territory size variable 5-67 ha. Males do not provide parental care. Forms loosely organized flocks of broods, unsuccessful females, and males in late summer. Flocks segregated by sex during winter.

Willow buds, leaves, and twigs common diet items, especially during winter.

Status

Breeding densities vary between populations but in general are 2.0-13.5 birds/km². Sex ratio (male:female) varies, 0.8-1.8:1.

Selected references

Braun and Rogers 1971; Johnsgard 1983; Campbell *et al.* 1990; Braun *et al.* 1993.

2.7 Sharp-tailed grouse, *Tympanuchus phasianellus*

Description

Medium sized grouse (42-47 cm long). Body feathers brownish with extensive white, buff, brown, and black barring/spotting. Breast feathers are buffy with brownish "V" shaped markings. Tail feathers are graduated with the

center rectrices longest. Males are slightly larger, have violet coloured neck apteria, and pale yellow eye combs.

Distribution

Local populations in the Taiga Plains, Boreal Plains, Southern Interior Mountains, Sub-Boreal, Central and Southern Interior ecoregions.

Habitat

Grassland interspersed with deciduous and conifer copses. Shrubs and small trees are important habitat components. Vegetative communities include, shrub-steppe (*Artemisia-Agropyron*), mountain mahogany-oak scrub (*Cercocarpus-Quercus*), fescue-wheatgrass (*Festuca-Agropyron*), wheatgrass-bluegrass (*Agropyron-Poa*), and riparian and mountain shrub. May use cropland adjacent to native habitat.

Movement

Move 0-34 km between breeding and winter range. Females tend to move further than males. Juveniles may disperse as far as 150 km.

Behaviour

Social. Males form flocks associated with specific leks (communal display sites) during breeding season; females often visit leks in small flocks. Lek mating system; number of males attending lek varies, 2-57 males/lek. Males maintain territories by aggressive displays including "flutter-jump", "cackling call", and physical contact. Dominance hierarchy among males, dominant birds are centrally located on lek. Male courtship display, "dancing", consists of rapid stepping movements with erect tail, extended wings, outstretched head, and exposed neck apteria. Males produce soft hooting or cooing calls and vibrate their tail feathers to produce a rattling sound while dancing. Displays are most intense in early morning hours and during peak of female lek attendance. Males show high fidelity to specific leks. Lek sites are often relatively 'permanent'.

Diet is varied during summer (seeds, leaves, invertebrates); winter diet consists of fruits and buds of deciduous shrubs and trees.

Status

Breeding densities vary between years and areas; in South Dakota 3-9 males/km², Nebraska 9-14 males/km². Sex ratio (male:female) 1:1.5.

Selected references

Hillman and Jackson 1973; Johnsgard 1983; Gratson 1988; Campbell *et al.* 1990; Giesen and Connelly 1993.

2.8 Sage grouse, *Centrocercus urophasianus*

Description

Largest North American grouse. Sexually dimorphic for body size; males (65-76 cm long), females (48-58 cm long). Both sexes have long narrow rectrices and greyish brown plumage, variegated with buff and blackish markings and dark brownish abdominal area. Males have black philoplumes located at the base of the neck, dark brown throats, whitish breast feathers, and

two frontally located gular air sacs. Females lack air sacs and philoplumes, and have blackish-brown barring on throat and breast feathers.

Distribution

Historically, populations in extreme southern Okanagan and Similkameen Valleys. In 1958 sage grouse were introduced at Richter Pass near Osoyoos. Currently extirpated from historical range in British Columbia.

Habitat

Shrub-steppe habitat dominated by sagebrush (*Artemisia* sp.).

Movement

Seasonal movements between breeding and winter areas. Birds move to summer ranges in late April-early May, to winter sites in late August-early October, and to breeding areas in mid February-early March. Movements are as far as 82 km.

Behaviour

Gregarious, males form flocks associated with specific lek sites, females visit leks in small flocks. During winter flocks of 4-50 birds are common, occasionally as many as 200 birds. Lek mating system: males defend territories on communal display sites, number of males/lek varies from 16-32. Dominant males occupy centrally located territories on the lek site. Males perform an elaborate "strutting" display to attract females; birds stands erect with tail fanned and upright, gular air sacs are inflated and folded wings are brought up and moved across the neck feathers producing a 'swishing' sound. Movement of the wings is repeated several times until the gular air sacs are completely extended at which time the compressed air is suddenly released producing a distinctive 'popping' sound. Strutting activity is most intense during early morning hours and period of peak female lek attendance. Males display fidelity to lek sites; leks are traditional areas used repeatedly between years.

Sagebrush is eaten throughout the year, especially during winter when it comprises 100% of the diet. Forbs, grasses, and invertebrates are also consumed during summer.

Status

Breeding density 3-19 birds/km². Sex ratio (male:female) 1:1.5-2.0.

Selected references

Guiguet 1955; Wallestad 1975; Johnsgard 1983; Connelly *et al.* 1988; Braun 1991.

2.9 Chukar, *Alectoris chukar*

Description

Medium sized partridge (33-39 cm long). Males and females similar in appearance and difficult to distinguish. Plumage greyish brown to olive, buffy to white cheek patches, black streak passes through the eye and around the cheek forming a 'V' at the throat. Breast feathers greyish, buffy coloured flanks have vertical black and chestnut barring, legs and bill reddish.

Distribution

Introduced populations in the Okanagan and Similkameen valleys. Absent from most ecoregions except localized areas in the Central and Southern Interior.

Habitat

Rocky slopes, cliffs, and bluffs adjacent to shrub-steppe grassland communities where sagebrush is dominant shrub component. Brushy creek bottoms near mountain slopes. Proximity to water important during summer.

Movement

Migrate altitudinally from lower valleys during winter to higher elevations during the breeding season. Birds are usually found near streams and springs in hot summer months.

Behaviour

Gregarious, forms coveys in all months of the year except during spring when birds form breeding pairs. Coveys usually range from 5-40 birds. Pair formation commences in February; most pairs are monogamous, some males are polygynous. Males defend mates by head tilt, lateral stance, and circling displays. During circling display males utter "errrrrrr" call. Conflicting evidence concerning the degree of parental care by the male; in some cases males abandon territories in late incubation and form small flocks, in other cases males may provide parental care to the brood. A few weeks following hatch, broods form flocks.

The seeds and leaves of cheatgrass (*Bromus tectorum*) are most common diet items during all months of the year. Herbs and fruits are eaten in summer, forb and shrub seeds and fruits are consumed during winter.

Status

Breeding densities in Washington State average 72 birds/km².

Selected references

Galbreath and Moreland 1953; Johnsgard 1973; Molini 1976.

2.10 Gray partridge, *Perdix perdix*

Description

Small sized partridge (30-33 cm long). Sexes similar in appearance and difficult to distinguish in the field. Upper body parts greyish brown, facial and throat areas rusty orange, horseshoe shaped marking of dark brown feathers on lower breast. Flanks have brownish chestnut barring. Chestnut coloured rectrices are short and rounded.

