A SURVEY OF PESTICIDE USE AND BIRD ACTIVITY ON SELECTED GOLF COURSES IN BRITISH COLUMBIA

Ian E. Moul
John E. Elliott

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ABSTRACT

We examined the potential for pesticide poisoning of birds found on British Columbia golf courses. We counted birds, observed bird behaviour and compared the wildlife habitats on golf courses in the lower Fraser Valley with pesticide use information supplied by golf course superintendents throughout the province. A total of 103 bird species were observed on golf courses during this study. Eight species, the European Starling, American Robin, Mallard, Northwestern Crow, Canada Goose, Barn Swallow, Dark-eyed Junco and Black-capped Chickadee were among the 10 species most common and also the 10 most numerous species sighted. Water was the most intensively used habitat averaging 56.0 birds per hectare, followed by hedgerows, trees and grass (7.8, 4.4 and 4.1 birds per hectare respectively). Seven species, the Canada Goose, American Wigeon, Killdeer, Northwestern Crow, European Starling, American Robin and Brewer's Blackbird were observed feeding on turf. From the pesticide use data collected, it appears that acutely toxic products such as diazinon are not widely used on British Columbia golf courses. Providing the results of our questionnaire are representative and that turf care products are applied at recommended rates, the use of chemicals on British Columbia golf courses does not appear to pose a significant threat to birds. The majority of superintendents who responded to the questionnaire said they support and encourage wildlife on their courses and are willing to accept some damage to turf surfaces.

RÉSUMÉ

Nous avons étudié la possibilité que les oiseaux fréquentant les terrains de golf de la Colombie-Britannique soient intoxiqués par des pesticides utilisés à ces endroits. Nous avons dénombré les oiseaux, observé leur comportement et comparé les habitats de la faune sauvage sur les terrains de golf de la partie inférieure de la vallée du Fraser aux informations sur l'utilisation des pesticides fournies par les surintendants des terrains de golf de toute la province. Au cours de cette étude, on a observé un total de 103 espèces d'oiseaux sur ces terrains. Huit espèces, soit l'Étourneau sansonnet, le Merle d'Amérique, le Canard colvert, la Corneille d'Alaska, la Bernache du Canada, l'Hirondelle des granges, le Junco ardoisé et la Mésange à tête noire, figuraient parmi les dix espèces les plus courantes et les plus numbreuses observées. Le milieu aquatique étaient l'habitat le plus utilisé avec en moyenne 56,0 oiseaux par hectare, suivi des haies, des arbres et du gazon (avec respectivement 7,8, 4,4 et 4,1 oiseaux par hectare). Sept espèces, la Bernache du Canada, le Canard siffleur, le Pluvier kildir, la Corneille d'Amerique, l'Étourneau sansonnet, le Merle d'Amérique et le Quiscale de Brewer se nourrissaient de gazon. D'après les données recueillies sur l'utilisation des pesticides, il semble que l'application sur les terrains de golf de produits très toxiques comme le diazinon ne soit pas très répandue en Colombie-Britannique. Pourvu que les résultats de notre questionnaire soient représentatifs et que les produits d'entretien de gazon soient appliqués à la dose recommandée, il ne semble pas que les produits chimiques utilisés sur les terrains de golf dans cette province posent une menace importante pour les oiseaux. La plupart des surintendants qui ont répondu au questionnaire ont indiqué qu'ils tolèrent et encouragent la présence d'animaux sauvages sur leurs terrains et qu'ils sont prêts à accepter une certaine détérioration des surfaces gazonnées.

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CHAPTER 1 - INTRODUCTION

Wildlife mortality associated with the application of pesticides to turf has been reported throughout North America (e.g. Frank et al. 1991, Littrell 1986, Stone and Knoch 1982 and Zinkl et al. 1978). However, in 26 reported bird kills from November 1971 to August 1989 documenting mortality of approximately 3,000 birds in the Lower Fraser Valley, only one instance occurred on a golf course, a diazinon poisoning of 18 Mallards (Canadian Wildlife Service 1991). At the onset of this study it was unclear if wildlife mortality was occurring and remained undetected, or if the pesticide application practices on British Columbia golf courses were not a substantial direct risk to wildlife.

The popularity of golf in British Columbia has increased greatly in the past 20 years (Argyle *et al.* 1991). Many proposals for new golf course developments have come from eastern Vancouver Island, the Lower Fraser Valley and the Okanagan, regions of the province experiencing rapid urbanization and loss of agricultural lands (see Moore 1990; Kerr *et al.* 1985). A review of published literature showed limited information on wildlife use of golf courses. While the potential of golf courses as wildlife habitat has been examined elsewhere, (e.g. Dodson 1990; Green and Marshall 1987; Fordham and Iles 1987) we found no studies documenting the diversity of bird species or the behaviour of birds found on golf courses.

This study was in response to a perceived conflict between the use of agricultural chemicals for turf maintenance on golf courses in British Columbia and the health and wellbeing of the wildlife found on these golf courses. We had three main objectives:

1) to describe the bird communities found in the various habitats offered by golf courses,
2) to describe turf care chemical use on golf courses,
3) to determine if birds on golf courses are at risk to toxic exposure to chemicals.

CHAPTER 2 - METHODS

2.1 Study Sites

We counted and observed birds on eight golf courses located from Vancouver to South Langley in the lower Fraser Valley region of British Columbia (Figure 2.1). The sites were chosen to reflect a range of potential wildlife habitat from very open and sparsely foliated courses to others with large areas of trees and hedgerows (see section 2.4 for habitat definitions). Brief descriptions of each course are given below.

2.1.1 Beach Grove Golf Club (BGR) - Located in the Municipality of Delta approximately one city block from the west shore of Boundary Bay. This 49 ha private course was opened in 1929. At the time of this study there were many trees of varying sizes with minimal understorey vegetation. Approximately half of the west boundary and the northwest corner was forested with dense hedgerow vegetation. The portion of the course we surveyed contained two ponds and some drainage ditches, the vegetation in and around the ponds was closely cropped. The front and back nines were separated by a secondary road, the north and southeast boundary were also secondary roads and the northeast boundary was a residential street. About half of the west boundary was condominium development with the remaining regions hedgerow. The south boundary was a field. Enclosed within the front nine were a row of houses, this part of the course was excluded from the study.

2.1.2 Coyote Creek Golf and Country Club (CCR) - Located in the Municipality of Surrey, 8 km northeast of Boundary Bay, on the uplands of the Serpentine River with a tributary, Bear Creek, flowing through the course. About half the course was on a south facing slope, the remainder on the flat upper reaches of the Boundary Bay floodplain. This public course opened for play in 1990 and covered 24 ha. With the exception of hedgerows along Bear Creek, this course had minimal ground cover. While hundreds of trees had been planted, there was little or no understorey vegetation. The course had two ponds where natural aquatic vegetation had been allowed to grow. The north and east boundaries were rural housing, the south boundary a marshy abandoned horse pasture. On the west was a heavily used primary road across which was another golf course, a housing development and a horse pasture.

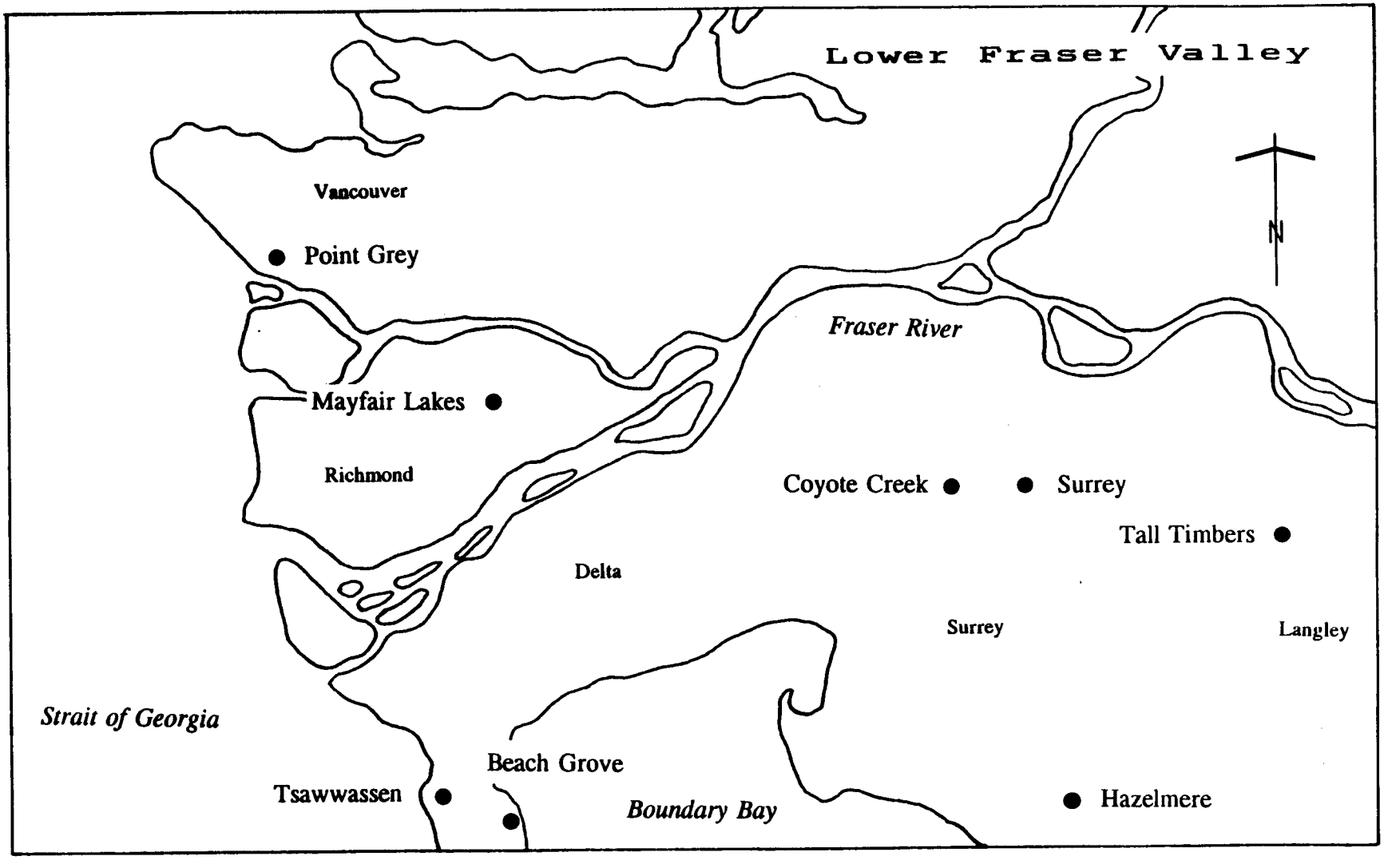

Figure 2.1 Location of golf course study sites in the Lower Fraser Valley of British Columbia.

2.1.3 Hazelmere Golf and Tennis Club (HAZ) - Located in the rolling hills of the Campbell Valley region of the Municipality of Surrey 5 km east of Boundary Bay. This was a semi-private course which opened in 1962 and covered 51 ha. This course was a mix of open sparsely foliated areas and clumps of forest and hedgerow where natural vegetation had been allowed to grow. There was one lake with minimal vegetation and a stream which flowed through blocks of forest. The north boundary was a primary rural road. The east and south boundaries were rural road and rural residential. Campbell Creek flowed along part of the west boundary, the remainder was a field.

2.1.4 Mayfair Lakes Golf Course (MLA) - Located on Lulu Island, part of the Fraser River delta in the Municipality of Richmond. This public course opened in 1989 and covered 65 ha. This course was built on the fields of a dairy farm, it was very open with small scattered trees. The large areas of lake had almost no exposed aquatic vegetation. The north boundary was a four lane freeway. The east and west boundaries were secondary farm roads across which were fields. The south bordered on a Christmas tree farm.

2.1.5 Point Grey Golf and Country Club (PGR) - Located in the city of Vancouver, immediately north of the Fraser River. This private course opened in 1922 and covered 57 ha. This course had large areas of forest and hedgerow. There were four small ponds where vegetation was minimal and several ditches where vegetation had been allowed to grow. The east boundary was an agricultural residential area with horse barns and pasture. The south boundary was the Fraser River. To the west was another golf course, and to the north, urban residential.

2.1.6 Surrey Golf Course (SRY) - Located immediately north of the Serpentine River 10 km northwest of Boundary Bay in the Municipality of Surrey. This was a public course which opened in 1972 and covered 49 ha. Most treed areas had minimal understorey vegetation. The small ponds and the ditches had minimal exposed vegetation. The south boundary, next to an agricultural area, was a dike-hedgerow of blackberries, low bushes and tall grasses. The Serpentine River adjoined the southeast corner. The west boundary was a primary rural road across which were fields. The north boundary is a rural-suburban housing development. The east boundary was another golf course and a highway.

2.1.7 Tall Timbers Golf Course (TTI) - Located on the upper reaches of the Nicomekl River in the municipality of Langley, 23 km west of Boundary Bay. This is family operated public course that was opened in 1980 and covered 65 ha. Much of this course was heavily treed with dense understorey vegetation. The course was bordered on the south and west by primary rural roads. The north and east boundary were rural residential.

2.1.8 Tsawwassen Golf and Country Club (TSA) - Located in the Municipality of Delta, 1 km from the Strait of Georgia - Fraser River foreshore. This public course opened in 1967 and covered 32 ha. The centre of this course was open with vegetation removed from tree bases. A pond system which wound through much of the centre of the course had minimal exposed aquatic vegetation. The south boundary was a hillside of natural vegetation above which were houses. The west boundary was a private residence. To the north and east were abandoned fields.

2.2 Golf and Golf Course Terminology

In writing this report we assume the reader has a general knowledge about golf and the object of play. When counting birds, observing bird behaviour or calculating application areas for turf care products, we adapted the following definitions from Beard (1982).

1) Green - the area of turf immediately surrounding the cup. A "normal" green area averages 560 m^2 (range from 450-700 m^2). While the total turf area of green is about 2% that of a golf course, greens probably receive as much traffic and maintenance as the rest of the course combined. The turf on greens is usually distinguished from other turf area by being cut at 4.8 to 6.4 mm.

2) Collar - a 0.9 - 1.5 m wide band of turfgrass around each green with the turf cut at 10.0 - 18.0 mm. For the purposes of this study, collars have been combined with greens.

3) Apron - an area of turf extending a minimum of 15 m in all directions from a green. The turf of the apron is cut between 13.0 - 25.0 mm. In this study, aprons have been combined with fairways.

4) Fairway - the turfed area of play between the tee and the green. Fairways on an average 18 hole course make up 20 ha or 2/5 of the course area. Fairways are usually between 32 and 55 m wide and the turf is cut at 13.0 - 30.0 mm.

5) Rough - the area surrounding each golf hole, which forms the background in which the game is played. It is not uncommon for rough to account for 1/2 of a course area. The turf of areas of rough is cut at 25.0 - 50.0 mm.
6) Tee - the turf surface where a golfer makes a first stroke of play on each hole. Next to the green, tees receive the highest traffic and maintenance. Turf of tees is cut between 7.6 - 20.0 mm. There are between one and four tee areas per hole on each course, the most common being three. The area of tee on each hole ranges from 30 - 60 m^2.

2.3 Bird Censuses

During July and August 1990, summer resident birds were counted on a total of 120.7 ha made up of the eight golf courses described in section 2.1 (henceforth referred to as summer counts). On each course we surveyed and flagged three to four straight lines (transects), parallel to each other and 150 m apart. Additional lines 50 m either side of the main transects, also surveyed and flagged, produced a 100 m wide survey belt with 50 m separation between each belt. While walking the transects we recorded all birds seen or heard during four early morning walks at each course. Course codes and transect areas may be found in Appendix 1. Codes, vernacular and scientific names of birds appear in Appendix 2.

From 30 November 1990 to 1 July 1991, birds were counted on four of the original eight courses, (BGR, PGR, SRY and TSA), a total area of 69.9 ha (henceforth called winter-spring counts). The original transects were lengthened to include up to 50 m of adjacent (usually hedgerow) habitat when practical. Where a 100 m wide transect incorporated only a portion of a pond, birds on the entire pond were counted and the additional water area was added to the total survey area. During these counts, to facilitate a habitat use study (see section 2.4), the locations of all birds were recorded on maps of the transect area. Waterfowl using rain pools on turf areas were recorded as using a water habitat but the pool area was not added to the total area classified as water habitat. When flocks of birds on turf spilled over the boundaries of the survey area the entire flock was counted and no additional area was added to the transect. Birds observed flying over the courses were counted and indicated as flying.

Before making any calculations with bird census data we made three adjustments:
1) Eight hundred Snow Geese were observed on one occasion flying over one transect. As this species was never observed using a golf course habitat, their sighting was noted, but their numbers were excluded from all calculations.

2) Belted Kingfishers observed flying over ponds were classified as using a "water" habitat.
3) All Barn Swallow observations were classified as "flying".

2.3.1 Species Richness

Following O'Connor and Shrubb (1986) and Fuller (1982) we defined those **species observed on greater than half of the golf courses censused (5,6,7 and 8 courses during summer counts and 3 or 4 courses during the winter-spring counts), as comprising the "community"** of birds found on golf courses. We used the same criteria when defining those species making up the communities found within specific habitats on golf courses. Those **species observed on over half of the counts were considered as "common".**

When graphically presenting species data for each month, (winter-spring counts), we used the maximum number of species observed in each habitat on a given month.

2.3.2 Average Bird Density

Bird density within each habitat type was calculated by dividing the total number of birds counted in each habitat by the habitat area and then by the total number of census days.

When graphically presenting data for bird density each month, (winter-spring counts), we took the total sightings each month, divided by the land area of each habitat and then divided by the number of census days in that month.

2.3.3 Relative Abundance

To calculate the relative abundance of individual species over all the courses sampled, we divided the number of each species by the total numbers of all species then multiplied by 100 to get a percent value.

2.4 Habitat Classification

To determine avian use patterns within the habitats offered on golf courses, we mapped the major vegetation on the transect routes of four courses. Vegetation was classified as either:
1) Grass - defined as all areas of intensive turf maintenance including the greens, tees, fairways and areas of rough not associated with trees, shrubs or brush;

2) Hedgerow - defined as all areas of trees, shrubs or brush where the understorey vegetation receives no maintenance and is allowed to grow naturally;
3) Trees - defined as individual or grouped trees or shrubs of any species where the understorey vegetation had been removed;
4) Water - defined as all lakes, ponds, streams, ditches and winter rain pools.

By using acetate overlays depicting regions under each classification in conjunction with the locations of birds counted during each census, we were able to determine the habitat use patterns of each bird species. To estimate the area of each habitat type, the acetate overlays were placed on 1/4 inch graph paper and the proportion of each habitat type was determined by counting squares (Table 2.1). Codes used for habitat classification appear in Appendix 3.