Distribution

Introduced populations in the Southern Interior ecoregion. Absent in all other ecoregions.

Habitat

Resident of shrub-steppe areas interspersed with croplands, especially cereal grains. In winter uses crop stubble and woody areas. Prefers agricultural areas with cereal crops and hedgerows.

Movement

Sedentary. Use the same habitat year round. In spring pairs may move up to 25 km in search of nesting habitat. During winter coveys rarely move further than 1 km, home range size 96 to 392 ha.

Behaviour

Gregarious except during pair formation in the breeding season. Form coveys in all seasons, coveys usually family groups (mated pair and offspring). Unmated males may join family coveys, adult coveys of nonbreeders form in autumn and winter. Monogamous mating system. Both sexes display aggressive behaviour during pairing; pairs form within and between coveys. Paired males utter “kee-uck” call during breeding season, most commonly prior to sunrise and just after sunset.

Main diet items include seeds of agriculture crops (wheat, barley, oats, corn, sunflower) and native vegetation. Some invertebrates consumed, primarily Orthoptera and Lepidoptera.

Status

Breeding densities < 1-4 pairs/km². Fall densities 15-84 birds/km². Sex ratio biased in favour of males.

Selected references

Johnsgard 1973; Austin 1980; Weigand 1980; Carroll 1993.

2.11 Ring-necked pheasant, *Phasianus colchicus*

Description

Large pheasant; males larger than females (84 and 53 cm long, respectively). Both sexes have long pointed tail and rounded wings. Sexually dimorphic for plumage colouration. Males have iridescent bronze upper body parts, spotted/barrred with black, brown, and green. Head and neck green-purplish with white ring around throat, red eye patch, and iridescent green ear tufts. Females generally buffy with brown, rust, and black mottling.

Distribution

Introduced populations in parts of Georgia Depression, Coast and Mountains, and Central Interior ecoregions.

Habitat

Inhabits numerous habitat types, common feature is presence of agricultural croplands (cereal grains, alfalfa). Nests in grassland, roadsides, and hedgerows where cover is moderate to dense. Woody cover used during winter, especially in cold temperatures.

Movement

Sedentary. Birds generally move less than 5 km between breeding and winter sites. Once localized on winter sites flocks range less than 1 km. Breeding range of adult birds average 1 km².

Behaviour

Social. Males defend loosely defined territories during early spring and establish "crowing" areas to attract females. Crowing activity by territorial males is most intense during early morning and evening hours. Females form harem flocks during spring and visit territorial males for mating. Considerable interchange of females between harems.

Cereal grains (corn, wheat, barley, rye, oats) constitute major diet items. Birds also consume leaves, seeds, fruits and invertebrates.

Status

Sex ratio (male:female); 1:1.9, 1:2.7.

Selected references

Gates and Hale 1975.

2.12 California quail, *Callipepla californica*

Description

Small quail (24-28 cm long). Both sexes have elongated 'teardrop' crests. Males have grey to brownish-grey upper parts, grey chest, chestnut-buffy abdomen scaled with dark brown markings; brownish flanks marked with buffy streaks; and black crest and black throat patch, white streak across forehead and under throat. Females similar, except have dark brown crests and lack black throats.

Distribution

Populations in the Georgia Depression, Southern Interior, and Southern Interior Mountains. Absent from all other ecoregions.

Habitat

Coastal forest birds use edge habitats and early successional stages of vegetation. Southern Interior populations are associated with orchards and irrigated cropland. Birds use brushy areas of aspen (*Populus* sp.), rose (*Rosa* sp.), chokecherry (*Prunus* sp.) and saskatoon berry (*Amelanchier* sp.). Require access to water.

Movement

Sedentary. Winter covey home range 7-18 ha. Covey structure dissolves in early February as unpaired birds move away to establish pair bonds and breeding ranges. The remaining covey is comprised of pairs mated for nesting activities. Movement of mated pairs is limited 5-10 ha. Broods, nonbreeding, and unsuccessful breeding birds form coveys during late summer. Late summer coveys remain together throughout the winter.

Behaviour

Social, forms coveys in all seasons of the year. During late winter and early spring members of a covey are aggressive toward conspecific intruders, hence little intercovey mixing. Monogamous pair bonds are initiated prior to covey break-up. Paired males are aggressive towards and drive out unpaired males. Birds do not establish and defend breeding territories. However, unmated males often maintain "crowing" areas near nest sites of mated pairs. Such birds utter a cow vocalization. Mated pairs utter contact calls, cu-ca-cow (or chi-ca-go). Bi-parental care of chicks. Unmated males may occasionally join a family group and provide foster care to the brood.

Leguminous plants, leaves, seeds, fruits, and grains constitute major diet items. Proportion of animal matter minimal (less than 5%).

Status

Population densities vary considerably, in areas of optimum habitat 125-250 birds/km² are not uncommon. Sex ratio (male:female) 1:0.8.

Selected references

Anthony 1970; Johnsgard 1973; Campbell *et al.* 1990.

2.13 Mountain quail, *Oreortyx pictus*

Description

Medium sized quail (27-29 cm long). Sexes similar and difficult to differentiate. Prominent narrow black plume (2 feathers). Upper body parts olive-grey, head, neck, and chest are grey. Facial area is chestnut and bordered by a white streak extending from behind the eye to the throat. Flanks dark brown with prominent white and black vertical barring.

Distribution

Rare. Absent from all ecoregions except Georgia Depression where it is confined to a small part of southwestern Vancouver Island.

Habitat

In the coastal forest prefers clearcut areas in early stages of regeneration, brushy canyons. Areas of mixed forest and brushy thickets are used during winter.

Movement

Migrates altitudinally between breeding (high elevation) and winter (low elevation) sites. Instances of birds moving 32 km between ranges. However, some populations show little variation in seasonal movements and occupy the same range throughout the year. Coveys are relatively sedentary when on winter range and move to breeding areas in late February. Little movement during brood-rearing but birds may move to water sources. In late summer-early autumn birds commence moving back to winter range.

Behaviour

When disturbed prefers to run rather than fly. Social, coveys form during all seasons of the year, average of 7 birds/covey. Monogamous pairs form in late

February to early March when birds are still in coveys. The covey then breaks down and pairs establish nesting sites. Unmated males advertise their presence by uttering a loud (audible to 1 km) quee-ark call from prominent locations. Biparental care. Males occasionally develop brood patches and may incubate the clutch if the female is killed. Late summer coveys are formed by family groups, unmated, and unsuccessful birds.

Fruits and seeds of numerous shrubs and trees, tubers and roots, acorns, leaves, buds, and flowers of a variety of plants constitute the diet.

Status

In California 9-30 birds/km².

Selected references

Guiguet 1955; Johnsgard 1973; Brennan and Block 1986; Campbell *et al.* 1990; Washington Department of Wildlife 1993.

2.14 Wild turkey, *Meleagris gallopavo*

Description

Largest North American game bird (males and females average 94 cm and 117 cm long, respectively). Both sexes have long necks and legs, large fan-shaped tail. Head and neck nearly bare. Males iridescent blackish brown, red dewlap, dark brown tuft of coarse feathers on lower breast, white barring on wings and spurs on tarsi. Female colouration more rusty brown tipped with white. Often lack frontal tuft, lack spurs.

Distribution

Absent from all ecoregions except Georgia Depression, Southern Interior and Southern Interior Mountains where populations have been introduced.

Habitat

Mixed stands of climax vegetation interspersed with openings, clearings, and pastures. May use riparian areas. Roosting habitat important.

Movement

Non-migratory. Immature birds disperse to first breeding range in early spring, females disperse further than males (16 and 9 km, respectively). Once established on breeding range birds are sedentary until autumn when they move to winter range. Some subspecies move 40-64 km between breeding and winter sites. Year round home range 3.6-78 km² for females, males 3-4 km².

Behaviour

Gregarious. Territorial behaviour minimal. Broods may join to form flocks in summer. During autumn, flocks are segregated by age and sex. Flock size is usually 40 birds but may reach >200. Females form small flocks (4 birds) termed 'harems' in April. Harems are accompanied by one or more males. Males establish pecking hierarchies to gain mating opportunities with females; hierarchies are maintained by threat displays and physical combat. In some populations leks may form. Males utter "gobble" call to advertise dominance

and attract females. Gobbling call is usually given from a roost site during the early morning hours and is most intense during March to April.

Diet items vary by region and subspecies. In general mast, fruits, seeds, green vegetation, and invertebrates.

Status

Densities of 1-5 birds/km².

Selected references

Campbell *et al.* 1990; Eaton 1992.

2.15 Band-tailed pigeon, *Columba fasciata*

Description

Large columbid (average 37 cm long). Sexes similar in size and appearance. Upper body parts greyish, head and chest purplish, rectrices light grey with broad darker grey band. Adults have white band across nape below which is a broad area of iridescent bronzy green. Legs and bill yellow. Bill tipped with black.

Distribution

Breeding populations of the coastal subspecies are found in the Georgia Depression and Coast and Mountains ecoregions. Absent from all other ecoregions.

Habitat

Coniferous forest of mixed species, light to medium density. Brushy clearings where berry producing shrubs dominate.

Movement

Migratory. Arrive on breeding range March to May, most birds have departed by early to late October.

Behaviour

Gregarious at all times of year except breeding season when pairs are nesting. Male emits a "perch" call during courtship, coo-coo, coo-coo, coo-coo. Cooing calls are audible to 0.4 km but distance varies by habitat. Males perform cooing calls from mid-May to late August, in Oregon peak cooing occurs in mid-May to mid-June. Cooing activity is most frequent prior to and just after sunrise. Nests consist of loosely constructed twigs and is located in a tree. Reproductive potential is extremely low, 1 egg/clutch.

Major diet items include acorns, berries, and seeds.

Status

Populations of band-tailed pigeons are relatively low.

Selected references

Bent 1932; Sisson 1968; Keppie *et al.* 1970; Braun *et al.* 1975; Jarvis and Passmore 1992.

2.16 Mourning dove, *Zenaida macroura*

Description

Medium sized dove (28-33 cm long). Sexes similar in appearance. Plumage greyish brown with black spots behind the eye and on upper wing feathers. Sides of lower neck have iridescent pink and greenish patches. Rectrices are long and pointed, outer tail feathers tipped with white.

Distribution

Breeding populations in parts of Georgia Depression, Coast and Mountains, Central Interior, Southern Interior, and Southern Interior Mountains ecoregions. Absent from all other ecoregions.

Habitat

Adapted to a variety of habitat types. Uses edge cover and mixed successional stages.

Movement

Migratory, birds winter in southern United States and northern Mexico. Birds depart during September and return to breeding areas in May and June. During the nesting season birds may range 0.8-7.8 km from nest sites.

Behaviour

Gregarious except during nesting. Monogamous pair bonds. Males establish and defend a territory after pairing. Male song during the breeding season is the "perch coo", Coo-co, OO, OO, OO. Calling by males peaks in mid-May to mid-June and is most intense just prior to and after sunrise. Unmated males perch coo more frequently than paired males.

Status

Abundant. Breeding Bird Survey routes in British Columbia report an average of 0-20 birds/route. Variable sex ratio usually skewed in favour of males, but most sampling of populations may not be random, 1:1, 1:0.8, 1:0.2. Sex ratios vary monthly and seasonally.

Selected references

Guiguet 1955; Aldrich 1993; Mirarchi and Baskett 1994.

3. PROTOCOLS

Visual and/or audio surveys can be used to detect the target species and be used to determine whether upland gamebirds are present/not detected (possible). Most of the techniques used to determine presence or absence of upland gamebirds can be modified to provide data regarding the relative or absolute abundance of a species. *Relative abundance* census methods rank or index population size. Comparisons can be made between areas and populations and data can be used to evaluate long-term population trends. Surveys of *absolute abundance* measure or estimate the number of individuals in a population. Collection of absolute abundance information often requires trade-offs between precision/accuracy and efficiency. Due to the expense and time required to determine absolute abundance, this method is not often employed for management decisions for upland gamebird species at this time. Although other methods may also be appropriate, only the complete lek survey method (used for Sharp-tailed grouse), and the territory mapping method (used for most of the inventory group) are provided in this manual. The recommended methods for the inventory of upland gamebirds is provided in Table 1.

Table 1. Recommended methods for inventory of upland gamebirds in British Columbia at the three levels of intensity.

Species	Presence/not detected (possible) and Relative abundance	Absolute abundance
Spruce grouse	Point Counts	Territory mapping
Blue grouse	Point Counts	Territory mapping
Ruffed grouse	Point Counts	Territory mapping
Willow ptarmigan	Point Counts	Territory mapping
Rock ptarmigan	Point Counts	Territory mapping
White-tailed ptarmigan	Point Counts	Territory mapping
Sharp-tailed grouse	Sample lek surveys	Complete lek surveys
Sage grouse	Sample lek surveys	-
Chukar	Point Counts	Territory mapping
Gray partridge	Point Counts	Territory mapping
Ring-necked pheasant	Point Counts	Territory mapping
California quail	Point Counts	Territory mapping
Mountain quail	Point Counts	Territory mapping
Wild turkey	Encounter Transects	-
Band-tailed pigeon	Point Counts	-
Mourning dove	Point Counts	-

3.1 Sampling Standards

The following standards are recommended to ensure comparison of data between surveys, and to mitigate several sources of bias common in surveys. Individual protocols provide more detailed standards applicable to the method(s) and design recommended.

3.1.1 Habitat Data Standards

A minimum amount of habitat data must be collected for each survey type. The type and amount of data collected will depend on the scale of the survey, the nature of the focal species, and the objectives of the inventory. As most, provincially-funded wildlife inventory projects deal with terrestrially-based wildlife, the terrestrial Ecosystem Field Form developed jointly by MOF and MELP (1995) will be used. However, under certain circumstances, this may be inappropriate and other RIC-approved standards for ecosystem description may be used. For a generic but useful description of approaches to habitat data collection in association with wildlife inventory, consult the manual, “Introduction to RIC Wildlife Inventory”.