Table 2.1 Land area of each habitat type surveyed on four golf courses.

Habitat Type	Area of each course (Ha)				
	BGR	PGR	SRY	TSA	Total
Grass	8.5	14.4	17.4	11.3	51.6
Hedgerow	0.9	2.8	0.6	0.9	5.2
Trees	1.2	5.2	2.0	1.8	10.2
Water	0.3	0.4	0.6	1.6	2.9
Totals	10.9	22.8	20.6	15.6	69.9

2.5 Feeding Behaviour of Birds on Turf

The feeding behaviour of American Robins, European Starlings, Northwestern Crows, Brewer's Blackbirds and Killdeer, was observed on six courses from June through August 1990. From three fixed points on each course, the amount of time and the location of feeding (greens, fairway or rough) of birds was measured using scan sampling (Altmann 1974) each three minutes for half hour periods. The study plots were approximately 1 Ha in

size and were chosen such that each contained green, fairway and rough and an observer, safe from golf balls, could have an uninterrupted view. As it was often quite difficult to distinguish fairway from rough, we defined rough as areas along each edge of the fairways and those areas away from direct play, around tree bases. There was no attempt to have the study plots fall within or without the transects described in section 2.3. Each study plot was observed on eight different days. Four observation sessions were within the three hours following dawn and four sessions were between 1200 and 1700 PDT.

To estimate the area of each study plot, we first photocopied sections of golf course irrigation system blueprints of known scale (supplied by course superintendents) onto 1/4 inch graph paper. Using compass bearings and a 50 m chain we marked the perimeter of each study plot on the graph paper. The areas of fairway and rough were calculated by counting squares. Due to the difficulty of plotting an accurate area for each green on the maps, the area of all greens was set at 560 m^2, the average size of a green (Beard 1982).

We compared the presence or absence of robins, starlings, crows, blackbirds and killdeer on turf during four morning and four afternoon observation sessions on 18 sites using a paired t-test (Zar 1984) run on SYSTAT (Wilkinson 1990).

To compare usage of turf surfaces (green, fairway and rough), we divided the total number of birds of each species counted on each turf surface during the 40 scans of four observation sessions at each of 18 sites, (morning and afternoon), by 40 to get the average number of birds observed at any one time. We then divided by the land area of each turf type specific to each site. We tested the null hypothesis that there would be equal numbers of birds per hectare on each turf type using a Friedman two-way analysis of variance (Zar 1984) run on SYSTAT (Wilkinson 1990). For results significant at $P<0.05$, we again used a Friedman two-way analysis of variance to separate significant differences of pairs of turf type: green-fairway; green-rough; and fairway-rough.

2.6 Behaviour of Waterfowl on Turf

Resource use and behaviour of flocks of Canada Geese, Mallards and American Wigeon were observed during five one hour sessions on one course (Tsawwassen) from November 1990 to January 1991. Each ten minutes during a session we scanned all visible waterfowl. Speaking into a tape-recorder, each individual was identified by species and classified into the following behaviours: feeding, loafing - defined as any terrestrial or aquatic activity other than feeding, and flying. In addition, the bird's location on either: green, fairway, rough or water was also indicated.

We used no fixed location for these surveys but rather chose locations, safe from golf balls, offering a clear view of as many birds as possible.

2.7 Calculation of Risk Index

We define a Risk Index as the proportion of time that an individual of a species spends in direct contact with a potential hazard, such as a turf care product. To calculate a Risk Index, following Fletcher and Greig-Smith (1988), we divided the average numbers of a species present on regular scans (n) by the estimated population size (N_{min})(=the maximum number of that species seen simultaneously). The result is a value between 0, a bird spending no time on turf and at no risk, and 1, a bird spending all its time in direct contact with turf and potential contamination.

$$\frac{n}{N_{min}} = \text{Risk Index}$$

For passerines and for Killdeer we assumed that all time spent on the turf, represented feeding. To set a risk factor for each individual species, we pooled data for course, date, time and site, and took the mean of the calculated risk indices for each session that species was observed.

When calculating a Risk Index for waterfowl, we first determined the proportion of time during each session that an average bird spent feeding (the total counts of birds feeding divided by the total count in that session). The Risk Index is the mean of the feeding times from each individual session.

2.8 Turf Care Chemicals and Wildlife Questionnaire

A chemical use and wildlife activity questionnaire (see Appendix 9) was either mailed or handed directly to superintendents at 75 golf courses in British Columbia. Selection of courses to be surveyed was initially made by a random sample of 50 golf courses from a list of addresses in the British Columbia section in membership directory of the Canadian Golf Course Superintendents Association. An additional 19 questionnaires were handed out at meetings of the Lower-mainland, Vancouver Island and Interior chapters of the British Columbia Golf Course Superintendents Association. A final six questionnaires were handed to golf course superintendents we met on their courses. A follow-up letter or phone call was made to superintendents that did not return questionnaires within two months.

Returned questionnaires were classified into one of three regions of the province. The Lower Fraser Valley (LFV) included all courses either side of

the Fraser River, south of the coast mountains, north of the Canada-United States border and west of the town of Hope. Vancouver Island (ISL) included all courses on Vancouver Island plus one course from Saltspring Island. Data from Prince Rupert, given its coastal climate, was included with Vancouver Island. The Okanagan and Interior (INT) included all inland courses beyond the immediate effect of a coastal climate. A list of the 36 superintendents who responded to the questionnaire may be found in Appendix 10.

2.8.1 Turf Care Chemical Use

Chemical use information was tabulated on the basis of active ingredient as indicated on the product labels. All units were converted to metric. If a product contained a mix of ingredients, each was recorded separately. If for example, a product was reported to be used three to four times each year, we entered 3.5 in our data set. If a product was reported to be used less than once each year, for example one time each five years, we used 0.2 as a yearly application rate and divided the total amount by five to get an average amount used per year. To determine the surface areas treated, we used information given in the questionnaires, and then divided by the number of applications per year. For tabulated data see Appendices 11 for codes and 12, 13, 14, 15 for fungicide, herbicide, insecticide and fertilizer use. Fungicides, herbicides and insecticides are listed by active ingredient. Nutrients are listed by course. Estimates of total nitrogen, phosphorus and potassium were calculated from total volumes applied, as indicated in the questionnaire, by first removing portions accounting for trace elements and/or pesticides and then multiplying by the nitrogen, phosphorus and potassium (N-P-K) ratios. When estimating amounts of fertilizers used on different turf surfaces, we used the following ratios, green:apron:tee:fairway:rough 4:4:2:60:30. When calculating kg/ha/year of fertilizers, we used average surface areas of each turf type on an 18 hole course as follows: greens = 1.0 ha, tees = 0.5 ha, fairways = 20 ha, and the fertilized portion of rough = 10 ha.

In presenting these data we have intentionally excluded all trade names and have considered information from individual courses as confidential. For a reader to examine these data on a course by course basis we have included non-identifiable course codes in Appendices 12 through 15.

2.8.2 Wildlife Questionnaire

Questions to golf course superintendents about wildlife produced qualitative results. In some instances we were able to categorize and rank opinions, in others we simply listed the responses and indicated the numbers of superintendents making similar comments.

CHAPTER 3 - RESULTS

3.1 Bird Censuses

In July and August of 1990 (summer counts), 70 species were recorded during 32 counts on eight golf courses (Appendices 4 and 5). Numbers of bird species on individual courses ranged from 14 to 46 (mean = 26.6, SD = 9.3). Nineteen species were recorded only once during the 32 counts. Eighteen species were found on five or more courses (Table 3.1) and were considered as making up the community of birds found on golf courses. Eight species, considered common, were recorded on over half the counts.

Table 3.1 The occurrence, frequency of detections and relative abundance (percent of all birds) of the eighteen most common bird species seen during 4 censuses on each of 8 golf courses during **July and August** 1990.

Species	Detections		Relative abundance (% of all birds) n=4,140
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Great Blue Heron	5	8	0.3
Mallard	8	23	2.9
Downy Woodpecker	5	6	0.2
Violet-green Swallow	6	10	0.7
Barn Swallow	8	31	13.6
Northwestern Crow	7	25	10.8
Black-capped Chickadee	7	24	3.8
Bushtit	5	10	4.2
American Robin	7	25	7.2
Cedar Waxwing	7	18	1.8
European Starling	8	26	25.1
Yellow Warbler	5	7	1.2
Red-winged Blackbird	5	7	0.6
Brewer's Blackbird	5	14	2.2
Brown-headed Cowbird	7	10	0.6
House Finch	6	13	0.8
American Goldfinch	7	21	1.7
Pine Siskin	5	9	0.6
Total			78.0

From 30 November 1990 to 1 July 1991 (winter-spring counts) we observed 82 species during 120 counts on four courses (Appendices 6 and 7). The number of species on individual courses ranged from 37 to 56 (mean = 45.5, SD = 7.2). Seventeen species were recorded only once. We considered 29 species, found on

three or four of the courses to be the community of birds founds on golf courses (Table 3.2). Five species, observed on more than half of the 120 counts, were considered common. The American Wigeon, while only observed in large numbers on one course, accounted for 15.1 % of all birds counted.

Table 3.2 The occurrence, frequency of detections and relative abundance (percent of all birds) of 29 bird species seen during 30 censuses on each of 4 golf courses from **November 1990 to July 1991.**

Species	Detections		Relative abundance (% of all birds) n=15,303
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Great Blue Heron	4	32	0.2
Canada Goose	4	58	6.0
Mallard	4	83	13.1
Bufflehead	4	21	0.3
Hooded Merganser	3	5	0.1
Bald Eagle	4	18	0.1
Red-tailed Hawk	4	35	0.3
Killdeer	3	8	0.1
Glaucous-winged Gull	4	51	1.6
Downy Woodpecker	3	11	0.1
Northern Flicker	4	23	0.2
Violet-green Swallow	4	19	0.3
Barn Swallow	4	30	1.3
Northwestern Crow	4	108	6.4
Black-capped Chickadee	4	80	1.3
Bushtit	4	34	1.5
Winter Wren	3	23	0.3
Golden-crowned Kinglet	4	32	1.4
Ruby-crowned Kinglet	3	4	<0.1
American Robin	4	97	15.6
Cedar Waxwing	4	14	0.3
European Starling	4	83	23.2
Rufous-sided Towhee	3	21	0.2
Song Sparrow	4	51	0.7
Dark-eyed Junco	4	57	2.5
House Finch	4	44	0.7
American Goldfinch	4	54	1.0
Pine Siskin	4	29	0.4
Evening Grosbeak	4	20	1.9
Total			80.9

3.2 Habitat Use

Just under half of all birds counted during winter-spring counts were seen on turfgrass (Table 3.3). If we consider bird numbers per land area of each habitat, (Figure 3.1) water accounts for 14 times as many birds as turf. Hedgerows, with a bird density about 1/7 that of water had the highest number of species, doubling both turf and water (Figure 3.2). Tree habitat had a similar number of species as hedgerows but with only 2/3 the total number of birds per hectare.

Table 3.3 Species counts and total number of birds counted in four types of habitat found on four golf courses during 30 counts at each course from November 1990 to July 1991.

Habitat	Number of bird species	Total number of birds	Land area surveyed (hectares)	Average number of birds/ha
Grass	19	6,355	51.6	4.1
Hedgerow	40	1,210	5.2	7.8
Trees	37	1,348	10.2	4.4
Water	22	4,871	2.9	56.0
Total	73	13,784[1]	69.9	6.6

[1] This total excludes 1,519 birds observed flying.

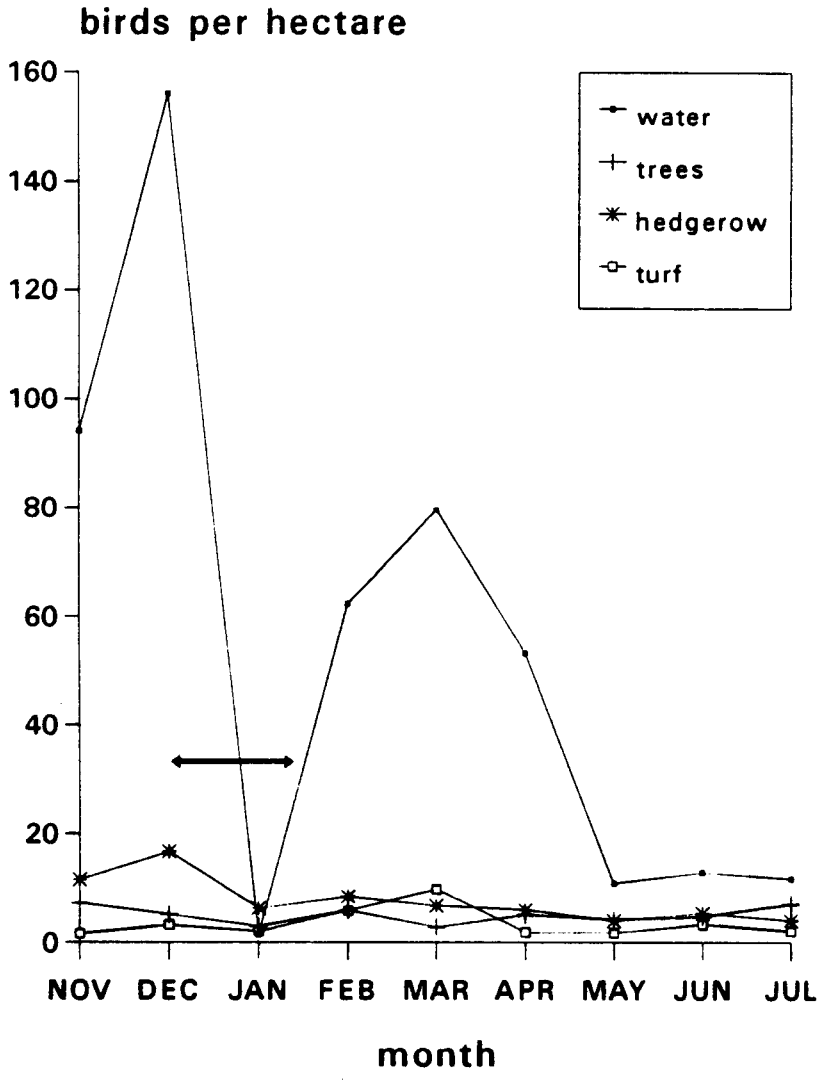

Figure 3.1 Birds per hectare in four habitats on four golf courses in the Lower Fraser Valley, British Columbia. The horizontal arrow represents the time when ponds and waterways were frozen.

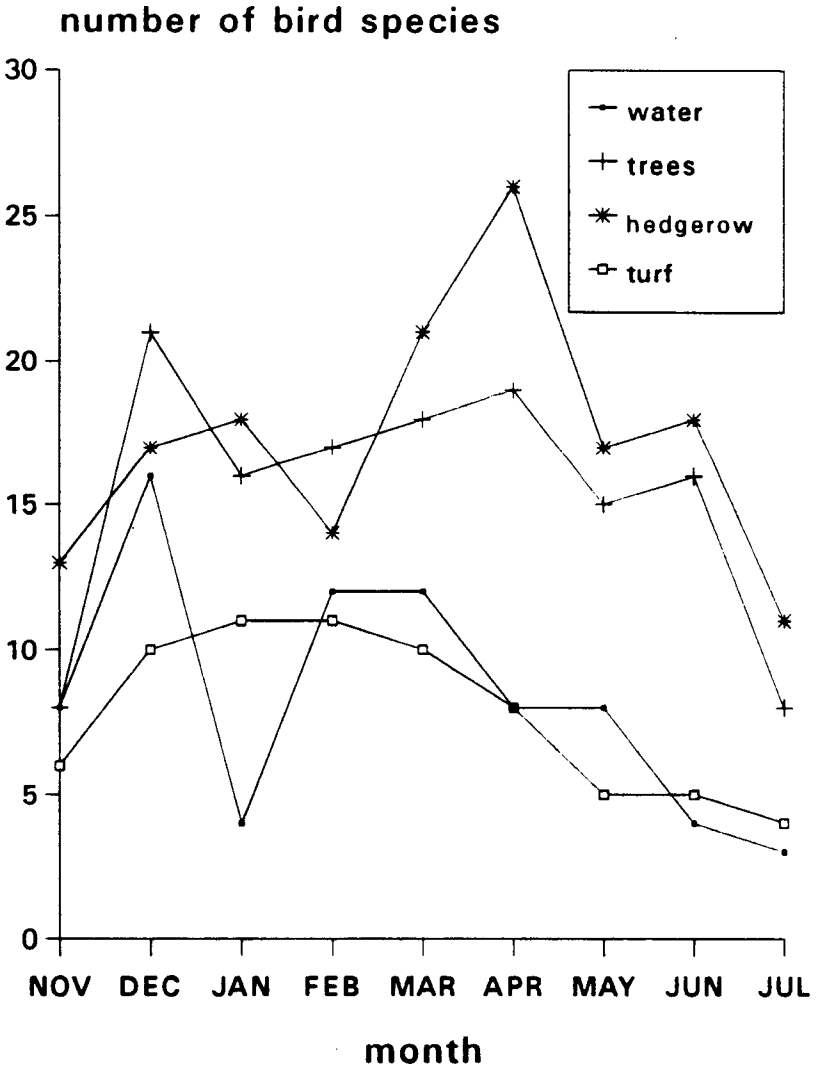

Figure 3.2 Monthly species counts of birds in four habitats on four golf courses in the Lower Fraser Valley, British Columbia.

3.2.1 Bird Species Found on Turfgrass

Of the 19 species found on turf (Appendix 8), eight were considered to make up the "community" of birds likely to be found on golf course turf (Table 3.4). Two species, seen on over half of the 120 counts, the American Robin (relative abundance 31.6%) and the European Starling (50.3%), together accounting for over 80% of the birds counted on turf, were considered common. The American Wigeon, notably absent from our list and frequently observed on turf, flushed to nearby ponds each time an observer approached and was therefore counted among the species using water (see sections 3.2.4 and 3.4). Across the months (Figure 3.3), migrating robins at SRY and starlings at TSA accounted for increased numbers of birds during late February and through March. Overall there was very little difference among the courses in terms of bird numbers per land area or in the maximum number of species.

Table 3.4 The eight bird species most commonly observed on turfgrass during counts on four golf courses from November 1990 to July 1991.