3.2 Inventory Surveys

The table below outlines the type of surveys that are used for inventorying upland gamebirds for the various survey intensities. These survey methods have been recommended by biology specialists and approved by the Resources Inventory Committee.

Table 2. Types of inventory surveys, the data forms needed, and the level of intensity of the survey.

Survey Type	Data Forms Needed	*Intensity
Upland Gamebird Point Count	<ul style="list-style-type: none"> • Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - Upland Gamebird • Animal Observations Form- Upland Gamebird Point Count • Ecosystem Field Form 	<ul style="list-style-type: none"> • PN • RA
Upland Gamebird Sample Lek Survey	<ul style="list-style-type: none"> • Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - Upland Gamebird • Animal Observations Form- Upland Gamebird Lek Survey • Ecosystem Field Form 	<ul style="list-style-type: none"> • PN • RA
Upland Gamebird Encounter Transect	<ul style="list-style-type: none"> • Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - Upland Gamebird • Animal Observations Form- Upland Gamebird Transect 	<ul style="list-style-type: none"> • PN • RA
Upland Gamebird Territory Mapping	<ul style="list-style-type: none"> • Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - Upland Gamebird • Animal Observations Form- Upland Gamebird Territory Mapping • Ecosystem Field Form 	<ul style="list-style-type: none"> • AA
Upland Gamebird Complete Lek Survey	<ul style="list-style-type: none"> • Wildlife Inventory Project Description Form • Wildlife Inventory Survey Description Form - Upland Gamebird • Animal Observations Form- Upland Gamebird Lek Survey • Ecosystem Field Form 	<ul style="list-style-type: none"> • AA

* PN = presence/not detected (possible); RA = relative abundance; AA = absolute abundance

3.3 Presence/Not detected (possible) and Relative Abundance

Recommended method(s): Point counts of undefined radius, sample lek surveys, encounter transects of undefined (see Table 1 for species specific recommendations).

3.3.1 Point Counts Of Undefined Radius

Point counts involve recording observations of the target species from a survey point, regardless of their distance.

Advantages

- Point counts with an undefined radius are the simplest to conduct, primarily because distances between the point and the individual do not need to be estimated.

Disadvantages

- An undefined radius precludes the opportunity to estimate absolute abundance.
- For some species, such as ptarmigan and spruce grouse, this technique may be less efficient than territory mapping which, with the same effort, allows estimation of absolute density.

Examples

- Types: Lek surveys, coo counts, crow counts, hooting counts.
- Spruce grouse: Schroeder and Boag 1989.
- Blue grouse: Rogers 1963.
- Ruffed grouse: Petraborg *et al.* 1953, Ammann and Ryel 1963.
- Gray partridge: March and Church 1980, Weigand 1980, Rotella and Ratti 1986.
- Ring-necked pheasant: Kimball 1949.
- Wild turkey: Scott and Boeker 1972.
- Band-tailed pigeon: Keppie *et al.* 1970, McCaughran and Jeffrey 1980.
- Mourning dove: Baskett *et al.* 1978, Sayre *et al.* 1978, Dolton 1993, Sauer *et al.* 1994.

Office procedures

- Review the section on Planning and Procedures in the Introductory manual.
- Obtain relevant maps for study area (e.g. Nautical charts, 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for survey areas from maps.
- Systematically chose areas to be sampled considering factors such as: 1) habitat diversity and continuity; 2) accessibility; 3) repeatability; and 4) management objectives (timber harvest, development, etc.).
- Record specific routes and points on maps so that surveys can be repeated in subsequent years.
- Points should be far enough apart (Table 3) so that most (if not all) birds are detected from one point. Avoid structures, such as houses, and areas of heavy vehicle traffic.
- Each transect should contain a minimum of 10 and a maximum of 30 points (stops). It may be important to select a consistent number of points on each transect to make transects more comparable.

- Surveys of migratory birds such as mourning doves and band-tailed pigeons should be designed to be compatible with surveys conducted in other provinces and states. For example, call-count surveys for mourning doves should consist of 20 points, 1.6 km apart.
- The number of transects should be determined with several factors in mind: 1) the size of differences in annual population size that should be detectable; 2) the typical variation in numbers of birds detected on routes; 3) the number of years of data collection; and 4) the number of desired comparisons between habitat types, management strategies, and/or regions.

Table 3. Species-specific considerations for conducting surveys using point counts of undefined radius. The details included in this table may also be applied to other survey techniques.

Species	Inter-point distance	Duration of observation	Time	Season	Detection Method
Spruce grouse (<i>D. c. franklinii</i>)	0.4 km	3 min	0.5 hours before sunrise to 2.5 after	Late April - early June	Res cantus playback response to female
Spruce grouse (<i>D. c. canadensis</i>)	0.4 km	3 min	0.5 hours before sunrise to 1.5 after	Late April - late May	Flutter-flights by males
Blue grouse (coastal races)	1.0 km	3 min	0.5 hours before sunrise to 2.0 after	Early May - early June	Hooting by males
Blue grouse (interior races)	0.4 km	3 min	0.5 hours before sunrise to 2.0 after	Late April - late May	Hotting by males
Ruffed grouse (interior races)	0.8 km	4 min	0.5 hours before sunrise to 1.0 after	Mid April - late May	Drumming by males
Ruffed grouse (coastal races)	0.4 km	4 min	0.5 hours before sunrise to 2.5 after	Mid March - late April	Drumming by males
Willow ptarmigan	1.0 km	3 min	Throughout day or night	Mid May - mid June	Response to flight song playback
Rock ptarmigan	1.0 km	3 min	Throughout day or night	Mid May - late June	Response to flight song playback
White-tailed ptarmigan	1.0 km	3 min	Throughout day, night or morning	Mid May - mid June	Response to challenge call playback
Sharp-tailed grouse	0.8 km	3 min	0.5 hours before sunrise to 2.0 after	Mid March - early May	Dancing by males
Sage grouse	0.8 km	3 min	0.5 hours before sunrise to 1.5 after	March - early April	Strutting by males

Species	Inter-point distance	Duration of observation	Time	Season	Detection Method
Chukar	1.6 km	3 min	0.5 hours before sunrise to 1.5 after	Early Feb. - mid March	Singing by males
Gray partridge	1.6 km	4 min	0.5 hours before sunrise to 1.5 after	Early Feb. - early March	Kee-uck calls by calling groups
Ring-necked pheasant	2.4 km	2 min	0.75 hours before sunrise to 1.25 after	Early May - Mid May	Crowing by males
California quail	1.6 km	3 min	0.5 hours before sunrise to 1.5 after	Late Feb. - early May	Singing by males
Mountain quail	1.6 km	3 min	0.5 hours before sunrise to 1.5 after	Late Feb. - early May	Singing by males
Wild turkey	1.6 km	4 min	0.75 hours before sunrise to 0.25 after	Mid April - late April	Gobbling by males
Band-tailed pigeon	0.8 km	3 min	0.2 hours before sunrise to 1.8 after	July 1-15	Calling by males visual detection
Mourning dove	1.6 km	3 min	0.5 hours before sunrise to 1.5 after	May 20-31	Cooing by males visual detection

Personnel

- Crew size depends on extent and thoroughness of the survey.
- Map reading and bird identification (visual and auditory) skills are essential.
- At least one crew member must be qualified to collect and record habitat data.