Species	Detections		Relative abundance (% of all birds) n=6,355
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Canada Goose	4	25	6.8
Mallard	4	10	0.7
Glaucous-winged Gull	3	10	1.6
Northern Flicker	4	9	0.2
Northwestern Crow	4	58	5.5
American Robin	4	70	31.6
European Starling	4	64	50.3
Dark-eyed Junco	3	10	1.0
Total			97.7

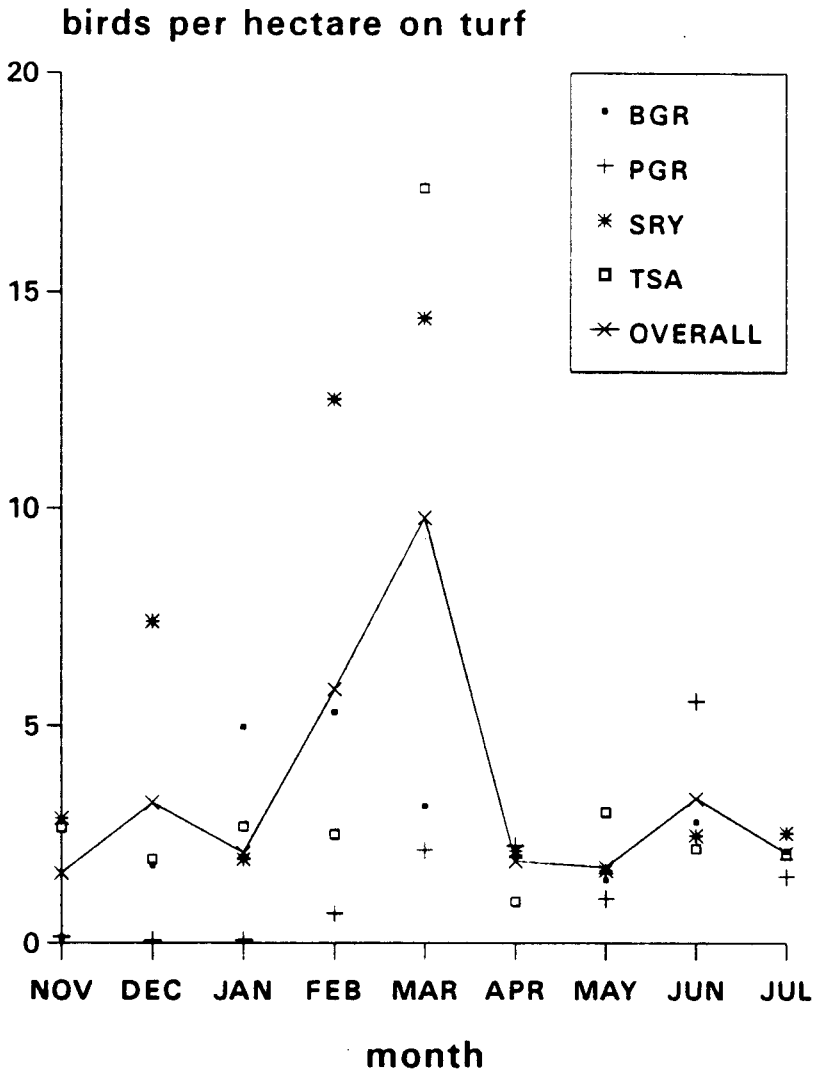

Figure 3.3 Course by course comparison of birds per hectare observed on turf on golf courses.

3.2.2 Bird Species Observed in Hedgerows

A total of 40 species were observed in hedgerows (Appendix 8), 11 were seen on over half the courses, no species was observed on over half the counts (Table 3.5). Overall, the relative abundance and the diversity of species found in hedgerows was even across the four courses and across the months (Figure 3.4). The only dramatic change in average numbers sighted occurred in December when increased numbers of Red-winged Blackbirds and Brewer's Blackbirds were observed at SRY on one census day (Appendix 6).

Table 3.5 The 11 bird species most commonl observed in hedgerows during counts on four golf courses from November 1990 to July 1991.

Species	Detections		Relative abundance (% of all birds) n=1,210
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Northern Flicker	3	8	0.7
Northwestern Crow	3	23	5.5
Black-capped Chickadee	4	49	7.8
Bushtit	3	21	12.9
American Robin	4	23	3.3
European Starling	3	20	5.7
Rufous-sided Towhee	3	17	1.8
Song Sparrow	4	47	7.3
Dark-eyed Junco	4	45	17.4
House Finch	3	9	2.6
American Goldfinch	3	7	1.0
Total			66.0

3.2.3 Bird Species Observed in Trees

Of the 36 bird species observed in trees (Appendix 8), 15 were seen on over half the courses and two, the Northwestern Crow and American Robin, were observed on over half the counts (Table 3.6). Overall, the relative abundance and the diversity of species found in trees was even across the four courses (Figure 3.5). There was a slight increase in the number of species in early spring (Figure 3.2).

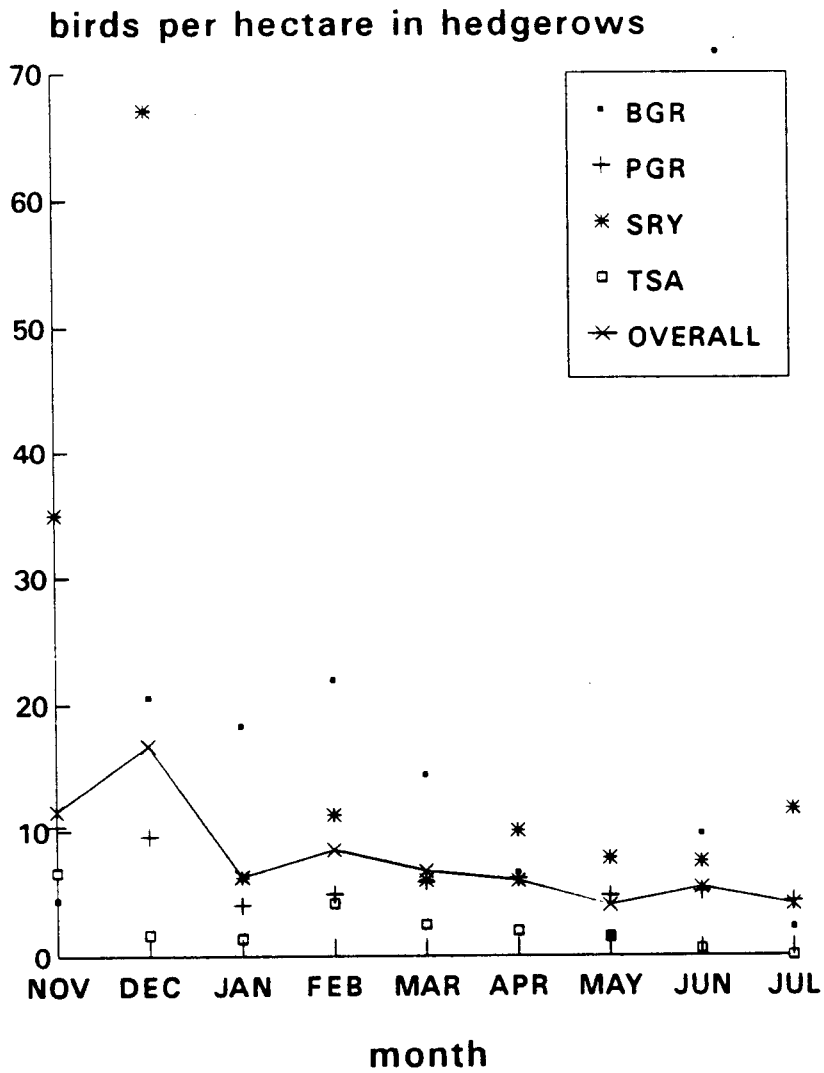

Figure 3.4 Course by course comparison of birds per hectare observed in hedgerows on golf courses.

Table 3.6 The 15 bird species most commonly observed in trees during counts on four golf courses from November 1990 to July 1991.

Species	Detections		Relative abundance (% of all birds) n=6,355
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Red-tailed Hawk	3	12	1.0
Downy Woodpecker	3	5	0.4
Northern Flicker	3	6	0.4
Northwestern Crow	4	75	26.8
Black-capped Chickadee	4	55	7.8
Bushtit	4	17	5.0
Golden-crowned Kinglet	4	29	9.1
Ruby-crowned Kinglet	3	3	0.2
American Robin	4	62	17.9
Cedar Waxwing	3	8	0.9
European Starling	4	23	8.2
Song Sparrow	4	7	0.5
Dark-eyed Junco	4	29	7.7
House Finch	4	13	2.2
American Goldfinch	4	14	1.4
Total			89.5

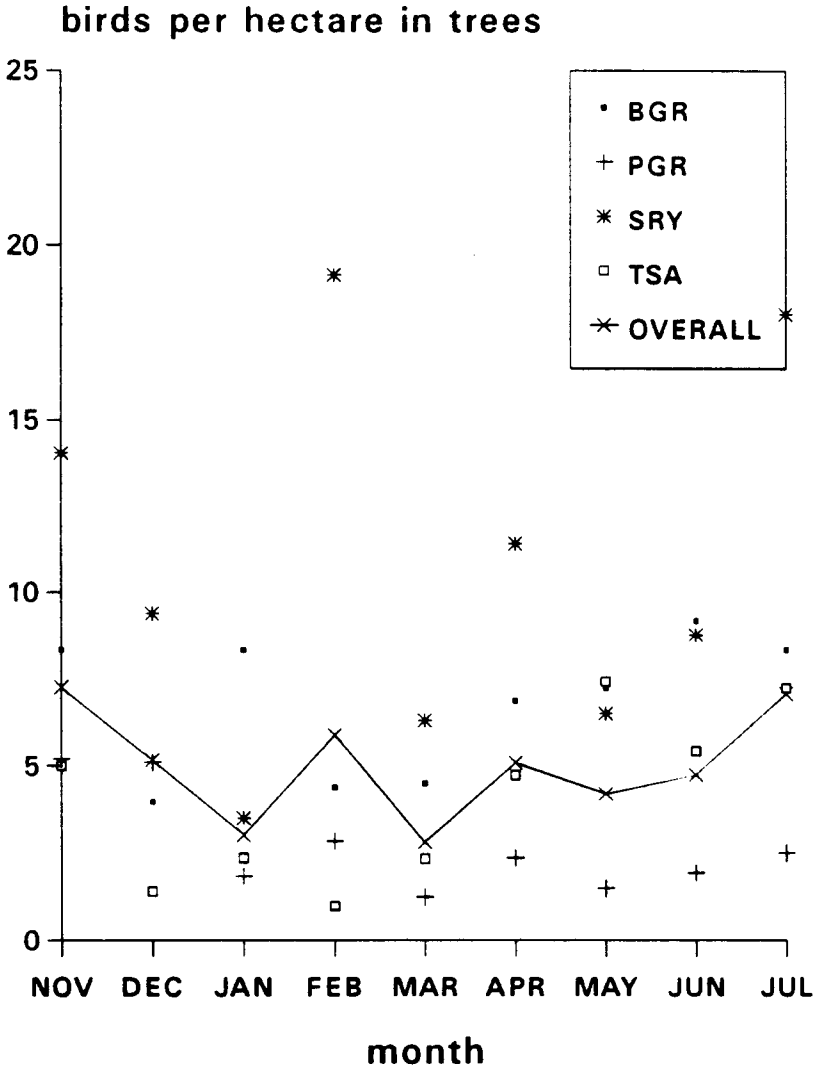

Figure 3.5 Course by course comparison of birds per hectare observed in trees on golf courses.

3.2.4 Bird Species Associated with Water

Of the 22 bird species observed using a water habitat (Appendix 8), five were observed on over half the courses and were considered as the golf course community (Table 3.7). The American Wigeon was the most numerous species, accounting for 47.5% of the birds seen on water. Wigeons were seen on only two courses, one bird on one day at BGR and 2,314 birds over 17 census days at TSA. Aside from the Mallard at 39.4% and the Canada Goose at 8.9% all other species had a relative abundance of less than 1%. Two other waterfowl species were observed on three or four of the courses; the Bufflehead seen on all four with 21 sighting days accounted for 0.9%, and the Hooded Merganser with five sightings on three courses accounted for 0.3% of birds using a water habitat. Great Blue Herons were observed on all four courses though only rarely was there more than one bird on a course. Belted Kingfishers were seen on two courses on a total of eight census days. During February and in April there was sufficient rain to produce rain pools on the turf surfaces of all four courses. We observed a total of 40 Mallards (0.6% of the 6,355 birds associated with water) using rain pools during three census days.

A course by course comparison shows TSA, with 75% of all waterbirds counted. PGR had the least numbers of waterbirds, about 0.5%. The numbers of waterfowl were highest during the winter months, trailing off to a small resident summer population (Figure 3.6). There was a complete absence of waterfowl on all courses from 20 December to 25 January when the ponds and waterways were frozen.

Table 3.7 The five bird species most commonly observed associated with water during counts on four golf courses from November 1990 to July 1991.

Species	Detections: Occurrence (no. of golf courses)	Detections: Frequency (no. of censuses)	Relative abundance (% of all birds) n=6,355
Great Blue Heron	4	18	0.6
Canada Goose	3	41	8.9
Mallard	4	77	39.4
American Wigeon[1]	2	18	47.5
Bufflehead	4	21	0.9
Hooded Merganser	3	5	0.3
Total			97.6

[1] By our definition of "community" the American Wigeon should not be included in this list, we include it due to its high relative abundance.

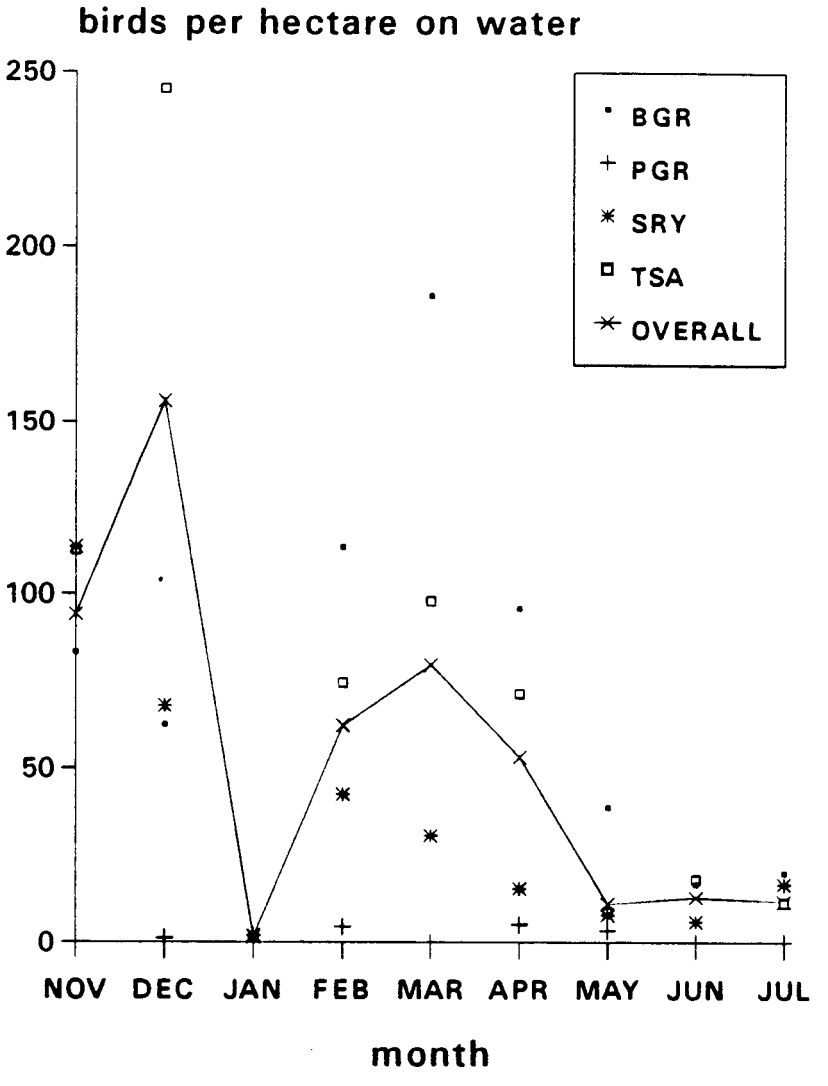

Figure 3.6 Course by course comparison of birds per hectare observed on water on golf courses.

3.2.5 Birds Flying Over Golf Courses

A total of 2,319 birds of 33 species were observed flying during 130 bird censuses (Appendix 8). Most of these birds were flying between habitats found on a golf course or to a location off course. As mentioned in the methods, 800 out of the above total were Snow Geese observed flying over a transect at TSA during one census. Since the Snow Geese were never observed using any golf course habitat, their numbers were excluded from all calculations. With the exception of one Greater Yellowlegs observed flying over TSA on one day, all other birds were considered as using the golf course habitat.

Fourteen bird species were observed flying over three or four of the courses (Table 3.8). Of these, Mallards, gulls, crows, robins, waxwings, starlings, finches and grosbeaks were all observed using golf course habitats. Bald Eagles often flew high above the golf courses, perched in trees and were reported to consume waterfowl. Red-tailed Hawks, observed more frequently than eagles and nesting on PGR, were considered in the golf course community. Barn Swallow and Violet-green Swallow, were seasonally common on all golf courses visited, flying over turf, ponds and around trees and hedgerows to forage.

Table 3.8 Fourteen bird species observed flying during counts on four golf courses from November 1990 to July 1991.

Species	Detections		Relative abundance (% of all birds) n=6,355
	Occurrence (no. of golf courses)	Frequency (no. of censuses)	
Mallard	4	12	2.4
Bald Eagle	4	12	0.9
Red-tailed Hawk	4	14	1.1
Glaucous-winged Gull	4	41	8.0
Violet-green Swallow	4	26	3.4
Barn Swallow	4	29	3.4
Northwestern Crow	4	70	12.8
American Robin	4	28	6.0
Cedar Waxwing	4	9	1.4
European Starling	4	43	11.4
House Finch	4	31	3.2
Pine Siskin	4	23	2.4
American Goldfinch	4	50	8.3
Evening Grosbeak	4	18	14.9
Total			89.6

3.3 Feeding Behaviour of Passerines and Killdeer on Turf

During July and August, Killdeer, Northwestern Crows, European Starlings, American Robins and Brewer's Blackbirds were observed feeding on turf. Of these five species, starlings, robins and blackbirds were seen significantly more often during morning sessions ($P<0.05$) (Table 3.9). Killdeer, were also more commonly observed in the morning though the small sample size reduced statistical power and we were not confidant of our result at the $P<0.05$ level. Crows, with 27 morning and 23 afternoon sightings appeared to have no preference for foraging times.

Table 3.9 Presence of five bird species on turf during four morning and four afternoon sessions on 18 golf course sites.