Time requirements

- Time allotted depends on extent and thoroughness of the survey.
- A minimum of five years of data are probably needed to assess population trends.
- Each transect should be surveyed once a year.

Equipment

- Vehicle (optional)
- Binoculars
- Tape recorder and appropriate recordings (see Table 3 for species-specific method of detection)
- Global positioning unit (optional)
- Compass
- Maps
- Data forms

Field procedures

- Crews should visit areas in early spring (Table 3) to maximize opportunity for observing birds.
- Each route should be surveyed by one observer, generally in early morning (Table 3).
- Wind should be calm or light (< 20 km/h) and precipitation minimal.
- The observer should remain at each point for a standard length of time (Table 3), recording all birds detected by sound and/or sight. In the case of mourning doves, all birds detected in transit between points are also recorded.
- Playbacks should consist of approximately 30 seconds of recordings, 1 minute of silence, 30 seconds of recordings, and 1 minute silence.

Data analysis

- The number of birds per transect (when there is a consistent number of stops) or the number of birds per point is determined. These data enable the comparison of relative abundance for habitat type, management strategy, region, and/or year.
- If surveys are continued for several years, log-linear regressions offer the best opportunity to detect fluctuations and/or differences in population trends (Geissler and Noon 1981; Geissler 1984; Dolton 1993).

3.3.2 Sample Lek Surveys

Sample lek surveys involve the counts of leks and the numbers of birds observed on leks. Sample surveys monitor specific leks or routes to obtain presence/not detected (possible) and/or an estimate of relative abundance.

Advantages

- Provides counts of individual leks and number of birds/lek on an area permitting estimates of relative abundance.
- Lek sites are traditional and counts are fairly reliable and easy to repeat between years.

Disadvantages

- Thorough surveys are time consuming and require a skilled observer.
- Relative abundance estimates may be biased because of differences between observability of leks of different size or habitat.

Examples

- General: Cannon and Knopf 1981.
- Sharp-tailed grouse: Ammann 1957, Hillman and Jackson 1973, Grensten 1987.
- Sage grouse: Willis *et al.* 1993.

Office procedures

- Review the section on Planning and Procedures in the Introductory manual.
- Obtain relevant maps for study area (e.g. Nautical charts, 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for survey areas from maps.
- Leks should be found by systematically choosing areas to be sampled considering factors such as: 1) habitat suitability; 2) accessibility; 3) repeatability; 4) historic presence; and 5) management objectives (grazing, prescribed fire, development, etc.).
- The number of leks monitored should be determined with several factors in mind: 1) the size of differences in annual population size that should be detectable; 2) the typical variation in numbers of birds detected on leks; 3) the number of years of data collection; and 4) the number of desired comparisons between habitat types, management strategies, and/or regions.
- Contact landowners for permission to survey private land.

Personnel

- Crew size depends on extent and thoroughness of the survey.
- Map reading and bird identification (visual and auditory) skills are essential.
- At least one crew member must be qualified to collect and record habitat data.

Time requirements

- Time allotted depends on extent and thoroughness of the survey.
- A minimum of five years of data are probably needed in order to allow assessment of population trends.

Equipment

- Vehicle
- Binoculars

- Global positioning unit (optional)
- Parabolic microphone (optional)
- Compass
- Maps
- Data forms

Field procedures

- Crews should search for new leks and visit previously discovered leks in early spring (Table 3) to maximize opportunity for detecting and observing birds.
- The weather should be calm or light wind (< 20 km/h) and no precipitation.
- New leks can be located by stopping at regular distances (Table 3) throughout the proposed search area. The observer should remain at each site approximately 3 minutes, listening for sounds of displaying males (perhaps with a parabolic microphone).
- Accurately record locations of all known leks on maps (with UTM coordinates) so that leks can be relocated on subsequent occasions.
- Each lek should be surveyed by one observer in early morning (Table 3).
- The observer should record all birds detected on the lek, by sex if possible.
- Three counts should be obtained each year for each sage grouse lek throughout the breeding season and one annual count should be obtained for each sharp-tailed grouse lek (Table 3). Counts can be repeated for either species under the following conditions: 1) there was an obvious source of disturbance on the morning of the lek count (raptor, coyote, human); 2) weather was marginal; 3) the lek was 'vacant', despite previous years of attendance; 4) the lek is new and its status needs to be verified; and 5) the lek is in a critical area and an accurate count is especially important.

Data analysis

- The number of birds per lek (sharp-tailed grouse) and the number of males per lek (sage grouse) can be used in data analysis. These data enable the comparison of relative abundance for each year, habitat, management strategy, and/or region.
- If surveys are continued for several years, linear regressions offer the best opportunity to detect fluctuations and/or differences in population trends.

3.3.3 Encounter Transects

Encounter transects involve recording all observations of a target species from a transect, regardless of their apparent distance.

Advantages

- Transects with an undefined width can be used to estimate relative abundance.
- Simple to conduct and replicate in subsequent years, primarily because distances between the transect and the individual do not need to be estimated.

Disadvantages

- An undefined transect width precludes the opportunity to estimate absolute abundance.
- If conducted on a province wide scale requires cooperation from federal employees.

Examples

- Types: Brood, winter flock, and rural mail carrier routes.
- Blue grouse: Rogers 1963, Zwickel 1982.
- Ruffed grouse: Allison 1963, Ammann and Ryel 1963. Sharp-tailed grouse: Hillman and Jackson 1973.
- Sage grouse: Willis *et al.* 1993.
- Gray partridge: Schultz 1992.
- Ring-necked pheasant: Greeley *et al.* 1962.
- Wild turkey: Wakeling 1991, Hoffman *et al.* 1993.

Office procedures

- Systematically chose areas to be sampled considering factors such as: 1) habitat diversity and continuity; 2) accessibility; 3) repeatability; 4) management objectives (grazing, development, etc.); and 5) known observations of the target species.
- Record specific transects on maps so that surveys can be repeated in subsequent years. The same transects can be surveyed for different species, and at different times of year, for breeding, brood, and winter flock data.
- Transects should be 20-40 km in length.
- The number of transects should be determined with several factors in mind: 1) the size of differences in annual population size that should be detectable; 2) the typical variation in numbers of birds detected on routes; 3) the number of years of data collection; and 4) the number of desired comparisons between habitat types, management strategies, and/or regions.

Personnel

- Crew size depends on extent and thoroughness of the survey.
- Map reading and bird identification skills are essential.
- At least one crew member must be qualified to collect and record habitat data.