	# of sessions when sighted				
Species	AM	PM	t	DF	Probability
Killdeer	7	1	2.062	17	0.06
Northwestern Crow	27	23	0.846	17	0.41
American Robin	33	9	4.574	17	<0.01
European Starling	32	9	4.165	17	<0.01
Brewer's Blackbird	8	1	2.715	17	0.02

When comparing the overall sighting of birds on the three types of turf surface, green, fairway and rough, only about 2% were associated with greens (Table 3.10). Killdeer were sighted most often on fairways. When disturbed by approaching golfers, Killdeer usually departed the study area by flying to the next fairway. Crows were observed most often on either fairways or rough. Crows could be seen singly or in groups. When foraging crows would often walk the fairways flipping over divots and inspecting the exposed soil. Of all the passerines, crows appeared the least concerned with approaching and passing golfers. Robins were observed with similar frequency on both fairways and rough. Robins foraged either singly or in loose groups of five or less. With the approach of golfers robins usually flew to the trees, returning to the turf as the golfers passed by. Starlings accounted for almost 60% of birds observed during this part of the study. Starlings were seen most often in the rough along the margins of the fairways. Starlings were seen feeding singly,

in groups up to 10 birds or in large flocks. When disturbed by approaching golfers, starling would usually depart the immediate area. Brewer's Blackbirds were observed most often in the rough where they stayed close to tree bases. As most golfing occurs away from trees, Brewer's Blackbirds were less often disturbed by golfers.

Table 3.10 Numbers of birds counted on turfgrass during 144 sessions in July and August 1990.

	Type of turf			
Species	Green	Fairway	Rough	Total
Killdeer	2	100	23	125
Northwestern Crow	17	204	227	448
American Robin	19	180	163	362
European Starling	9	496	905	1,410
Brewer's Blackbird	0	8	52	60
Total (%)	1.9	41.1	57.0	

Observations of total numbers of birds on the three types of turf are useful to predict where we are more likely to find birds, however, given the unequal areas of types of turf on each study site they tell us little of the turf preferences of these birds. If we consider birds per land area on each turf type, we found no significant difference (at $P<0.05$) for Killdeer, robins or blackbirds (Table 3.11). Crows, during afternoon sessions were seen significantly more often in the rough than on greens ($P=0.034$). Starlings, during morning sessions, were observed least on greens and most often in the rough. Statistical differences between Starling sightings on greens versus fairway and fairway versus rough were both significant at $P<0.05$ ($P=0.018$, $P=0.034$ respectively).

Table 3.11 Birds per hectare on three turf surfaces during 72 morning and 72 afternoon observation sessions in July and August 1990.

		Mean birds/ha on turf (SD)			
Species	Time	Green	Fairway	Rough	Probability
Killdeer	AM	0.03 (0.12)	0.27 (0.73)	0.20 (0.61)	0.08
	PM	0	<0.00 (0.02)	0	1.00
Northwestern Crow	AM	0.38 (0.84)	0.29 (0.47)	0.64 (1.19)	0.96
	PM	0.03 (0.11)	0.09 (0.15)	1.20 (2.50)	0.04*
American Robin	AM	0.47 (1.25)	0.43 (0.52)	1.80 (5.52)	0.11
	PM	0	0.03 (0.11)	0.50 (1.26)	0.20
European Starling	AM	0.21 (0.74)	1.21 (1.79)	7.72 (16.05)	0.01*
	PM	0	0.03 (0.09)	0.82 (2.73)	0.36
Brewer's Blackbird	AM	0	0.02 (0.07)	0.36 (0.87)	0.13
	PM	0	0	0.02 (0.08)	1.00

* Statistically signifant at P<0.05

3.4 Resource Use and Behaviour of Waterfowl

From November 1990 to January 1991, on the Tsawwassen golf course, during five hours of observation of each of three species of waterfowl we did not observe a bird on a green. Canada Geese spent 52 percent of their time feeding and 42 percent of their time loafing on turfgrass (Table 3.12). American Wigeon spent 30 percent of their time feeding on turf and 64 percent of their time in the water. Canada Geese did not appear at all disturbed by golfers or by golf balls passing through their midst. Wigeon moved frequently between turf and water with the passing of golfers. Mallards were not observed feeding while on turf or on the water. Presumably Mallards depart the golf course to feed in nearby ditches (personal observation), in fields or along the Tsawwassen and Boundary Bay foreshore where they are seen in large numbers (Butler et. al. 1990; Butler and Cannings 1989).

Table 3.12 Time budgets for three species of waterfowl on the Tsawwassen golf course.

Species	Average flock size	Activity (%)			
		Feeding	Loafing	Swimming	Flying
Canada Goose	25	51.6	41.9	1.6	1.6
Mallard	93	0	46.0	53.6	0.4
American Wigeon	141	29.7	4.9	64.2	1.8

3.5 Risk Index

During behavioural observations (sections 3.3 and 3.4) eight species of birds were observed on turf surfaces and were potentially at risk of exposure to turf core chemicals (Table 3.13). The calculation of a useful Risk Index proved more complex than our sampling method allowed. We present our results to facilitate discussion on improved methods (see Section 4.5).

Table 3.13 Calculated risk indices for bird species while present on turf.

Species	Mean risk index	SD	Sample size[1]
Canada Goose	0.52	0.08	5
Mallard	0		5
American Wigeon	0.30	0.12	5
Killdeer	0.60	0.30	8
Northwestern Crow	0.31	0.19	50
American Robin	0.30	0.15	42
European Starling	0.29	0.14	41
Brewer's Blackbird	0.30	0.23	9

[1] Number of observation sessions.

3.6 Turf Care Chemical Questionnaire

Thirty-six out of 75 questionnaires (48%) were returned (Appendix 10). Classifying returned questionnaires by region of the province, we had 10 from Vancouver Island (ISL), 14 from the Lower Fraser Valley (LFV) and 12 from the Okanagan and Interior (INT) (Figure 3.7).

There was considerable variation in the quality of reporting in the questionnaires. One superintendent returned only the portion of the questionnaire concerned with wildlife. Six superintendents gave no pesticide control product (PCP) numbers, making cross reference with our label file and the determination of active ingredient concentration difficult. In numerous instances we received stock or lot numbers in place of PCP numbers. The most difficult information to interpret involved fertilizers. Only ten superintendents responded with separate records for pesticides and fertilizers, four of which gave no yearly totals or simply wrote "fertilizer" and gave no indication of its composition.

3.6.1 Fungicide Use

Thirty-five courses reported the use of fungicides. The most commonly used products were quintozene and thiophanate-methyl accounting for 29 and 17 courses respectively (Table 3.14 and Appendix 12). When comparing fungicide use throughout the province, courses in the Lower Fraser Valley used greater amounts of benomyl (in treating Pink Snow Mould) than other areas. The greatest use of chlorneb was in the interior regions (to treat Grey Snow Mould). All other products had relatively equal distribution throughout the province. Most fungicide use is confined to greens where they are used up to four times each year, primarily in the spring and fall.

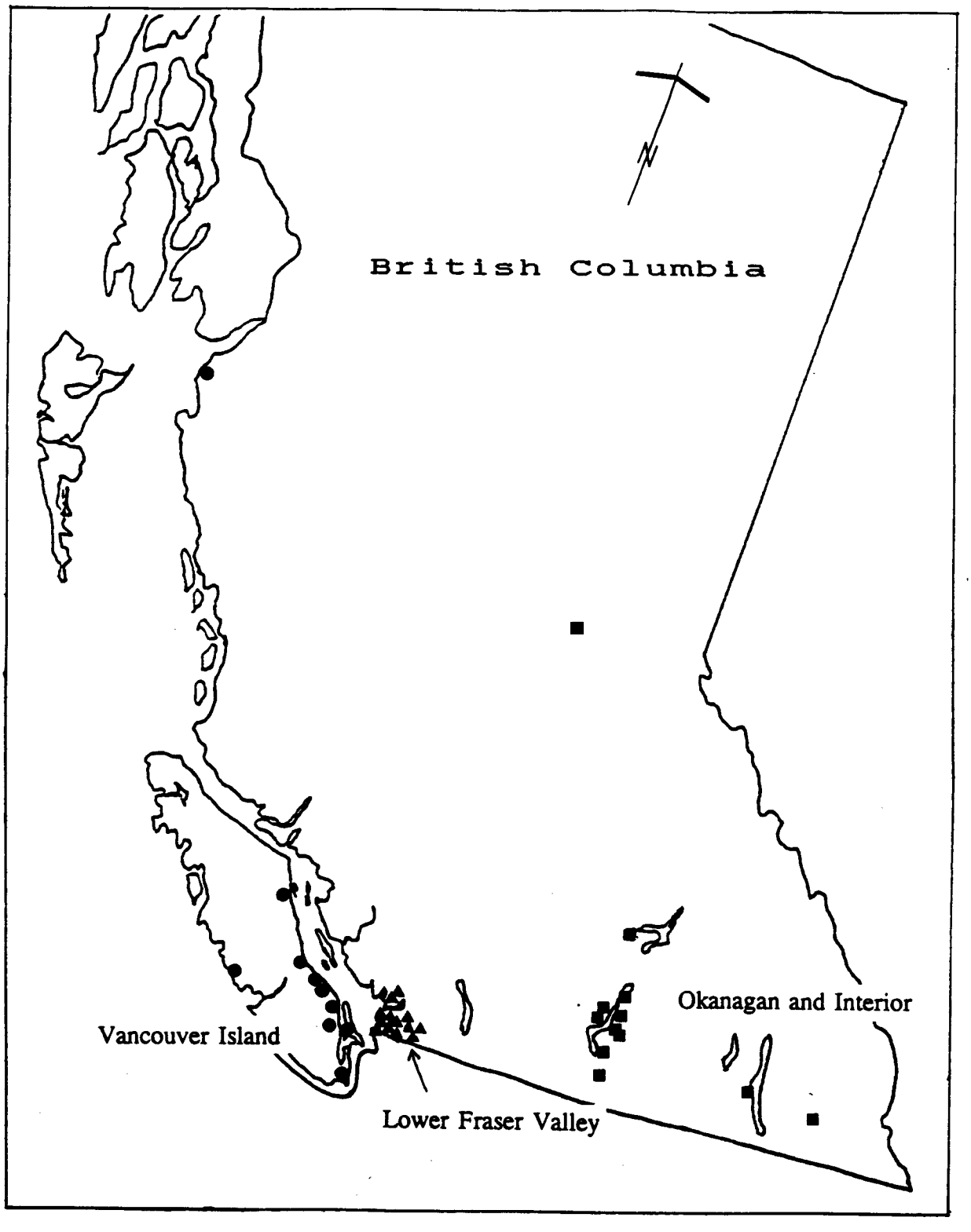

Figure 3.7 Location of golf courses whose superintendents completed and returned the chemical use - wildlife questionnaire.

Table 3.14 Fungicides use on 35 British Columbia golf courses.

Active Ingredient	# of courses using each product, region of province: ISL	LFV	INT	total	Average active ingredient per year/course	Sample[1] size
Anilazine	0	0	1	1	4.0 kg	1
Benomyl	1	6	1	8	10.7 kg	7
Chloroneb	1	2	5	8	9.7 kg	7
Chlorthalonil	2	2	2	6	18.5 kg	5
Iprodione	3	2	5	10	6.2 kg	9
Mancozeb	3	5	2	10	39.4 kg	9
Maneb	1	0	0	1	?	0
Metalaxyl	0	1	0	1	0.5 g	1
Quintozene	9	11	9	29	55.2 kg	23
Thiophanate-methyl	4	9	4	17	3.7 kg	13
Triforine	0	1	0	1	?	0

[1] The number of courses providing sufficient information to calculate total active ingredient.

3.6.2 Herbicide Use

Twenty-six courses reported herbicide use. The usage of herbicides appears about equal across the province (Table 3.15 and Appendix 13). The most commonly used products are mecoprop, dicamba and 2,4-D amine salt, which in most cases were combined within a trade product. In general, herbicides are used for control of broadleaf weeds on turf surfaces and grasses and weeds along paths and at tree bases. Six courses reported the use of the herbicide diquat for control of aquatic weeds.

Table 3.15 Herbicide use on 26 British Columbia golf courses.

Active Ingredient	# of courses using each product, region of province: ISL	LFV	INT	total	Average active ingredient per year/course	Sample[1] size
2,4-D	5	7	6	18	18.8 kg	14
Chlorthal	0	1	1	2	32.0 kg	2
Dicamba	6	6	6	18	2.2 kg	14
Diquat	1	3	2	6	7.1 kg	5
Glyphosate	3	4	4	11	1.3 kg	10
Mecoprop	5	8	6	19	12.7 kg	15
Paraquat	0	1	1	2	1.0 kg	2

[1] The number of courses providing sufficient information to calculate total active ingredient.

3.6.3 Insecticide Use

Insecticides were reported to be used on 13 courses (Table 3.16 and Appendix 14). Of the two products used on turf, carbaryl was used in the greatest amounts. Diazinon was reported to be used on the greens of five courses and the fairways of one course. Aside from application to turf, diazinon was reported to be used to control insects in trees on five courses. The highest reported use of diazinon on turf was from courses within the Vancouver Island region. Metaldehyde, technically a molluscicide and not a insecticide was reported to be used on one course.

3.6.4 Fertilizer Use

From the information we received in the questionnaires, we were able to determine that 34 superintendents used fertilizers on their turf. Ten courses (listed as AH,AI,B,C,D,G,I,O,P and Z in Appendix 15) indicated use of both unmixed fertilizer and mixes of fertilizer combined with other products such as fungicides or herbicides. Of these ten, six gave sufficient information to determine yearly amounts used. As we do not know if the 18 courses who listed only mixed products also used unmixed fertilizers, they were excluded from Table 3.17.

Table 3.16 Insecticide use on 13 British Columbia golf courses.

Active Ingredient	# of courses using each product, region of province: ISL	LFV	INT	total	Average active ingredient per year/course	Sample[1] size
Carbaryl	1	2	0	3	234.9 kg	3
Diazinon						
- turf	4	1	0	5	6.2 kg	5
- other	1	2	2	5	2.2 kg	4
Dimethoate	0	1	0	1		0
Malathion	0	1	1	2	2.4 kg	2
Metaldehyde[2]	1	0	0	1		0

[1] The number of courses providing sufficient information to calculate total active ingredient.
[2] Metaldehyde is a molluscicide.

Table 3.17 Average yearly fertilizer use on 6 British Columbia golf courses.

Grass type	Total number applications	Quantity applied (kg/year/course) N	P	K	Estimated yearly kg/ha N	P	K
Green	11	958	103	629	958	103	629
Tee	8	403	50	212	806	100	424
Fairway	3	2,900	639	1,000	145	32	50
Rough	1	792	171	272	79	17	27
Totals		5,053	963	2,113			

3.7 Wildlife Questionnaire

While the responses we received to this part of the questionnaire were largely subjective, there were frequent similarities between accounts and it was possible to categorize or rank the comments. The following is a summary of the responses we received from superintendents at 36 British Columbia golf courses.

3.7.1 - Are there any particular times of year when you see more or less wildlife on your golf course? Please list time of year, species and location (greens, roughs, ponds, trees etc.).

Most superintendents responded with lists of species and the times of year they appeared. The answers we received to this question reflected the individual characteristics of each golf course within its location in the province. Courses along waterfowl migration routes were used as stopovers. Courses located in more rural areas experienced deer, bears, cougars and other mammals less common in the cities. Most superintendents indicated connections between insect cycles and bird feeding, for example, starling and emerging cranefly larva.

3.7.2 - List any animals, fish or birds you consider beneficial to your golf course (for insect control etc.).

Twenty-six superintendents indicated wildlife as having a beneficial impact on their course. Ten superintendents made no comment, were not sure, or did not consider wildlife as beneficial. Four superintendents considered all wildlife as beneficial to golfers for aesthetic reasons. Essentially all responses noted some form of natural population control (Table 3.19). In 31 instances birds were cited has beneficial for insect control.

3.7.3 - Are there certain species of animals or birds you consider pests, and what problems do they cause?

Thirty-five superintendents indicated some problems with wildlife, one superintendent had no problems. Canada Geese and crows were considered the greatest nuisance, receiving 29 and 25 citations respectively (Table 3.18). The most commonly cited problems involve damage to turf.

Table 3.18 Wildlife species considered beneficial to golf courses in British Columbia.

Species	Beneficial act	# citations
Badgers	gopher control	1
Bald Faced Hornet	insect control	1
Bats	insect control	2
Birds in general	mosquito control	1
Bluejays	none stated	1
Carp	none stated	2
Cougars	deer control	1
Coyotes	mole control	2
	crow control	1
Crows	cranefly control	1
Ducks	control pond vegetation	3
	insect control	1
Frogs	none stated	1
Goldfish	algae control	1
Gulls	cranefly control	1
Hawks	rodent control	2
	none stated	1
Herons	consume carp	1
Killdeer	none stated	1
Mallards	none stated	1
Mink	none stated	1
Nighthawks	none stated	1
Pheasants	aesthetic	1
Ravens	cranefly control	1
Robins	cranefly control	3
Salmon	insect control	1
Snakes	consume rodents	1
Starlings	cranefly control	6
Swallows	mosquito control	10
Trout	insect control	2
Turtles	none stated	1
Weasels	rodent control	1
Woodpeckers	insect control	1
	indicators of insect problem	1

Table 3.19 Problems associated with nuisance wildlife on golf courses in British Columbia.

Species	Undesirable activities	# citations
Badgers	digging holes	1
Bears	distributing garbage	1
	scaring golfers	1
Beavers	flooding	2
	cutting trees	2
Carp	make ponds muddy	1
Coyotes	digging in sand traps	2
Crows	flipping divots	10
	damaging greens	8
	distributing garbage	4
	preying upon small birds	2
	excessive noise	1
Deer	eating ornamental trees	2
	damaging greens	1
Ducks	getting in the way	1
Geese	droppings on turf	18
	damaging turf on greens	10
	aggressive behaviour	1
Gophers	holes on fairways	2
	chewing irrigation hose	1
Ground squirrels	digging holes	1
Herons	regurgitating on greens	1
Marmots	overgrazing	1
Mice	digging holes in grass	1
Moles	dirt mounds	5
	chewing irrigation hose	1
Muskrats	tunneling at pond edges	4
Pigeons	droppings on equipment	1
	droppings on greens	1
Porcupines	girdling trees	1
Raccoons	distributing garbage	1
	damaging flower beds	1
Ravens	stealing golf balls	2
	damaging greens	1
Robins	damaging greens	1
Rattle snakes	scaring golfers	1
Skunks	damaging greens	1
Starlings	damaging greens	1
Squirrels	messing up washrooms	1
Wigeon	overgrazing	2

3.7.4 - Have these problems been increasing or decreasing over the years.

Seventeen superintendents have noticed no change in problems with wildlife, 12 have increasing problems, three have noticed a decrease and four indicated their courses were too new to notice any trends. There were no obvious differences in wildlife related problems in three regions of the province (Table 3.20).