Time requirements

- Time allotted depends on extent and thoroughness of the survey.
- A minimum of five years of data are probably needed to assess population trends.

Equipment

- Vehicle
- Binoculars
- Spotting scope (window mounted)
- Maps
- Data forms

Field procedures

- Crews should survey transects for broods in early to mid-August and for winter flocks in mid-February to early March.
- Each transect should be surveyed by one observer driving less than 25 km/h.
- The observer occasionally should stop and scan openings with binoculars.
- Transects should be driven to the end and back (40-80 km round trip).
- Each route survey should be repeated on two consecutive mornings.
- The wind should be calm or light (< 20 km/h) and precipitation minimal.
- Observer records all birds seen along the transect and categorizes birds according to sex, age, group size, location, habitat type, and time.
- The locations of all observations should be recorded to avoid double counting individuals when transects are repeated.

Data analysis

- The number of birds per route, male:female ratios, hen:juvenile ratios, average flock or brood size, and proportion of hens with broods can be determined. These data enable the comparison of relative abundance for habitat type, management strategy, region, and/or year.
- If surveys are continued for several years, linear regressions offer the best opportunity to detect fluctuations and/or differences in population trends.

3.4 Absolute Abundance

Recommended method(s): Territory mapping and complete lek surveys (see Table 1 for species-specific recommendations).

3.4.1 Territory Mapping

Territory mapping involves determining all territories on a particular area. Mapping is important because it prevents territories from being double counted. Territorial birds can be located by visual or auditory detection and/or with the aid of trained dogs or playbacks.

Advantages

- Provides complete count of territorial individuals (usually males) on an area, thus permitting estimates of both relative and absolute density.

Disadvantages

- Precision of density estimates are difficult to evaluate.
- Estimates biased by unknown behavioural differences between adult and young males, proportion of non-territorial individuals, and undefined sex ratios.

Examples

- Spruce grouse: Schroeder and Boag 1989.
- Blue grouse: Stirling and Bendell 1966.
- Ruffed grouse: Davies and Bergerud 1988.
- Willow ptarmigan: Jenkins *et al.* 1963, Mossop 1988.
- Rock ptarmigan: Weeden 1965.
- White-tailed ptarmigan: Braun *et al.* 1973.
- Gray partridge: McCabe and Hawkins 1946, Tapper 1988.
- Ring-necked pheasant: Tapper 1988.

Office procedures

- Review the section on Planning and Procedures in the Introductory manual.
- Obtain relevant maps for study area (e.g. Nautical charts, 1:50 000 air photo maps, 1:20 000 forest cover maps, 1:20 000 TRIM maps, 1:50 000 NTS topographic maps).
- Determine Biogeoclimatic zones and subzones, Ecoregion, Ecosection, and Broad Ecosystem Units for survey areas from maps.
- Areas should be selected for survey based on factors such as: 1) habitat diversity and continuity; 2) accessibility; 3) repeatability; and 4) management objectives (grazing, timber management, development, etc.).
- The number and/or size of areas to be monitored should be determined with several factors in mind: 1) the size of differences in annual population size that should be detectable; 2) the typical variation in numbers of territories; 3) the number of years of data collection; and 4) the number of desired comparisons between habitat types, management strategies, and/or regions.
- Each area should be 'gridded' with observation points to insure detection of all territorial males. The distance between observation points should be approximately half the distance used for points undefined radius (Table 3).
- Contact landowners for permission to survey private land.

Personnel

- Crew size depends on extent and thoroughness of the survey.
- Map reading and bird identification (visual and auditory) skills are essential.
- At least one crew member must be qualified to collect and record habitat data.

Time requirements

- Time allotted depends on extent and thoroughness of the survey.
- A minimum of five years of data are needed to assess of population trends.

Equipment

- Vehicle (optional)
- Binoculars
- Tape recorder and appropriate recordings (if doing playbacks)
- Global positioning unit (optional)
- Compass
- Maps
- Data forms

Field procedures

- Crews should thoroughly survey each area once for territorial males in early spring (Table 3).
- Surveys should be conducted by an observer in early morning (Table 3).
- The weather should be calm or light wind (< 20 km/h) and no precipitation.
- The observer should remain at each observation point long enough to detect sounds of displaying males and/or responses to playbacks. Distances between observation points should be approximately half the distances used for point counts of undefined radius (Table 3).
- Playbacks should consist of approximately 30 seconds of recordings, 1 minute of silence, 30 seconds of recordings, and 1 minute silence.
- Record locations of territorial birds to avoid counting them more than once. Care needs to be taken when using playbacks as birds can be 'drawn' in from long distances in response to the recording.
- Record all miscellaneous observations of females and males encountered while travelling between observation points.

Data analysis

- The number of males per km² should include both territorial and non-territorial males; large numbers of non-territorial males will result in biased estimates of population size.
- Population size and/or density (birds/km²) are estimated by multiplying the number of males by two (assumes a male:female sex ratio of 1:1). If more females than males are detected, multiply the number of females by two.
- These data enable the comparison of estimated absolute abundance for each year, habitat, management strategy, and/or region.
- If surveys are continued for several years, linear regressions offer the best opportunity to detect fluctuations and/or differences in population trends.

3.4.2 Complete Lek Surveys

Lek surveys are counts of leks and numbers of birds observed on leks. Complete lek surveys are counts of all leks in a defined area, providing an estimate of absolute abundance.

Procedures for complete lek surveys are the similar as those provided for sample lek surveys (see section 3.3.2), except for the following changes.

Field procedures

- As in section 3.3.2 except - New leks can be located by stopping at regular distances (Table 2). The entire survey area should be 'gridded' with observation sites to insure detection of all leks. The observer should remain at each site approximately 3 minutes, listening for sounds of displaying males (perhaps with a parabolic microphone).

Data analysis

- Data collected include number of birds per lek (sharp-tailed grouse) or number of males per lek (sage grouse), number of birds per km² (sharp-tailed grouse) or number of males per km² (sage grouse), and number of leks per km². These data enable the comparison of estimated absolute abundance for each year, habitat, management strategy, and/or region.
- Population size and/or density (birds/km²) are estimated using the following equations:
 1. Sharp-tailed grouse: population = total number of birds on leks X 2
 2. Sage grouse: population = total number of males on leks X 3
- The equation for sharp-tailed grouse assumes the following: 1) male:female sex ratio is approximately 1:1; 2) most males are observed on leks; and 3) most birds counted on leks are males. The equation for sage grouse assumes the following: 1) male:female sex ratio is approximately 1:2; and 2) most males are observed on leks.
- If surveys are continued for several years, linear regressions offer the best opportunity to detect fluctuations and/or differences in population trends.

GLOSSARY

LEKKING: clumped polygyny of grouse

LEKS: communal display sites (during breeding season) of grouse.

POLYGyny: having more than one mate

GREGARIOUS: living in flocks or communities.

CREPUSCULAR: appearing or active at dusk or dawn (during twilight).

COVEYS: a brood or small flock of partridges.

LITERATURE CITED

- Aldrich, J.W. 1993. Classification and Distribution. Pp. 47-54. *In*. Ecology and management of the mourning dove. Wildlife Management Institute. Stackpole Books. Harrisburg, PA.
- Aldrich, J. W., and A. J. Duvall. 1955. Distribution of American Gallinaceous Game Birds. Fish and Wildlife Service, Circular 34. 30pp.
- Allison, D. G. 1963. Basic features of the New Hampshire ruffed grouse census. *J. Wildl. Manage.* 27:614-616.
- Ammann, G. A. 1957. The prairie grouse of Michigan. Department of Conservation, Lansing, Michigan. 200pp.
- Ammann, G. A., and L. A. Ryel. 1963. Extensive methods of inventorying ruffed grouse in Michigan. *J. Wildl. Manage.* 27:617-633.
- Anthony, R. 1970. Ecology and reproduction of California quail in southeastern Washington. *Condor.* 72:276-287.
- Austin, D. E. 1980. The distribution and density of gray partridge in northern New York. Pages 1-8 *In* S. R. Peterson and L. Nelson, Jr., Eds., *Proc. Perdix II: Gray partridge workshop. For., Wildl., and Range Exp. Stn., Univ. Idaho, Moscow.*
- Baskett, T. S., M. J. Armbruster, and M. W. Sayre. 1978. Biological perspectives for the mourning dove call-count survey. *Trans. North Am. Wildl. Nat. Resour. Conf.* 43:163-180.
- Bent, A.C. 1932. Life histories of North American gallinaceous birds. Dover Publications, Inc. New York. 490 pp.
- Boag, D. A., and M. A. Schroeder. 1992. Spruce grouse. *In* The Birds of North America, No. 5 (Eds. A. Poole, P. Stettenheim, and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 28pp.
- Braun, C.E. 1991. Distribution and status of sage grouse in Colorado. *Trans. West. States Sage and Sharp-tailed Grouse Workshop* 17:12.
- Braun, C.E., and G.E. Rogers. 1971. The white-tailed ptarmigan in Colorado. *Colo. Div. Game, Fish, and Parks Tech. Publ. No. 27.* 80pp.
- Braun, C. E., K. Martin, and L. A. Robb. 1993. White-tailed ptarmigan. *In* The Birds of North America, No. 68 (Eds. A. Poole, P. Stettenheim, and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 24pp.
- Braun, C. E., R. K. Schmidt, Jr., and G. E. Rogers. 1973. Census of Colorado white-tailed ptarmigan with tape-recorded calls. *J. Wildl. Manage.* 37:90-93.

- Braun, C.E., D.E. Brown, J.C. Pederson, and T.P. Zapatka. 1975. Results of the four corners cooperative band-tailed pigeon investigation. Fish and Wildl. Ser. Res. Pub. 126. 20pp.
- Brennan, L. A., and W. M. Block. 1986. Line transect estimates of mountain quail density. J. Wildl. Manage. 50:373-377.
- Brewer, L. W. 1980. The ruffed grouse in western Washington. Washington State Game Department. Biological Bull. No. 16. 101pp.
- Bump, G., R. W. Darrow, F. C. Edminster, and W. F. Crissey. 1947. The ruffed grouse. New York State Conservation Department. The Holling Press, Inc., Buffalo, NY. 915pp.
- Campbell, R.W., N.K. Dawe, I. McT. Cowan, J.M. Cooper, G.W. Kaiser, and M.C.E. McNall. 1990. The birds of British Columbia. Vol. 2. Royal British Columbia Museum, Victoria.
- Cannon, R. W., and F. L. Knopf. 1981. Lek numbers as a trend index to prairie grouse populations.
- Carroll, J. P. 1993. Gray partridge. *In* The Birds of North America, No. 58 (Eds. A. Poole and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 20pp.
- Connelly, J.W., H.W. Browsers, and R.J. Gates. 1988. Seasonal movement of sage grouse in southeastern Idaho. J. Wildl. Manage. 52(1):116-122.
- Davies, R. G., and A. T. Bergerud. 1988. Demography and behavior of ruffed grouse in British Columbia. Pages 78-121 *in* A. T. Bergerud and M. W. Gratson, Eds., Adaptive strategies and population ecology of northern grouse. Univ. Minnesota Press, Minneapolis. 809pp.
- Dill, H. H., and W. H. Thornsberry. 1950. A cannon-projected net trap for capturing waterfowl. J. Wildl. Manage. 14:132-137.
- Dolton, D. D. 1993. The call-count survey: historic development and current procedures. Pages 233-252 *in* T. S. Baskett, M. W. Sayre, R. E. Tomlinson, and R. E. Mirarchi, eds. Ecology and management of the mourning dove. Stackpole Books, Harrisburg, PA.
- Eaton, S. W. 1992. Wild turkey. *In* The Birds of North America, No. 22 (Eds. A. Poole, P. Stettenheim, and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 28pp.
- Edminster, F. C. 1947. The ruffed grouse. The MacMillan Company, New York. 385pp.
- Galbreath, D.S., and R. Moreland. 1953. The chukar partridge in Washington. Wash. State Game Dept. Biol. Bull. No. 11, 54pp.
- Gates, J. M., and J.B. Hale. 1975. Reproduction of an east central Wisconsin pheasant population. Wis. Dept. Nat. Res. Tech. Bull. 85. 70pp.

- Geissler, P. H. 1984. Estimation of animal population trends and annual indices from a survey of call-counts or other indications. Proc. Am. Stat. Assoc., Sect. Surv. Res. Methods 1984:472-477.
- Geissler, P. H., and B. R. Noon. 1981. Estimates of avian population trends from the North American Breeding Bird Survey. Pages 42-51 in C. J. Ralph and J. M. Scott, eds. Estimating the numbers of terrestrial birds. Stud. Avian Biol. 6.
- Giesen, K. M., and J. W. Connelly. 1993. Guidelines for management of Columbian sharp-tailed grouse habitats. Wildl. Soc. Bull. 21:325-333.
- Gratson, M.W. 1988. Spatial patterns, movements, and cover selection by sharp-tailed grouse. Pp. 158-192. In. Adaptive strategies and population ecology of northern grouse (A.T. Bergerud and M.W. Gratson, Eds.). Univ. Minnesota Press, Minneapolis.
- Greeley, F., R. F. Labisky, and S. H. Mann. 1962. Distribution and abundance of pheasants in Illinois. Illinois Nat. Hist. Surv., Biological Notes No. 47. 16pp.
- Grensten, J. J. 1987. Locating sharp-tailed grouse leks from color infrared aerial photography. BLM Technical Note 377. 7pp.
- Gruys, R.C. 1991. Autumn and winter movements and mortality of willow ptarmigan at Chilkat Pass, British Columbia. MSc. Thesis. Univ. Alberta. Edmonton. 182pp.
- Guiguet, C.J. 1955. The birds of British Columbia (4) upland game birds. British Columbia Provincial Museum. Handbook No. 10. 48pp.
- Hillman, C. N., and W. W. Jackson. 1973. The sharp-tailed grouse in South Dakota. South Dakota Dep. of Game, Fish and Parks. Tech. Bull. No. 3. 62pp.
- Hoffman, R. W., H. G. Shaw, M. A. Rumble, B. F. Wakeling, C. M. Mollohan, S. D. Schemnitz, R. Engel-Wilson, and D. A. Hengel. 1993. Management guidelines for Merriam's wild turkeys. Colorado Div. Wildlife, Div. Rep. No. 18. 24pp.
- Holder, K., and R. Montgomerie. 1993. Rock ptarmigan. In The Birds of North America, No. 51 (Eds. A. Poole and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 24pp.
- Jarvis, R. L., and M. F. Passmore. 1992. Ecology of band-tailed pigeons in Oregon. U.S. Fish and Wildl. Serv., Biol. Rep. No. 6. 38pp.
- Jenkins, D., A. Watson, and G. R. Miller. 1963. Population studies on red grouse *Lagopus lagopus scoticus* (Lath.) in north-east Scotland. J. Anim. Ecology 32:317-376.