Table 3.20 Incidence of wildlife related problems on golf courses in three regions of British Columbia.

	Trend				
Location	Increase	Decrease	No change	New course	Total
Lower Fraser Valley	4	1	7	1	13
Vancouver Island	3	1	5	1	10
Okanagan - Interior	5	1	5	2	13
Combined	12	3	17	4	36

3.7.5 - What measures do you use to get rid of these animals or birds?

Twelve superintendents reported taking no action to remove problem wildlife, 24 use some technique (Table 3.21). Of the 44 citations we received, scaring nuisance wildlife (usually flocks of waterfowl) by loud noises or by approaching on foot or in a vehicle was the most common method uses to shift or remove unwanted wildlife.

3.7.6. - What is the overall reaction of golfers to the wildlife on your golf course?

We scored the response to this question into five categories (Table 3.22). Of the 36 respondents, 31 believed that most golfers enjoy the wildlife encountered while playing golf.

Table 3.21 Techniques used to remove problem wildlife.

Technique	Target	# citations
Addling eggs	geese	1
Covering garbage cans	raccoons	1
Fencing	none indicated	1
Insecticides	insects[1]	4
Irrigation	geese	2
	pocket gophers	1
Loud noise	geese	7
	crows	3
Pellet gun	pigeons	1
	muskrats	1
Poisoning	mice and moles	1
Shooting (kill permits)	geese	3
	ravens	1
	ground squirrels	1
	none indicated	1
Shovel	moles	1
Traps - killing	rats	1
	moles	1
- live	bears	1
	beaver	1
	raccoons	1
Walking or driving	geese	7
	wigeon	1
	crows	3
	snakes	1

[1] With no insects in the soil of the greens, birds no longer damage the turf.

Table 3.22 How 36 British Columbia golf course superintendents view the reaction of golfers to wildlife.

Response category	# citations
Really enjoy	4
Enjoy	15
Enjoy if no effect on their game	12
Consider wildlife as a nuisance	4
Eliminate wildlife	1

3.7.7. - Do you encourage or discourage wildlife on your course?

We scored the response to this question into four categories (Table 3.23). Of the 36 respondents, 21 encouraged wildlife, two of which reported installing nest boxes and one described building a nesting island in a pond and retaining dead trees for woodpeckers.

Table 3.23 How 36 British Columbia golf course superintendents encouraged or discouraged the wildlife on their courses.

Response category	# citations
Actively encouraged	2
Encouraged	19
Neither encouraged or discouraged	10
Discouraged	5

3.7.8. - How close is your golf course to a river or stream, or to a ditch leading to a river or stream.

Twenty-seven superintendents indicated their golf courses as being directly in contact with water. Four golf courses were adjacent to either a lake or the ocean, three golf course had river frontage, 13 contained streams or creeks and seven were beside or contained drainage ditches. Nine golf courses were said to be away from water. Four had no water at all, four were

within a 1.5 kilometre of a stream or creek. One superintendent indicated the his course was a "closed system" with respect to water.

3.7.9 - Additional information or comments.

We received a variety of comments in response to this question. Two superintendents indicated the need for help in solving wildlife related problems on golf courses. One superintendent made a very serious and clear statement about taking responsibility for the environment and the need to balance the needs of both golfers and wildlife. Another echoed this statement saying that a golf course can supply the needs of both wildlife and golfers. One superintendent described efforts of a salmon enhancement program on his course.

CHAPTER 4 - DISCUSSION

4.1 Birds Found on Golf Courses

A total of 19,443 birds made up of 103 bird species were observed during this study (Appendix 2). We used two criteria to determine which bird species use golf courses for breeding, foraging or resting habitat. Our first classification of "**community**", **included all species observed on over half the courses censused**, encompassed species seen in large numbers and also some select species seen less often, but valuable as indicators of habitat quality. Our second classification of "**common**", **included those species observed on over half the counts**, and highlighted a smaller group of species that were either year-round residents or seasonally very abundant. Eight species, the European Starling, American Robin, Mallard, Northwestern Crow, Canada Goose, Barn Swallow, Dark-eyed Junco and Black-capped Chickadee were among the 10 species most common in overall days sighted and also the 10 most numerous species (Table 4.1). Collectively these species are commonly found in parks and residential areas throughout the study area (Lancaster and Rees 1979).

Table 4.1 The occurrence and frequency of detections and relative abundance of the eight most common bird species observed during 152 censuses on 8 golf courses from July 1990 to July 1991 (combines all terrestrial and aquatic habitats).

Species	Detections: Occurrence (no. of golf courses)	Detections: Frequency (no. of censuses)	Relative abundance (% of all birds) n=19,443
European Starling	8	109	23.6
American Robin	7	122	13.8
Mallard	8	106	10.9
Northwestern Crow	8	132	7.3
Canada Goose	5	63	6.5
Barn Swallow	8	61	3.9
Dark-eyed Junco	5	61	2.0
Black-capped Chickadee	7	104	1.8
Total			69.8

Birds species considered in the golf course community but observed in low numbers were often associated with a specific habitat. Great Blue Herons and Hooded Mergansers were found associated with water. Woodpeckers, kinglets and wrens were found in hedgerows and treed areas.

4.2 Bird Habitat on Golf Courses

Bird habitats offered by golf courses may be judged by how effectively they meet the most basic requirements of birds: food and cover. We noticed considerable differences among the habitats found on the golf courses surveyed. During the initial surveys in July and August of 1990 the species count ranged from 14 to 46 (Appendix 5). While we did not measure the habitats at the time, it was clear that those courses with minimal foliage, or few recently planted trees (Mayfair Lakes and Coyote Creek) had less habitat to offer birds and the species diversity was accordingly low (14 and 16 species respectively). This is not to say that these courses are without some suitable habitat; on Coyote Creek we frequently observed a Green-backed Heron foraging or roosting in vegetation along the edges of one pond. The presence of this uncommon species indicates the value of the habitat offered.

Turf proportionally accounted for 74% of the area we surveyed, and was the lowest in species richness. Of the species using turf, only geese, Mallards and gulls used turf surfaces for resting and even those species departed the immediate area when approached. On the courses we surveyed, turf had minimal value as cover.

Water, while it only accounted for 4% of the land area surveyed, contained the greatest density of birds. It was interesting to observe large numbers of wigeon and Mallards on the water at Tsawwassen despite the fact that they did not use the habitat for foraging. At least during winter, ponds seem to be used mainly as a safe place to rest.

The differences between hedgerow and tree habitats, as we defined them, was due to the clearing of underbrush at tree bases. From the golfers perspective, minimal vegetation makes it easier to locate stray golf balls. The removal of ground vegetation, from the perspective of a bird feeding on the surface, means the elimination of a place to retreat from predators or from perceived threats such as passing golfers. On the courses we visited, those with both the highest numbers of bird species and also the greatest numbers of birds (excluding those found on water) had extensive areas of unmaintained vegetation.

Butler (1992) comparing the bird communities of hedgerows in the Boundary Bay area, observed 30 and 40 different species in shrub and treed-hedgerows respectively during the non-breeding season. While the species

richness he observed was similar to ours, the species mix and their relative abundance were in some instances quite different. Combining all terrestrial golf course habitats, we observed more American Robins than Butler (relative abundance 25.7 in our study; 19.1 shrub-hedgerow, 12.4 treed-hedgerow in Butler). The greatest difference between the two studies was the Northwestern Crow (relative abundance 0.1 and 1.4 in Butler; 8.7 for combined terrestrial habitats in our study). Two species, with relative abundance greater than one, that we observed in golf course hedgerows and were not seen by Butler, the Varied Thrush (relative abundance 1.9) and the Evening Grosbeak (relative abundance 5.0), were probably a reflection of small stands of conifers within our definition of hedgerow. The Western Meadowlark (relative abundance 1.8 and 0.3 in Butler) was not observed on golf courses, possibly due to differences between the length of turfgrass in old fields as compared to golf courses.

The courses on which we counted birds were all located on the Fraser River floodplain which includes the lands surrounding Boundary Bay. This area supports a diverse population of wintering birds of prey (raptors) (Butler and Campbell 1987). We observed five species of raptors on golf courses during winter-spring bird counts (appendix 6). The most abundant raptor wintering in the study area, the Northern Harrier (Sullivan 1991; Butler and Campbell 1987) was not observed flying over or using golf course habitats. We frequently observed Northern Harriers foraging over fields directly adjacent to the SRY and TSA golf courses, suggesting that golf courses do not provide suitable habitat for this species.

4.3 Turf Care Chemicals

We were concerned with the potential for both chronic and acute exposure of wildlife to turf care chemicals. Chronic toxicity refers to adverse health effects developing slowly with exposure to small quantities of a toxin over longer periods of time, such as months or years. The most important endpoints of chronic exposure to wildlife include effects on the immune and reproductive systems and major organs such as the liver, kidney and brain. Effects on wildlife populations may be detected only after many years of repeated observations.

Acute toxicity refers to death or severe debilitation within a few hours or days following a single exposure to a toxin. The acute toxicities of many turf care products have been measured in laboratory studies and are available in the scientific literature. Toxicity is measured as either a lethal dose (LD) or a lethal concentration (LC). An LD_{50} refers to the amount of a product administered in a single dose, required to kill 50 percent of the test population. LD_{50}s are usually listed in milligrams of product per kilogram weight of the test animal. An LC_{50} refers to the concentration of a product

present in either air, water or food which is lethal to 50 percent of the test population over a specific period of time, usually 6 to 14 days for birds. LC_{50}s are listed as the ratio of product to a million (ppm) or a billion (ppb) parts air, water or food (for further detail see Adams 1987). The use of LD_{50}s and LC_{50}s in determining pesticide risk to wildlife is often criticized as it does not take into account chronic sub-lethal effects that may reduce survival (Mineau 1991); however, they are usually the only data available. For the purposes of this study we used LD_{50}s and LC_{50}s when comparing the relative toxicities of turf care products reported to be used on golf courses (see Appendices 16,17 and 18).

When considering the chemicals used on golf courses, those of greatest concern to birds are acetylcholinesterase (AChE) inhibiters such as organophosphate and carbamate insecticides. Inhibition of AChE results in accumulation of the neurotransmitter acetylcholine at nerve synapses, disrupting the normal transmission of nerve impulses (Ecobichon 1991). Birds suffering from a reduction in AChE activity exhibit a number of signs including a lack of muscle coordination, laboured breathing, wing spasms, diarrhoea and arching the neck over the back (Hudson et al. 1984). Mammals appear to be less sensitive than birds to diazinon (Eisler 1986).

Of the fungicides reported to be used on golf courses in British Columbia all have relatively high LD_{50}'s (low toxicity) to birds and do not appear to constitute a threat of acute poisoning to birds (Appendix 16). Four products, anilazine, benomyl, chlorthalonil and thiophanate-methyl were listed by Adams (1987) as being toxic to fish. Of the herbicides used, none are considered a risk to birds using turf surfaces (Appendix 17). Two of the insecticides used on golf courses, diazinon and dimethioate are toxic to birds (Appendix 18). Malathion is highly toxic to fish.

4.4 Risk to Birds

Results from the Chemical Use Questionnaire indicate that the largest volumes of turf care chemicals are applied to greens and tees. In particular, use of the most toxic products, such as diazinon, was largely restricted to greens. Our observations of avian behaviour (during daylight hours) revealed minimal use of greens and tees. Although with passerines and Killdeer we found little difference in bird numbers per land area for greens, fairways and rough, the small size of the greens together with the low numbers of birds counted suggest minimal risk of exposure. With waterfowl, while during our sample sessions we observed no use of the greens, various superintendents have reported green damage due to overgrazing.

There are numerous reports of wildlife mortality associated with golf course use of insecticides, particularly diazinon, elsewhere in North America (see Frank et al. 1991, Littrell 1986, Stone and Knoch 1982 and Zinkl et al. 1978). However, we are not aware of any bird die-offs occurring during this study. In British Columbia, provided the results of our chemical use questionnaire are representative and products are applied at the recommended rates, the use of turf care products on golf courses does not appear to pose a significant hazard to birds.

4.5 Calculation of a Risk Index

As mentioned in section 3.5, our sampling approach did not provide suitable data for determining a useful Risk Index. We identified three flaws inherent in our method:

1) The calculation of N_{min} from Fletcher and Greig-smith (1988) assumes a stable population within the study site. In our study this may be acceptable for robins and crows and possibly blackbirds and Killdeer that are nesting within or near the study site. Starlings, flying in from a larger area to feed in flocks do not fit this model.

2) Our measure of Risk Index was for birds while they were present on turf. Since we have demonstrated significant differences between the presence on turf, AM and PM, a more useful Risk Index would have to include observations throughout the day. Fletcher and Greig-smith (1988) developed a Risk Index to compare specific sites before and after a pesticide application, as long as observations were at the same time each day their measure should work.

3) When using a time budget to calculate a Risk Index for waterfowl we measured time feeding as the only potential contact with a turf care product. Mallards, while they were not observed feeding may have some risk with direct contact to turf via dermal exposure through their feet or by ingestion during preening following resting on turf surfaces. To increase the accuracy of a Risk Index for any species of waterfowl we must account for skin and preening contact.

4.6 Golfers, Golf Courses and Wildlife

The majority of golf course superintendents who responded to our questionnaire support and encourage at least some of the wildlife on their courses. They believe that golfers enjoy viewing birds and other wildlife while playing golf. Many superintendents expressed interest in cooperative golf course - wildlife sanctuary plans similar to those found in Great Britain

(see Fordham and Iles 1987; Green and Marshall 1987) and New York state (see Dodson 1990.

The main wildlife associated problem on golf courses is caused by excess numbers of Canada Geese. Turf surfaces of golf courses, as with parks and playgrounds, provide ideal habitats for geese. For more details on problems caused by Canada Geese in the Lower Fraser Valley, see Breault and McKelvey (1991).

4.7 Recommendations

1) To increase the wildlife habitat value of golf courses, golf course designers and the superintendents of existing courses should be encouraged to include pockets of undisturbed vegetation. Small changes in management practice, such as allowing understory vegetation to grow in areas away from the immediate area of play, could increase the quality of habitat offered to wildlife without great inconvenience to the golfer.

2) Of the pesticides reported to be used on British Columbia golf courses, only diazinon poses a potential serious threat to birds. Provided that diazinon application rates do not exceed those reported in the returned questionnaires, birds should not be at risk. Nevertheless golf course superintendents should be encouraged to continue or initiate policies of minimal pesticide use to eliminate the potential for accidental over-application. Superintendents still using highly toxic insecticides such as diazinon should be informed of alternative solutions to their turf problems. One approach reported by several superintendents, is to tolerate flocks of robins, starlings and crows feeding on emerging cranefly. Those superintendents who considered these birds as beneficial accepted a moderate degree of turf damage for short periods of time.

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Appendix 1. Codes, names of golf courses and transect areas for summer and winter-spring bird censuses.

Code	Course name	Transect area (ha)	
		summer	winter-spring
BGR	Beach Grove Golf Club	9.5	10.9
CCR	Coyote Creek Golf and Country Club	10.7	
HAZ	Hazelmere Golf and Tennis Club	15.6	
MLA	Mayfair Lakes Golf Course	17.5	
PGR	Point Grey Golf and Country Club	20.5	22.8
SRY	Surrey Golf Course	18.7	20.6
TTI	Tall Timber Golf Course	15.4	
TSA	Tsawwassen Golf and Country Club	12.8	15.6

Appendix 2. Codes, vernacular and scientific names of birds observed on golf courses during this study. Names and their sequence follow Campbell (1990).

RTLO	Red-throated Loon	*Gavia stellata*
DCCO	Double-crested Cormorant	*Phalacrocorax auritus*
AMBI	American Bittern	*Botaurus lentiginosus*
GBHE	Great Blue Heron	*Ardea herodias*
GRHE	Green-backed Heron	*Butorides striatus*
MUSW	Mute Swan	*Cygnus olor*
SNGO	Snow Goose	*Chen caerulescens*
CAGO	Canada Goose	*Branta canadensis*
GWTE	Green-winged Teal	*Anas crecca*
MALL	Mallard	*Anas platyrhynchos*
NOPI	Northern Pintail	*Anas acuta*
BWTE	Blue-winged Teal	*Anas discors*
CITE	Cinnamon Teal	*Anas cyanoptera*
GADW	Gadwall	*Anas strepera*
EUWI	Eurasian Wigeon	*Anas penelope*
AMWI	American Wigeon	*Anas americana*
CANV	Canvasback	*Aythya valisineria*
GRSC	Greater Scaup	*Aythya marila*
COGO	Common Goldeneye	*Bucephala clangula*
BUFF	Bufflehead	*Bucephala albeola*
HOME	Hooded Merganser	*Lophodytes cucullatus*
COME	Common Merganser	*Mergus merganser*
RUDU	Ruddy Duck	*Oxyura jamaicensis*
BAEA	Bald Eagle	*Haliaeetus leucocephalus*
SSHA	Sharp-shinned Hawk	*Accipiter striatus*
COHA	Cooper's Hawk	*Accipiter cooperii*
RTHA	Red-tailed Hawk	*Buteo jamaicensis*
RLHA	Rough-legged Hawk	*Buteo lagopus*
RNPH	Ring-necked Pheasant	*Phasianus colchicus*
AMCO	American Coot	*Fulica americana*
KILL	Killdeer	*Charadrius vociferus*
GRYE	Greater Yellowlegs	*Tringa melanoleuca*
SPSA	Spotted Sandpiper	*Actitus macularia*
WESA	Western Sandpiper	*Calidris mauri*
COSN	Common Snipe	*Gallinago gallinago*
MEGU	Mew Gull	*Larus canus*
RBGU	Ring-billed Gull	*Larus delawarensis*
THGU	Thayer's Gull	*Larus thayeri*
GWGU	Glaucous-winged Gull	*Larus glaucescens*
RODO	Rock Dove	*Columba livia*
BTPI	Band-tailed Pigeon	*Columba fasciata*
MODO	Mourning Dove	*Zenaida macroura*
VASW	Vaux's Swift	*Chaetura vauxi*
ANHU	Anna's Hummingbird	*Calypte anna*
BEKI	Belted Kingfisher	*Ceryle alcyon*
RBSA	Red-breasted Spasucker	*Sphyrapicus ruber*
DOWO	Downy Woodpecker	*Picoides pubescens*
HAWO	Hairy Woodpecker	*Picoides villosus*
NOFL	Northern Flicker	*Colaptes auratus*
PIWO	Pileated Woodpecker	*Dryocopus pileatus*
OSFL	Olive-sided Flycatcher	*Contopus borealis*

Appendix 2, cont...