- Johnsgard, P.A. 1973. Grouse and quails of North America. Univ. Nebraska Press, Lincoln. 551pp.
- Johnsgard, P.A. 1983. The grouse of the world. Univ. Nebraska Press, Lincoln. 413pp.
- Keppie, D. M., H. M. Wight, and W. S. Overton. 1970. A proposed band-tailed pigeon census - a management need. Trans. North Am. Wildl. and Nat. Resour. Conf. 35:157-171.
- Kimball, J. W. 1949. The crowing count pheasant census. J. Wildl. Manage. 13:101-120.
- MacDonald, S. D. 1970. The breeding behavior of the rock ptarmigan. The Living Bird 9:195-238.
- March, J. R., and K. E. Church. 1980. Use of roadside calling counts as an index to spring gray partridge abundance. Pages 87-100 in S. R. Peterson and L. Nelson, Jr., eds. Proc. Perdix II: gray partridge workshop. For., Wildl., and Range Exp. Station, Univ. Idaho, Moscow.
- McCabe, R. A., and A. S. Hawkins. 1946. The Hungarian partridge in Wisconsin. Amer. Midland Naturalist 36:1-75.
- McCaughran, D. A., and R. Jeffrey. 1980. Estimation of the audio index of relative abundance of band-tailed pigeons. J. Wildl. Manage. 44:204-209.
- McGowan, J.D. 1975. Effect of autumn and spring hunting on ptarmigan population trends. J. Wildl. Manage. 39:491-495.
- Mirarchi, R.E., and T.S. Baskett. 1994. Mourning dove (*Zenaida macroura*). In. The Birds of North America, No. 117 (A. Poole and F. Gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, D.C.: The American Ornithologists Union.
- Molini, W.A. 1976. Chukar partridge species management plan. Nevada Dept. Fish and Game. 51pp.
- Mossop, D. H. 1988. Winter survival and spring breeding strategies of willow ptarmigan. Pages 330-378 in A. T. Bergerud and M. W. Gratson, Eds., Adaptive strategies and population ecology of northern grouse. Univ. Minnesota Press, Minneapolis. 809pp.
- Petraborg, W. H., E. G. Wellein, and V. E. Gunvalson. 1953. Roadside drumming counts: a spring census method for ruffed grouse. J. Wildl. Manage. 17:292-295.
- Robinson, W. L. 1980. Fool hen. The spruce grouse on the Yellow Dog Plains. The Univ. of Wisconsin Press, Madison. 221pp.
- Rogers, G. E. 1963. Blue grouse census and harvest in the United States and Canada. J. Wildl. Manage. 27:579-585.

- Rotella, J. J., and J. T. Ratti. 1986. Test of a critical density index assumption: a case study with gray partridge. *J. Wildl. Manage.* 50:532-539.
- Sauer, J. R., D. D. Dolton, and S. Droege. 1994. Mourning dove population trend estimates from call-count and North American breeding bird surveys. *J. Wildl. Manage.* 58:506-515.
- Sayre, M. W., R. D. Atkinson, T. S. Baskett, and G. H. Haas. 1978. Reappraising factors affecting mourning dove perch cooing. *J. Wildl. Manage.* 42:884-889.
- Schroeder, M. A., and D. A. Boag. 1989. Evaluation of a density index for territorial male spruce grouse. *J. Wildl. Manage.* 53:475-478.
- Schulz, J. W. 1992. Grey partridge (*Perdix perdix*) populations and management in North Dakota: a review. *Gibier Faune Sauvage* 9:807-816.
- Scott, V. E., and E. L. Boeker. 1972. An evaluation of wild turkey call counts in Arizona. *J. Wildl. Manage.* 36:628-630.
- Sisson, L.H. 1968. Calling behavior of band-tailed pigeons in reference to a census technique. MSc. Thesis, Oregon State Univ., Corvallis. 57pp.
- Stirling, I., and J. F. Bendell. 1966. Census of blue grouse with recorded calls of a female. *J. Wildl. Manage.* 30:184-187.
- Tapper, S. C. 1988. Population changes in gamebirds. Pages 18-47 *in Ecology and Management of Gamebirds* (Eds. P. J. Hudson and M. R. W. Rands). BSP Professional Books, Oxford, Great Britain. 263pp.
- Wakeling, B. F. 1991. Population and nesting characteristics of Merriam's turkey along the Mogollon Rim, Arizona. Arizona Game and Fish Dep., Res. Branch Tech. Rep. No. 7. 48pp.
- Wallestad, R. 1975. Life history and habitat requirements of sage grouse in central Montana. Montana Dept. Fish and Game. 65pp.
- Washington Department of Wildlife. 1993. Distribution status of the mountain quail (*Oreortyx pictus*) in Washington. Unpubl. rep. Wash. Dept. Wildl., Olympia. 22pp.
- Weeden, R. B. 1965. Breeding density, reproductive success, and mortality of rock ptarmigan in Eagle Creek, central Alaska, from 1960 to 1964. *Trans. N. Am. Wildl. Conf.* 30:336-348.
- Weigand, J. P. 1980. Ecology of the Hungarian partridge in North-central Montana. *Wildl. Monogr.* 74. 106pp.
- Willis, M.J., G.P. Keister Jr., D.A. Immell, D.M. Jones, R.M. Powell, and K.R. Durbin. 1993. Sage grouse in Oregon. Oregon Dept. Fish and Wildl. No. 15. 71pp.
- Zwicker, F. C. 1982. Blue grouse. Pages 63-65 *in* D. E. Davis, ed. *Handbook of census methods for terrestrial vertebrates*. CRC Press, Inc., Boca Raton, Fla.

Zwickel, F. C. 1992. Blue grouse. *In* The Birds of North America, No. 15 (Eds. A. Poole, P. Stettenheim, and F. Gill). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union. 28pp.