WWPE	Western Wood-Pewee	*Contopus sordidulus*
WIFL	Willow Flycatcher	*Empidonax traillii*
HAFL	Hammmond's Flycatcher	*Empidonax hammondii*
TRSW	Tree Swallow	*Tachycineta bicolor*
VGSW	Violet-green Swallow	*Tachycineta thalassina*
CLSW	Cliff Swallow	*Hirundo pyrrhonota*
BNSW	Barn Swallow	*Hirundo rustica*
STJA	Steller's Jay	*Cyanocitta stelleri*
NWCR	Northwestern Crow	*Corvus caurinus*
CORA	Common Raven	*Corvas corax*
BCCH	Black-capped Chickadee	*Parus atricapillus*
CBCH	Chestnut-backed Chickadee	*Parus rufescens*
BUSH	Bushtit	*Psaltriparus minimus*
RBNU	Red-breasted Nuthatch	*Sitta canadensis*
BRCR	Brown Creeper	*Certhia americana*
BEWR	Bewick's Wren	*Thryomanes bewickii*
WIWR	Winter Wren	*Troglodytes troglodytes*
MAWR	Marsh Wren	*Cistothorus palustris*
GCKI	Golden-crowned Kinglet	*Regulus satrapa*
RCKI	Ruby-crowned Kinglet	*Regulus calendula*
SWTH	Swainson's Thrush	*Catharus ustulatus*
HETH	Hermit Thrush	*Catharus guttatus*
AMRO	American Robin	*Turdus migratorius*
VATH	Varied Thrush	*Ixoreus naevius*
CEWA	Cedar Waxwing	*Bombycilla cedrorum*
EUST	European Starling	*Sturnus vulgaris*
WAVI	Warbling Vireo	*Vireo gilvus*
OCWA	Orange-crowned Warbler	*Vermivora celata*
YEWA	Yellow Warbler	*Dendroica petechia*
YRWA	Yellow-rumped Warbler	*Dendrocia coronata*
BTGW	Black-throated Gray Warbler	*Dendrocia nigrescens*
COYE	Common Yellowthroat	*Geothlypis trichas*
WIWA	Wilson's Warbler	*Wilsonia pusilla*
WETA	Western Tanager	*Piranga ludoviciana*
BHGR	Black-headed Grosbeak	*Pheucticus melanocephalus*
RSTO	Rufous-sided Towhee	*Pipilo erythrophthalmus*
SAVS	Savannah Sparrow	*Passerculus sandwichensis*
FOSP	Fox Sparrow	*Passerella iliaca*
SOSP	Song Sparrow	*Melospiza melodia*
WCSP	White-crowned Sparrow	*Zonotrichia leucophrys*
DEJU	Dark-eyed Junco	*Junco hyemalis*
RWBL	Red-winged Blackbird	*Agelaius phoeniceus*
BRBL	Brewer's Blackbird	*Euphagus cyanocephalus*
BHCO	Brown-headed Cowbird	*Molothrus ater*
NOOR	Nothern Oriole	*Icterus galbula*
PUFI	Purple Finch	*Carpodacus purpureus*
HOFI	House Finch	*Capodacus mexicanus*
RECR	Red Crossbill	*Loxia curvirostra*
PISI	Pine Siskin	*Carduelis pinus*
AMGO	American Goldfinch	*Carduelis tristis*
EVGR	Evening Grosbeak	*Coccothraustes vespertinus*
HOSP	House Sparrow	*Passer domesticus*

Appendix 3. Codes used for habitat classification.

F	flying
G	grass
H	hedegrow
T	trees
W	water

Appendix 4. Vernacular, species code, course code and numbers of birds counted during four visits to eight golf courses in July and August 1990.

			11-Jul	26-Jul	07-Aug	20-Aug
Great Blue Heron	GBHE	BGR	1			
Mute Swan	MUSW	BGR	6	7	2	2
Mallard	MALL	BGR	17	7	9	9
Ring-billed Gull	RBGU	BGR			2	
Belted Kingfisher	BEKI	BGR	1			
Downy Woodpecker	DOWO	BGR			1	
Violet-green Swallow	VGSW	BGR		1	2	
Barn Swallow	BNSW	BGR	9	8	13	15
Northwestern Crow	NWCR	BGR	14	12	21	7
Black-capped Chickadee	BCCH	BGR	7	4	3	13
Chestnut-backed Chickadee	CBCH	BGR				3
Bushtit	BUSH	BGR	10	1		10
Red-breasted Nuthatch	RBNU	BGR				2
Brown Creeper	BRCR	BGR				2
Bewick's Wren	BEWR	BGR			2	1
Golden-crowned Kinglet	GCKI	BGR			2	
American Robin	AMRO	BGR	11	8	13	39
European Starling	EUST	BGR	49	76	43	30
Warbling Vireo	WAVI	BGR				3
Orange-crowned Warbler	OCWA	BGR				25
Yellow Warbler	YEWA	BGR				22
Wilson's Warbler	WIWA	BGR				21
Brewer's Blackbird	BRBL	BGR	3			
Red Crossbill	RECR	BGR	1			
Pine Siskin	PISI	BGR	2			
American Goldfinch	AMGO	BGR	1		1	
House Sparrow	HOSP	BGR		3	2	9

			19-Jul	02-Aug	16-Aug	30-Aug
Great Blue Heron	GBHE	CCR				1
Green-backed Heron	GRHE	CCR		2		
Mallard	MALL	CCR	10	3		5
Spotted Sandpiper	SPSA	CCR	2			
Barn Swallow	BNSW	CCR	9	11	4	
Northwestern Crow	NWCR	CCR		2	2	1
Black-capped Chickadee	BCCH	CCR				3
American Robin	AMRO	CCR	6	4		
Cedar Waxwing	CEWI	CCR	1			
European Starling	EUST	CCR			3	
Common Yellowthroat	COYE	CCR		1		
Song Sparrow	SOSP	CCR		1		1
Red-winged Blackbird	RWBL	CCR	1			
Brewer's Blackbird	BRBL	CCR	1	7	15	
Brown-headed Cowbird	BHCO	CCR	2	1		
House Finch	HOFI	CCR	1			

Appendix 4, cont...

			19-Jul	01-Aug	15-Aug	29-Aug
Canada Goose	CAGO	HAZ	31			
Green-winged Teal	GWTE	HAZ			1	
Mallard	MALL	HAZ	2	5	8	
Hooded Merganser	HOME	HAZ	1			
Killdeer	KILL	HAZ	2	3		2
Common Snipe	COSN	HAZ		1		
Downy Woodpecker	DOWO	HAZ			2	
Northern Flicker	NOFL	HAZ		2		
Hammond's Flycatcher	HAFL	HAZ			1	
Tree Swallow	TRSW	HAZ		2	3	
Violet-green Swallow	VGSW	HAZ	4		1	
Cliff Swallow	CLSW	HAZ	3	5	2	
Barn Swallow	BNSW	HAZ	5	26	46	6
Northwestern Crow	NWCR	HAZ	11	31	16	22
Black-capped Chickadee	BCCH	HAZ	6	1	2	1
Chestnut-backed Chickadee	CBCH	HAZ	8	6	7	8
Red-breasted Nuthatch	RBNU	HAZ	1	1	2	
Brown Creeper	BRCR	HAZ	3	4	1	2
Bewick's Wren	BEWR	HAZ		4	1	
Golden-crowned Kinglet	GCKI	HAZ	4	6	1	4
Swainson's Thrush	SWTH	HAZ		2		
American Robin	AMRO	HAZ	7	9	24	1
Cedar Waxwing	CEWI	HAZ	1	14	3	
European Starling	EUST	HAZ	33	82	46	12
Western Tanager	WETA	HAZ		1		
Rufous-sided Towhee	RSTO	HAZ	2	3		
Song Sparrow	SOSP	HAZ	2		3	
Dark-eyed Junco	DEJU	HAZ	1	8	4	2
Red-winged Blackbird	RWBL	HAZ	2			
Brown-headed Cowbird	BHCO	HAZ		2	1	
House Finch	HOFI	HAZ	3	1		
Pine Siskin	PISI	HAZ			2	3
American Goldfinch	AMGO	HAZ	4		10	5

			13-Jul	30-Jul	08-Aug	28-Aug
Great Blue Heron	GBHE	PGR	4		1	
Mallard	MALL	PGR			2	
Red-tailed Hawk	RTHA	PGR	2			
Vaux's Swift	VASW	PGR				3
Belted Kingfisher	BEKI	PGR		1		
Downy Woodpecker	DOWO	PGR		1		
Hammond's Flycatcher	HAFL	PGR				1
Violet-green Swallow	VGSW	PGR	3			
Barn Swallow	BNSW	PGR	10	11	21	9
Steller's Jay	STJA	PGR				1
Northwestern Crow	NWCR	PGR	17	7	13	104

Appendix 4, cont...

			13-Jul	30-Jul	08-Aug	28-Aug
Black-capped Chickadee	BCCH	PGR	8	8	13	18
Bushtit	BUSH	PGR	5	55	18	
Bewick's Wren	BEWR	PGR		1	1	1
Golden-crowned Kinglet	GCKI	PGR	4	5		1
American Robin	AMRO	PGR	6	10	5	14
Cedar Waxwing	CEWI	PGR		3	5	
European Starling	EUST	PGR	49	21	18	63
Warbling Vireo	WAVI	PGR				8
Orange-crowned Warbler	OCWA	PGR			2	12
Yellow Warbler	YEWA	PGR			1	21
Wilson's Warbler	WIWA	PGR			2	
Red-winged Blackbird	RWBL	PGR		7		
Brown-headed Cowbird	BHCO	PGR		1		
House Finch	HOFI	PGR	3	5	3	
American Goldfinch	AMGO	PGR	1	3		1
House Sparrow	HOSP	PGR		6	2	1

			12-Jul	30-Jul	06-Aug	21-Aug
Great Blue Heron	GBHE	MLA		2		
Mallard	MALL	MLA			2	
Western Sandpiper	WESA	MLA		1		
Thayers Gull	THGU	MLA				1
Violet-green Swallow	VGSW	MLA	1			
Cliff Swallow	CLSW	MLA		15		
Barn Swallow	BNSW	MLA	21	58	15	17
Cedar Waxwing	CEWI	MLA	3	6	2	4
European Starling	EUST	MLA			1	13
Brewer's Blackbird	BRBL	MLA			3	2
Brown-headed Cowbird	BHCO	MLA	9			
Pine Siskin	PISI	MLA				2
American Goldfinch	AMGO	MLA		1		
House Sparrow	HOSP	MLA			1	

			10-Jul	25-Jul	09-Aug	22-Aug
American Bittern	AMBI	SRY			1	
Mallard	MALL	SRY	10	1	4	1
Hooded Merganser	HOME	SRY				1
Killdeer	KILL	SRY		5	2	12
Mew gull	MEGU	SRY				2
Ring-billed Gull	RBGU	SRY			3	5
Downy Woodpecker	DOWO	SRY	1			
Western Wood Pewee	WWPE	SRY				1
Tree Swallow	TRSW	SRY		3		
Barn Swallow	BNSW	SRY	11	22	3	49
Northwestern Crow	NWCR	SRY	31	25	26	44

Appendix 4, cont....

			10-Jul	25-Jul	09-Aug	22-Aug
Black-capped Chickadee	BCCH	SRY	9			2
Chestnut-backed Chickadee	CBCH	SRY		4	10	
Bushtit	BUSH	SRY				10
American Robin	AMRO	SRY	1	8	4	
Cedar Waxwing	CEWI	SRY		2	1	
European Starling	EUST	SRY	71	78	55	139
Orange-crowned Warbler	OCWA	SRY				6
Yellow Warbler	YEWA	SRY			1	
Wilson's Warbler	WIWA	SRY				1
Song Sparrow	SOSP	SRY		1		
Red-winged Blackbird	RWBL	SRY	1		1	
Brewer's Blackbird	BRBL	SRY	11	9	14	9
Brown-headed Cowbird	BHCO	SRY			1	
House Finch	HOFI	SRY	4	2	5	
Pine Siskin	PISI	SRY			1	
American Goldfinch	AMGO	SRY	1	1	10	1

			17-Jul	03-Aug	17-Aug	31-Aug
Green-backed Heron	GRHE	TTI		1		1
Canada Goose	CAGO	TTI	10	10	280	
Mallard	MALL	TTI	1	12	1	1
Killdeer	KILL	TTI		2	1	
Belted Kingfisher	BEKI	TTI				2
Downy Woodpecker	DOWO	TTI		2	1	
Hairy Woodpecker	HAWO	TTI	1			
Northern Flicker	NOFL	TTI		3		
Pileated Woodpecker	PIWO	TTI				2
Olive-sided Flycatcher	OSFL	TTI	1	3		
Western Wood Pewee	WWPE	TTI			5	
Willow Flycatcher	WIFL	TTI	5	4	8	5
Violet-green Swallow	VGSW	TTI	5			
Barn Swallow	BNSW	TTI	7	7	19	3
Steller's Jay	STJA	TTI	1	2	1	
Northwestern Crow	NWCR	TTI	2		1	
Black-capped Chickadee	BCCH	TTI	9	12	5	11
Chestnut-backed Chickadee	CBCH	TTI	5	4		6
Bushtit	BUSH	TTI		20	40	
Brown Creeper	BRCR	TTI		2	1	
Bewick's Wren	BEWR	TTI	2	1	3	3
Marsh Wren	MAWR	TTI	1			
Golden-crowned Kinglet	GCKI	TTI	6	2	5	
Swainson's Thrush	SWTH	TTI	7	4	1	4
Hermit Thrush	HETH	TTI				1
American Robin	AMRO	TTI	25	17	30	8
Cedar Waxwing	CEWI	TTI	3	16	3	4
European Starling	EUST	TTI	3	1	1	

Appendix 4, cont....

			17-Jul	03-Aug	17-Aug	31-Aug
Warbling Vireo	WAVI	TTI			2	
Orange-crowned Warbler	OCWA	TTI		3		5
Yellow Warbler	YEWA	TTI		1		1
Black-throated Gray Warbler	BTGW	TTI		1		
Common Yellowthroat	COYE	TTI	3	3	3	4
Wilson's Warbler	WIWA	TTI		1	2	
Black-headed Grosbeak	BHGR	TTI	4	5	1	
Rufous-sided Towhee	RSTO	TTI	2	2	2	6
Song Sparrow	SOSP	TTI	14	6	10	8
White-crowned Sparrow	WCSP	TTI			2	1
Red-winged Blackbird	RWBL	TTI	7	4		
Brown-headed Cowbird	BHCO	TTI	5			1
Northern Oriole	NOOR	TTI	2			
Purple Finch	PUFI	TTI	1	1	2	3
House Finch	HOFI	TTI		1		
American Goldfinch	AMGO	TTI	3	4	14	3
Pine Siskin	PISI	TTI	1	5	5	2
Evening Grosbeak	EVGR	TTI				1

			09-Jul	24-Jul	08-Aug	23-Aug
Great Blue Heron	GBHE	TSA		1	1	1
Canada Goose	CAGO	TSA	7			
Mallard	MALL	TSA	7	1		
Killdeer	KILL	TSA	1			
Mourning Dove	MODO	TSA	1			
Belted Kingfisher	BEKI	TSA	1			
Tree Swallow	TRSW	TSA	9	2		
Violet-green Swallow	VGSW	TSA	3	3		4
Cliff Swallow	CLSW	TSA		2		
Barn Swallow	BNSW	TSA	23	31	35	37
Northwestern Crow	NWCR	TSA	13	8	11	2
Black-capped Chickadee	BCCH	TSA	2	3		3
Bushtit	BUSH	TSA	5			
American Robin	AMRO	TSA	20	10	14	2
Cedar Waxwing	CEWI	TSA	3			1
European Starling	EUST	TSA	79	23	40	9
Yellow Warbler	YEWA	TSA			1	
Yellow-rumped Warbler	YRWA	TSA			1	
Brewer's Blackbird	BRBL	TSA	10	2	2	1
Brown-headed Cowbird	BHCO	TSA		2		
House Finch	HOFI	TSA		2	1	3
Red Crossbill	RECR	TSA	1	4		
American Goldfinch	AMGO	TSA	3	3	1	1
House Sparrow	HOSP	TSA			10	

Appendix 5. Summary of Appendix 4 - Numbers of counts when each species was present and total numbers of birds counted during 4 visits to 8 golf courses in July and August 1990.

Species	Number of counts when species was present										Total numbers of birds in 4 counts									
	course								number	Total/32	course								total	Relative abundance
	BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA	courses	counts	BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA		(% of 4,140)
AMBI						1			1	1			1						1	0.02
GBHE	1	1		1	2			3	5	8	1	1		2	5	1		3	13	0.31
GRHE		1					2		2	3		2					2		4	0.10
MUSW	4								1	4	17								17	0.41
CAGO			1				3	1	3	5			31				300	7	338	8.16
GWTE			1						1	1			1						1	0.02
MALL	4	3	3	1	2	4	4	2	8	23	42	18	15	2	2	16	15	8	118	2.85
HOME			1			1			2	2			1			1			2	0.05
RTHA					1				1	1					2				2	0.05
KILL			3			3	2	1	4	9			7			19	3	1	30	0.72
SPOT		1							1	1		2							2	0.05
WESA				1					1	1				1					1	0.02
COSN			1						1	1			1						1	0.02
MEGU						1			1	1						2			2	0.05
RBGU	1					2			2	3	2					8			10	0.24
THGU				1					1	1				2					2	0.05
MODO								1	1	1								1	1	0.02
VASW					1				1	1					3				3	0.07
BEKI	1				1		1	1	4	4	1				1		2	1	5	0.12
DOWO	1		1		1	1	2		5	6	1		2		1	1	3		8	0.19
HAWO							1		1	1							1		1	0.02
NOFL			1				1		2	2			2				3		5	0.12
PIWO							1		1	1							2		2	0.05
OSFL							2		1	2							4		4	0.10
WWPE						1	1		2	2						1	5		6	0.14
WIFL							4		1	4							22		22	0.53
HAFL			1		1				2	2			1		1				2	0.05
TRSW			2			1		2	3	5			5			3		11	19	0.46
VGSW	2		2	1	1		1	3	6	10	3		5	1	3		5	10	27	0.65

Appendix 5. Continued.

Species	Number of counts when species was present										Total numbers of birds in 4 counts									Relative abundance
	course								number	Total/32	course								total	
	BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA	courses	counts	BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA		(% of 4,140)
CLSW			3	1				1	3	5			10	15				2	27	0.65
BNSW	4	3	4	4	4	4	4	4	8	31	45	24	83	111	51	85	36	126	561	13.55
STJA					1		3		2	4					1		4		5	0.12
NWCR	4	3	4		4	4	2	4	7	25	54	5	80		146	126	3	34	448	10.82
BCCH	4	1	4		4	4	4	3	7	24	27	3	10		47	25	37	8	157	3.79
CBCH	1		4				3		3	8	3		29				15		47	1.14
BUSH	3				3	1	2	1	5	10	21				78	10	60	5	174	4.20
RBNU	1		3						2	4	2		4						6	0.14
BRCR	1		4				2		3	7	2		10				3		15	0.36
BEWR	2		2		3		4		4	11	3		5		3		9		20	0.48
MAWR							1		1	1							1		1	0.02
GCKI	1		4		3		3		4	11	2		15		10		13		40	0.97
SWTH			1				4		2	5			2				16		18	0.43
HETH							1		1	1							1		1	0.02
AMRO	4	2	4		4	3	4	4	7	25	71	10	41		35	13	80	46	296	7.15
CEWA		1	3	4	2	2	4	2	7	18		1	18	15	8	3	26	4	75	1.81
EUST	4	1	4	2	4	4	3	4	8	26	198	3	173	14	151	343	5	151	1038	25.07
WAVI	1				1		1		3	3	3				8		2		13	0.31
OCWA	1				2	1	2		4	6	25				14	6	8		53	1.28
YEWA	1				2	1	2	1	5	7	22				22	1	2	1	48	1.16
YRWA								1	1	1								1	1	0.02
BTGW							1		1	1							1		1	0.02
COYE		1					4		2	5		1					13		14	0.34
WIWA	1				1	1	2		4	5	21				2	1			24	0.58
WETA			1						1	1			1						1	0.02
BHGR							3		1	3							10		10	0.24
RSTO			2				4		2	6			5				12		17	0.41
SOSP		2	2			1	4		4	9		2	5			1	38		46	1.11
WCSP							2		1	2							3		3	0.07
DEJU			4						1	4			15						15	0.36

Appendix 5. Continued.

Species	Number of counts when species was present										Total numbers of birds in 4 counts									
	course								number courses	Total/32 counts	course								total	Relative abundance (% of 4,140)
	BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA			BGR	CCR	HAZ	MLA	PGR	SRY	TTI	TSA		
RWBL		1	1		1	2	2		5	7		1	2		7	2	11		23	0.56
BRBL	1	3		2		4		4	5	14	3	23		5		43		15	89	2.15
BHCO		2	2	1	1	1	2	1	7	10		3	3	9	1	1	6	2	25	0.60
NOOR							1		1	1							2		2	0.05
PUFI							4		1	4							7		7	0.17
HOFI		1	2		3	3	1	3	6	13		1	4		11	11	1	6	34	0.82
RECR	1							2	2	3	1							5	6	0.14
AMGO	2		3	1	3	4	4	4	7	21	2		19	1	5	13	24	8	72	1.74
PISI	1		2	1		1	4		5	9	2		5	2		1	13		23	0.56
EVGR							1		1	1							1		1	0.02
HOSP	3			1	3			1	4	8	14			1	9			10	34	0.82
Totals	27	16	33	14	27	26	46	24	8	32	588	100	611	181	627	737	830	466	4140	100

Appendix 6. Species codes, course codes, habitat codes and numbers of birds counted during 30 visits to four golf courses from 30 November 1990 to 1 July 1991.

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
GBHE BGR W	1	1		1	1						1	1			
CAGO BGR W													4	30	12
CAGO BGR G						52							22		
CAGO BGR F										3					
MALL BGR W	18	18	24	13						10	27	26	42	41	45
MALL BGR G									3	13					
MALL BGR F															
GADW BGR W										2	2	2	2		2
AMWI BGR W			1												
CANV BGR W		1	3							1	1	1			
COGO BGR W	1	2	1								1				
BUFF BGR W	1	1	2							3	3	3	1	2	
HOME BGR W			2							2					
BAEA BGR F				1	1										
RTHA BGR T															1
RTHA BGR F													2		
MEGU BGR G											57				
GWGU BGR W	4												1	1	
GWGU BGR G	1		34							1	19	27			
GWGU BGR F		2		4		3	1	1	2	2				1	
BTPI BGR H															
BEKI BGR W		1	1	1	1			1							
RBSA BGR T						1									
DOWO BGR T															
DOWO BGR H															
NOFL BGR G	1								2			1			
NOFL BGR T															
NOFL BGR H															
NOFL BGR F				1											
VGSW BGR F															
BNSW BGR F															
NWCR BGR G			1	2		36	1	2	5		7	2		3	7
NWCR BGR T		2	1											2	
NWCR BGR H											4		7	3	
NWCR BGR F			2			2							1	5	
BCCH BGR T		2		2		2	3	1					1	1	
BCCH BGR H		3	1	1		2		1	4	2	5	1	1	1	
BUSH BGR T										14	3				
BUSH BGR H															
RBNU BGR H															
BEWR BGR H															
GCKI BGR G			12			11									
GCKI BGR T	10	1	2	2	3	2	1	4							
GCKI BGR H		2	1	4	4			1							

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
GBHE BGR W															
CAGO BGR W	2	6	2	2	2	4	2	2			3	1			
CAGO BGR G															
CAGO BGR F											1				
MALL BGR W	39	31	54	41	19	13	22	20	6	7	3	3	2	7	6
MALL BGR G						7		2					2		
MALL BGR F	2					1			1						
GADW BGR W	2		2	2	2	2					1				
AMWI BGR W															
CANV BGR W		2	2												
COGO BGR W															
BUFF BGR W			3	4											
HOME BGR W															
BAEA BGR F															
RTHA BGR T															
RTHA BGR F															
MEGU BGR G															
GWGU BGR W	1														
GWGU BGR G		2													
GWGU BGR F	1						1					1			1
BTPI BGR H							1								1
BEKI BGR W															
RBSA BGR T															
DOWO BGR T					1								1		
DOWO BGR H										1					1
NOFL BGR G			1												
NOFL BGR T				1											
NOFL BGR H			1		1								1		
NOFL BGR F															
VGSW BGR F							2	4	1	1		1		1	1
BNSW BGR F								2	2	7	3	3	4	8	6
NWCR BGR G						2			1	4	2	2			2
NWCR BGR T		1	1	1	2	1	3	2	4		2	4	2	6	3
NWCR BGR H		3		1	1	1	1				1	4		4	
NWCR BGR F		1		1		1				1	1	2	3	1	
BCCH BGR T	1		1	5		1						1			1
BCCH BGR H	1	1		1	2	1			1	1			1		
BUSH BGR T	2			1	3	1			2						
BUSH BGR H	12	5	11								3	4			
RBNU BGR H				1											
BEWR BGR H										1					
GCKI BGR G															
GCKI BGR T															
GCKI BGR H															

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
RCKI BGR T															
RCKI BGR H															
AMRO BGR G									6			8	24	64	
AMRO BGR T					1						1				2
AMRO BGR H															
AMRO BGR F		5					2								
VATH BGR H	1														
CEWA BGR H															
CEWA BGR F															
EUST BGR G				12				14	30					7	
EUST BGR T			3			20	4					2			
EUST BGR H						1									
EUST BGR F					1							2			
RSTO BGR H		1	1			1			1		3		3		
FOSP BGR H									1						
SOSP BGR T							1								
SOSP BGR H	2	5			1	3	1	2	3		2		2		
WCSP BGR H															
DEJU BGR G									1						
DEJU BGR T									1						
DEJU BGR H	1	26	1	6		8	7	3	9			7	5	10	3
RWBL BGR T															
HOFI BGR T															
HOFI BGR H		1		2			1		3	2					
HOFI BGR F				1				2	1						
PISI BGR H	1														
PISI BGR F					1										
AMGO BGR T															
AMGO BGR H				2											
AMGO BGR F					1	5								1	
EVGR BGR G						6									
EVGR BGR H				12		8		6		27			8		
EVGR BGR F	12			2	6	2	3		5	54	12	24			4
HOSP BGR T															
HOSP BGR H															
RTLO PGR W											1				
DCCO PGR F									2						
AMBI PGR F															
GBHE PGR W						1	1								
GBHE PGR T				1	1										
GBHE PGR F							1								
CAGO PGR G															

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
RCKI BGR T							1								
RCKI BGR H				1											
AMRO BGR G		33	5	12	27	2					4	2	3	2	4
AMRO BGR T	3	1	5	1		3	6	2	1	2	1		1	2	
AMRO BGR H					2									2	
AMRO BGR F						2				2	1	1			
VATH BGR H															
CEWA BGR H												5			
CEWA BGR F												3			
EUST BGR G		8	2	3	2	14			1	29	23	23	24	8	12
EUST BGR T					1				2			3		2	
EUST BGR H			1					1						6	
EUST BGR F					12	2		2		4	2			3	3
RSTO BGR H					1										
FOSP BGR H				1											
SOSP BGR T															
SOSP BGR H		2	1		1	1						1			
WCSP BGR H		1													
DEJU BGR G		2													
DEJU BGR T		1													
DEJU BGR H	1	4	3	2	4										
RWBL BGR T								1							
HOFI BGR T	1							2		1					
HOFI BGR H															
HOFI BGR F			2					1	1		2				1
PISI BGR H															
PISI BGR F					1										1
AMGO BGR T							1	1				3		1	
AMGO BGR H											2				
AMGO BGR F						2	2		2		1	3	3	2	
EVGR BGR G															
EVGR BGR H															
EVGR BGR F															
HOSP BGR T		4													
HOSP BGR H			1												
RTLO PGR W															
DCCO PGR F															
AMBI PGR F								1							
GBHE PGR W						1				1					
GBHE PGR T															
GBHE PGR F								1							
CAGO PGR G								4							

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
MALL PGR W							1				2	2			
MALL PGR G															
MALL PGR F															
BUFF PGR W												2			
HOME PGR W		2													
BAEA PGR F					1										1
COHA PGR T		1						1							
COHA PGR F			1											1	
RTHA PGR T	1									1	1	1			
RTHA PGR H												1	1	1	1
RTHA PGR F					1						1				
KILL PGR F													1		
MEGU PGR F		12													
GWGU PGR F		1			1				2	12		2		1	2
RODO PGR F			5		8					20					
BTPI PGR T	5		30	1											
BTPI PGR F															
ANHU PGR H															
DOWO PGR T					1										
DOWO PGR H				1				1							
NOFL PGR G				1							1				2
NOFL PGR T				1							1	1			
NOFL PGR H	1								1						
NOFL PGR F		2													
WWPE PGR T															
VGSW PGR F															
BNSW PGR F															
NWCR PGR G															
NWCR PGR T	1					1		1	1		19		1		
NWCR PGR H		4													
NWCR PGR F		30		3	1	2		3	1	1		13	2	4	
BCCH PGR T		1	2	3	1	2	2		1		4		3		3
BCCH PGR H	2	2	1		2	5	3	1	2	1	1		5	1	5
BUSH PGR T										5					
BUSH PGR H			8	14							18			11	
BRCR PGR T					1										
BEWR PGR H															
WIWR PGR T		3		2			1	1							
WIWR PGR H	1	4	2	1	2	1	1	2		2	2			1	
GCKI PGR T	19	6	5	17	3	3		15			1	1			
GCKI PGR H	11	10	2	6	13			2		2					
RCKI PGR T															
RCKI PGR H															

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
MALL PGR W				5		2		1	1	1					
MALL PGR G						2									
MALL PGR F				3									2		2
BUFF PGR W															
HOME PGR W															
BAEA PGR F			1												
COHA PGR T															
COHA PGR F															
RTHA PGR T													1		
RTHA PGR H		1						1	1	1	1	2	1		1
RTHA PGR F	1		1	1	1										
KILL PGR F					1										
MEGU PGR F															
GWGU PGR F	4	2		2	1		2			1					
RODO PGR F	6			10	3							2			
BTPI PGR T															
BTPI PGR F						1									
ANHU PGR H								1	1		1				
DOWO PGR T						1									
DOWO PGR H		1	1												
NOFL PGR G				2											
NOFL PGR T															
NOFL PGR H															1
NOFL PGR F															
WWPE PGR T											1	1			
VGSW PGR F						5	2		1	1	3	1	3	1	
BNSW PGR F								1	3	10	14	5	7	6	8
NWCR PGR G	8	2		29			1	2	3	4		6	2		6
NWCR PGR T		1	1		1	1			3	1		3	3		11
NWCR PGR H	3							2			8	3			
NWCR PGR F		1	5	6	5	3		3	2	1	1	1	2	2	1
BCCH PGR T	1			6	8	2			1	1				1	
BCCH PGR H	2	1	3		1		2	1				1	3	6	1
BUSH PGR T					6	4	3	3						1	
BUSH PGR H		7	4	15	4		5	3	6	2	4		5		
BRCR PGR T	1														
BEWR PGR H						1							1		
WIWR PGR T															
WIWR PGR H	2	1	1			1									
GCKI PGR T						1									
GCKI PGR H		1													
RCKI PGR T				1											
RCKI PGR H				1											

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
AMRO PGR G		1									36			25	14
AMRO PGR T												10		5	
AMRO PGR H					1				1						
AMRO PGR F											3	5		4	
VATH PGR G															
VATH PGR T	1			2	2		1				1				
VATH PGR H						1	1	2			2				
CEWA PGR T															
CEWA PGR H															
CEWA PGR F															
EUST PGR G															
EUST PGR T									4						
EUST PGR H		7							2		2	3			
EUST PGR F		1													
WAVI PGR T															
WAVI PGR H															
YRWA PGR T															
YRWA PGR H															
WIWA PGR H															
RSTO PGR T		1		1	1						1				
RSTO PGR H	1	2	1		1	1		1	1			1			
FOSP PGR H						1									
SOSP PGR G									2	1				1	
SOSP PGR T				1			1								
SOSP PGR H	4	4	3	2	3		1	3		1	2	1		1	1
DEJU PGR G	2			1				2							
DEJU PGR T		2		1			2			3		2	1		
DEJU PGR H	5			4	6	2	2	1	5		5	3	1		2
DEJU PGR F													2		
BHCO PGR T															
BHCO PGR H															
PUFI PGR H						1									
HOFI PGR T															
HOFI PGR H		1													
HOFI PGR F			1						1						
PISI PGR T				4							2				1
PISI PGR H											1				
PISI PGR F			1		2	1	1	1							
AMGO PGR T		1													
AMGO PGR H															
AMGO PGR F		33		2	2		1		2		2	3			1
EVGR PGR T					10										
EVGR PGR F				3	24			4	7					6	
HOSP PGR G												1			
HOSP PGR T									1						
HOSP PGR H	3														

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
AMRO PGR G	9	5	36	11	18	9	5	5	3	6	5	2	1	3	5
AMRO PGR T	1	2		3	2		2	3	2		1	1	1		1
AMRO PGR H	3	3	2	1		2	2	2	1	1	1	1	2	1	2
AMRO PGR F	2			1	1		1			1					
VATH PGR G	1					1									
VATH PGR T		4				1									
VATH PGR H	1	1		6	4	4									
CEWA PGR T															1
CEWA PGR H													2	1	
CEWA PGR F												2			
EUST PGR G	8	40	3	37	4	8	1		5	12	250	12	16	24	11
EUST PGR T	4	4		1						2			16		
EUST PGR H	4	2				3	4			14	1	4	3		5
EUST PGR F	3	1		6		2		1		3		3		1	2
WAVI PGR T											1				
WAVI PGR H											2				
YRWA PGR T						1		1	1		1				
YRWA PGR H						1	4								
WIWA PGR H							1								
RSTO PGR T			1												
RSTO PGR H												1			
FOSP PGR H															
SOSP PGR G															
SOSP PGR T															
SOSP PGR H		1		2	1					1				1	
DEJU PGR G															
DEJU PGR T	1	1			1										
DEJU PGR H	6	5	2												
DEJU PGR F															
BHCO PGR T								1	1						
BHCO PGR H												1			2
PUFI PGR H															
HOFI PGR T									1						
HOFI PGR H															
HOFI PGR F		1						2			1		2	2	
PISI PGR T				1	2				1		2			1	
PISI PGR H					1		2	1							
PISI PGR F	3	3	2	4	1	2		4	1	2	1	1			1
AMGO PGR T								1			4		1		
AMGO PGR H						1									
AMGO PGR F							2	5	1	1	1	3	1	3	1
EVGR PGR T															
EVGR PGR F															
HOSP PGR G						1									
HOSP PGR T		1			1										
HOSP PGR H								1							

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
GBHE SRY W				1				1							
GBHE SRY T											2				
GBHE SRY F					1					1					
CAGO SRY W											39		16	36	
CAGO SRY G			6								6	30			
CAGO SRY F	44											2			2
GWTE SRY W														2	
MALL SRY W	68	80	82						4		18	10	12	13	2
MALL SRY G															
MALL SRY F										4		12	2		
BUFF SRY W											3	4		1	
BAEA SRY T		1	1					1			3		1		
BAEA SRY F															1
RTHA SRY T	1	2	1						1						1
RTHA SRY H	2					1									
RTHA SRY F		1						1							
RNPH SRY H															
KILL SRY G				2											
RBGU SRY G											1				
GWGU SRY G											12				
GWGU SRY F			4						1	7					2
RODO SRY F															1
DOWO SRY T															
NOFL SRY G	1														
NOFL SRY T		1													
VGSW SRY F															
BNSW SRY F															
NWCR SRY G	8	4		14				3	11	6	1				
NWCR SRY T	4	9	21	1		4	3	1	2	3	29	4	6		6
NWCR SRY H	3					3									3
NWCR SRY F			1			1	1	1		3	1	2	2	2	3
BCCH SRY G	1														
BCCH SRY T	1	1	1	1				1	1				1	1	
BCCH SRY H			2					1							
BUSH SRY T	7														
WIWR SRY T															
GCKI SRY T	2	3	1		4	1	1	1							
AMRO SRY G	3	24	28								156	1	109	86	250
AMRO SRY T		2								2		51		3	6
AMRO SRY H								1							
AMRO SRY F									1				2		13
CEWA SRY T															
CEWA SRY F															

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
GBHE SRY W															
GBHE SRY T															
GBHE SRY F															
CAGO SRY W	2	8				2	2	4		4		1		4	
CAGO SRY G		13	7	8	5	2	5	6		7			3	6	
CAGO SRY F			1			1	2								
GWTE SRY W															
MALL SRY W	12	9	7	19		12	2		3	3	2	1	2	4	10
MALL SRY G					6										
MALL SRY F			3				1								
BUFF SRY W															
BAEA SRY T	1														
BAEA SRY F															
RTHA SRY T	1														
RTHA SRY H															
RTHA SRY F			1				1								
RNPH SRY H			1	2											
KILL SRY G															
RBGU SRY G															
GWGU SRY G															
GWGU SRY F									1						
RODO SRY F															
DOWO SRY T												1			
NOFL SRY G															
NOFL SRY T													1		
VGSW SRY F							1							1	
BNSW SRY F										8	12	4		9	
NWCR SRY G		1	2	2	6	5		1	1	1	1		5	3	11
NWCR SRY T	9	2	16	17	16	3	6	9	4	7	5	10	9	16	13
NWCR SRY H					2							2	2		2
NWCR SRY F	5	5	4			1	3			1	1	1	2	2	
BCCH SRY G															
BCCH SRY T			3	1							1	1			2
BCCH SRY H															
BUSH SRY T															
WIWR SRY T			1												
GCKI SRY T															
AMRO SRY G	188	287	223		46	6	4				4	2		4	
AMRO SRY T	2	1		26	7	7	3	5	4	4	5		2	3	2
AMRO SRY H				4	2				2						
AMRO SRY F	30						2				1				
CEWA SRY T											1		1	3	
CEWA SRY F											4	4	2	2	

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
EUST SRY G	35	300	32	4					120		550				55
EUST SRY T										4					
EUST SRY H		1													
EUST SRY F			2					5		12		1			
OCWA SRY T															
YEWA SRY T															
YEWA SRY F					1										
COYE SRY H															
SAVS SRY H															
SOSP SRY T				1				1							
SOSP SRY H	3	2	3			4	1	1				1			
WCSP SRY H	1	1													2
DEJU SRY G	2	21	2	27	1										
DEJU SRY T	13	11	11	1	1	3		5	2	24	7	2	2	1	1
DEJU SRY H	12	14	7			1	2				2		9		3
DEJU SRY F						1									
RWBL SRY G		50													
RWBL SRY H		86													
BRBL SRY H		45													1
BRBL SRY F															
HOFI SRY T											1	11			2
HOFI SRY H												15			
HOFI SRY F				2								1			
PISI SRY F							1								
AMGO SRY T															
AMGO SRY H															
AMGO SRY F	4	1													
EVGR SRY F							55	2							
DCCO TSA W		1													
GBHE TSA W	1	1	1				1				2	1	2	1	1
SNGO TSA F													800		
CAGO TSA W		55		27							5		2		
CAGO TSA G	30		45				17		19	58					
MALL TSA W	79	188	426	2						97	65	42	4		4
MALL TSA G															
MALL TSA F															
NOPI TSA W		1													
BWTE TSA W															
CITE TSA W															
GADW TSA W															
EUWI TSA W		1													
AMWI TSA W	98	270	570	6						60	100	16	64	154	130

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
EUST SRY G	26	44	70		40	12			15	56	32	41	36	35	33
EUST SRY T				2						1	5		4		18
EUST SRY H										2			3		
EUST SRY F	1			52		1		2	2	1	1	3	4	8	
OCWA SRY T										1					
YEWA SRY T								1		3	1				
YEWA SRY F															
COYE SRY H							1	2	1		2	1	1	1	
SAVS SRY H							1	2			1	1		1	
SOSP SRY T															
SOSP SRY H		1	2		2	2		2	1						2
WCSP SRY H					2		1				1			1	
DEJU SRY G															
DEJU SRY T			1		1										
DEJU SRY H					1										
DEJU SRY F															
RWBL SRY G															
RWBL SRY H			1				1								
BRBL SRY H															
BRBL SRY F				3		1							1		
HOFI SRY T	2	2		1	1										
HOFI SRY H	4			2											
HOFI SRY F	2		2			3			2		2				1
PISI SRY F															
AMGO SRY T			1								1				1
AMGO SRY H					1					2		1			3
AMGO SRY F					1	2	1	1	2	1	3	2	1	4	2
EVGR SRY F															
DCCO TSA W															
GBHE TSA W	1			2			1					1			1
SNGO TSA F															
CAGO TSA W		5	6	10	2	2	12	3	4		27	10	29	31	14
CAGO TSA G						5		27	27	19					
MALL TSA W			1	41	1	3	3	2	17	4	4	4	3	6	3
MALL TSA G	3			2	2										
MALL TSA F								3							
NOPI TSA W															
BWTE TSA W									5	1					
CITE TSA W									1						
GADW TSA W									2	1					
EUWI TSA W		1	1	1											
AMWI TSA W	92	208	170	131	165	75	5								

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
GRSC TSA W															
COGO TSA W													1		
BUFF TSA W											1	1	4		
HOME TSA W		4											4		
COME TSA W		6										2	2	3	
RUDU TSA W		1													
BAEA TSA F									1	1			2		
SSHA TSA F															
RTHA TSA F									2			1			
RLHA TSA F					1										
AMCO TSA W	1	1	2												
KILL TSA G							1								
KILL TSA F														2	
GRYE TSA F															
COSN TSA H							1								
GWGU TSA W		1	4					7		2					
GWGU TSA G		1	1								2				
GWGU TSA F			3	17	1			3		1		1		16	9
BEKI TSA W	1	1	1												
RBSA TSA T						1	1	1							
NOFL TSA G										1					
NOFL TSA H						1									1
VGSW TSA F															
BNSW TSA F															
NWCR TSA G		2	3	5				1	80						
NWCR TSA T			2	1					5						
NWCR TSA F							1	1		1		1	9		7
CORA TSA F							1								
BCCH TSA T		1				1					1				
BCCH TSA H	3	2						1				1			
CBCH TSA T													1		
CBCH TSA H															2
BUSH TSA T															
BUSH TSA H												14		1	
RBNU TSA T		1				2									
BRCR TSA T															
WIWR TSA H	1	1	1												1
GCKI TSA T	7	4		1				1							
GCKI TSA H	1	2													
RCKI TSA T															
AMRO TSA G								2	1			23	3	69	3
AMRO TSA T							1			3	1			2	5
AMRO TSA H															
AMRO TSA F					3			1		2	1	1			1

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
GRSC TSA W								1							
COGO TSA W	1														
BUFF TSA W		2	2	1	1										
HOME TSA W															
COME TSA W															
RUDU TSA W															
BAEA TSA F				1		2								1	
SSHA TSA F					1										
RTHA TSA F							1								
RLHA TSA F															
AMCO TSA W															
KILL TSA G															1
KILL TSA F									1			1			
GRYE TSA F									1						
COSN TSA H															
GWGU TSA W				1						1					
GWGU TSA G															
GWGU TSA F							1	1		1					
BEKI TSA W															
RBSA TSA T															
NOFL TSA G															
NOFL TSA H															
VGSW TSA F					7	5	1		2	2	2	1	1	1	
BNSW TSA F							2	6	18	11	11	10	16	4	3
NWCR TSA G	10			5	2			1		1	3			6	5
NWCR TSA T		5	1	1	2		2	3	2	3	1	3	1	4	4
NWCR TSA F		2	3		1	6			1	1	1	1	2		
CORA TSA F						1									
BCCH TSA T			2	1	2	5		1		1	2		5		3
BCCH TSA H												1			
CBCH TSA T	1				2										
CBCH TSA H															
BUSH TSA T					2								6		5
BUSH TSA H															
RBNU TSA T					1	1		1							
BRCR TSA T			1												
WIWR TSA H			1	1					1						
GCKI TSA T															
GCKI TSA H								1							
RCKI TSA T			1												
AMRO TSA G	21	7	23	4	16	2	3		1	2	3	2	2	3	3
AMRO TSA T	2			4		2	6	7	2	1	1	1	1		1
AMRO TSA H														1	
AMRO TSA F			1					1							

Appendix 6. Continued

	30-Nov	06-Dec	14-Dec	20-Dec	28-Dec	04-Jan	10-Jan	18-Jan	25-Jan	01-Feb	08-Feb	15-Feb	22-Feb	01-Mar	08-Mar
CEWA TSA T															
CEWA TSA F															
EUST TSA G				30									26	321	220
EUST TSA T															
EUST TSA F					1	4		6							
YRWA TSA T															
BTGW TSA H															
RSTO TSA H															
SAVS TSA G															
SOSP TSA T							1			1					
SOSP TSA H	1														
DEJU TSA T						1									
DEJU TSA H								2							1
BHCO TSA T															
BHCO TSA H															
HOFI TSA T								2							
HOFI TSA F	1	3		1		1	3	1							
RECR TSA F		1													
AMGO TSA T															
AMGO TSA F		1													
PISI TSA F															
EVGR TSA F					1										

Appendix 6. Continued

	15-Mar	22-Mar	27-Mar	05-Apr	11-Apr	19-Apr	30-Apr	10-May	19-May	27-May	03-Jun	10-Jun	18-Jun	24-Jun	01-Jul
CEWA TSA T											1	1	1	3	
CEWA TSA F											1		2	1	
EUST TSA G	300	5					1	1	9	14	7	22	34	16	14
EUST TSA T							1		2				6		
EUST TSA F							1	1	1	4	1			2	3
YRWA TSA T							2								
BTGW TSA H									1						
RSTO TSA H			1												
SAVS TSA G				1											
SOSP TSA T															
SOSP TSA H					1										
DEJU TSA T			1												
DEJU TSA H			3	1		4									
BHCO TSA T										1					
BHCO TSA H								1							
HOFI TSA T															
HOFI TSA F					1	1									
RECR TSA F														3	
AMGO TSA T										1	1			1	
AMGO TSA F						1		4	1	2	1	1	2	1	1
PISI TSA F													1	1	
EVGR TSA F															

Appendix 7. Summary of Appendix 6 - Numbers of counts when each species was present and the total numbers of birds counted during 30 visits to 4 golf courses from 30 November 1990 to 1 July 1991.

Species	Number of counts when present						Number of birds in 30 counts					Relative abundance
	course				number	total/120	course					
	BGR	PGR	SRY	TSA	courses	counts	BGR	PGR	SRY	TSA	total	(% of 15,303)
Red-throated Loon		1			1	1		1			1	0.01
Double-crested Cormorant		1		1	2	2		2		1	3	0.02
American Bittern		1			1	1		1			1	0.01
Great Blue Heron	6	7	5	14	4	32	6	8	6	17	37	0.24
Snow Goose				1	1	1				(800)[1]		
Canada Goose	15	1	19	23	4	58	150	4	274	491	919	6.01
Green-winged Teal			1		1	1			2		2	0.01
Mallard	26	10	24	23	4	83	568	24	403	1009	2004	13.10
Northern Pintail				1	1	1				1	1	0.01
Blue-winged Teal				2	1	2				6	6	0.04
Cinnamon Teal				1	1	1				1	1	0.01
Gadwall	11			2	2	13	21			3	24	0.16
Eurasian Wigeon				4	1	4				4	4	0.03
American Wigeon	1			17	2	18	1			2314	2315	15.13
Canvasback	7				1	7	11				11	0.07
Greater Scaup				1	1	1				1	1	0.01
Common Goldeneye	4			2	2	6	5			2	7	0.05
Bufflehead	10	1	3	7	4	21	23	2	8	12	45	0.29
Hooded Merganser	2	1		2	3	5	4	2		8	14	0.09
Common Merganser				4	1	4				13	13	0.08
Ruddy Duck				1	1	1				1	1	0.01
Bald Eagle	2	3	7	6	4	18	2	3	9	8	22	0.14
Sharp-shinned Hawk				1	1	1				1	1	0.01
Cooper's Hawk		4			1	4		4			4	0.03
Red-tailed Hawk	2	20	10	3	4	35	3	24	14	4	45	0.29
Rough-legged Hawk				1	1	1				1	1	0.01
Ring-necked Pheasant			2		1	2			3		3	0.02
American Coot				3	1	3				4	4	0.03
Killdeer		2	1	5	3	8		2	2	6	10	0.07
Greater Yellowlegs				1	1	1				1	1	0.01
Common Snipe				1	1	1				1	1	0.01
Mew Gull	1	1			2	2	57	12			69	0.45
Ring-billed Gull			1		1	1			1		1	0.01
Glaucous-winged Gull	18	13	6	14	4	51	111	33	27	74	245	1.60
Rock Dove		7	1		2	8		54	1		55	0.36
Band-tailed Pigeon	2	4			2	6	2	37			39	0.25
Anna's Hummingbird		3			1	3		3			3	0.02
Belted Kingfisher	5			3	2	8	5			3	8	0.05
Red-breasted Sapsucker	1			3	2	4	1			3	4	0.03
Downy Woodpecker	4	6	1		3	11	4	6	1		11	0.07
Northern Flicker	8	9	3	3	4	23	9	14	3	3	29	0.19
Western Wood-Pewee		2			1	2		2			2	0.01
Violet-green Swallow	7	8	2	2	4	19	11	17	2	22	52	0.34
Barn Swallow	9	8	4	9	4	30	35	54	33	81	203	1.33
Northwestern Crow	26	27	29	25	4	107	167	225	380	202	974	6.36
Common Raven				2	1	2				2	2	0.01
Black-capped Chickadee	23	28	13	16	4	80	53	94	20	33	200	1.31
Chestnut-backed Chickadee				4	1	4				6	6	0.04
Bushtit	11	17	1	5	4	34	61	128	7	28	224	1.46
Red-breasted Nuthatch	1			5	2	6	1			6	7	0.05

continued...

Appendix 7. Continued.

Species	Number of counts when present						Number of birds in 30 counts					Relative abundance
	course				number courses	total/120 counts	course				total	(% of 15,303)
	BGR	PGR	SRY	TSA			BGR	PGR	SRY	TSA		
Brown Creeper		2		1	2	3		2		1	3	0.02
Bewick's Wren	1	2			2	3	1	2			3	0.02
Winter Wren		15	1	7	3	23		31	1	7	39	0.25
Golden-crowned Kinglet	8	12	7	5	4	32	60	118	13	17	208	1.36
Ruby-crowned Kinglet	2	1		1	3	4	2	2		1	5	0.03
American Robin	24	22	26	25	4	97	245	277	1614	245	2381	15.56
Varied Thrush	1	12			2	13	1	36			37	0.24
Cedar Waxwing	1	4	4	4	4	13	8	6	17	10	41	0.27
European Starling	22	19	24	18	4	83	289	539	1671	1053	3552	23.21
Warbling Vireo		1			1	1		3			3	0.02
Orange-crowned Warbler			1		1	1			1		1	0.01
Yellow Warbler			4		1	4			6		6	0.04
Yellow-rumped Warbler		5		1	2	6		9		2	11	0.07
Black-throated Gray Warbler				1	1	1				1	1	0.01
Common Yellowthroat			7		1	7			9		9	0.06
Wilson's Warbler		1			1	1		1			1	0.01
Rufous-sided Towhee	8	12		1	3	21	11	15		1	27	0.18
Fox Sparrow			5	1	2	6			6	1	7	0.05
Savannah Sparrow	2	1			2	3	2	1			3	0.02
Song Sparrow	14	18	15	4	4	51	28	38	29	4	99	0.65
White-crowned Sparrow	1		7		2	8	1		9		10	0.07
Dark-eyed Junco	17	17	17	6	4	57	105	70	191	13	379	2.48
Red-winged Blackbird	1		3		2	4	1		138		139	0.91
Brewer's Blackbird			5		1	5			51		51	0.33
Brown-headed Cowbird		4		2	2	6		5		2	7	0.05
Purple Finch		1			1	1		1			1	0.01
House Finch	13	9	14	8	4	44	24	12	56	16	108	0.71
Red Crossbill				2	1	2				4	4	0.03
American Goldfinch	12	18	14	10	4	54	4	50	1	2	57	0.37
Pine Siskin	4	22	1	2	4	29	32	72	35	18	157	1.03
Evening Grosbeak	12	5	2	1	4	20	191	47	57	1	296	1.93
House Sparrow	2	1			2	3	5	16			21	0.14
Totals	41	48	37	56	4	120	2321	2109	5101	6572	15303	100.00

[1] 800 Snow Geese were excluded from all totals and calculations.

Appendix 8. Appendix 6 summarized by habitat - Numbers of counts when each species was present and the total number of birds counted during 30 visits to 4 golf courses from 30 November 1990 to 1 July 1991.

Species	Habitat	Number of counts when present						Number of birds in 30 counts					Relative abundance
		course				number	total/120	course					
		BGR	PGR	SRY	TSA	courses	counts	BGR	PGR	SRY	TSA	total	(% of 6,355)
CAGO	grass	2	1	13	9	4	25	74	4	104	247	429	6.75
MALL	grass	5	1	1	3	4	10	27	2	6	7	42	0.66
KILL	grass			1	2	2	3			2	2	4	0.06
MEGU	grass	1				1	1	57				57	0.90
RBGU	grass			1		1	1			1		1	0.02
GWGU	grass	6		1	3	3	10	84		12	4	100	1.57
NOFL	grass	3	4	1	1	4	9	4	6	1	1	12	0.19
NWCR	grass	16	10	19	13	4	58	79	63	86	124	352	5.54
BCCH	grass			1		1	1			1		1	0.02
GCKI	grass	2				1	2	23				23	0.36
AMRO	grass	14	19	17	20	4	70	196	199	1421	193	2009	31.61
VATH	grass		2			1	2		2			2	0.03
EUST	grass	16	14	19	15	4	64	212	431	1536	1020	3199	50.34
SAVS	grass				1	1	1				1	1	0.02
SOSP	grass		3			1	3		4			4	0.06
DEJU	grass	2	3	5		3	10	3	5	53		61	0.96
RWBL	grass			1		1	1			50		50	0.79
EVGR	grass	1				1	1	6				6	0.09
HOSP	grass		2			1	2		2			2	0.03
Total		11	10	12	9	19	274	765	718	3273	1599	6355	100.00
RTHA	hedgerow		12	2		2	14		13	3		16	1.32
RNPH	hedgerow			2		1	2			3		3	0.25
COSN	hedgerow				1	1	1				1	1	0.08
BTPI	hedgerow	2				1	2	2				2	0.17
ANHU	hedgerow		3			1	3		3			3	0.25
DOWO	hedgerow	2	4			2	6	2	4			6	0.50
NOFL	hedgerow	3	3		2	3	8	3	3		2	8	0.66
NWCR	hedgerow	11	5	7		3	23	30	20	17		67	5.54
BCCH	hedgerow	19	23	2	5	4	49	31	52	3	8	94	7.77
CBCH	hedgerow				1	1	1				2	2	0.17
BUSH	hedgerow	5	14		2	3	21	35	106		15	156	12.89
RBNU	hedgerow	1				1	1	1				1	0.08
BEWR	hedgerow		2			1	2	1	2			3	0.25
WIWR	hedgerow		15		7	2	22		24		7	31	2.56
GCKI	hedgerow		8		3	2	11	12	47		4	63	5.21
RCKI	hedgerow	1	1			2	2	1	1			2	0.17
AMRO	hedgerow	2	16	4	1	4	23	4	26	9	1	40	3.31
VATH	hedgerow	1	9			2	10	1	22			23	1.90
CEWA	hedgerow	1	2			2	3	5	3			8	0.66
EUST	hedgerow	4	13	3		3	20	9	54	6		69	5.70
WAVI	hedgerow		1			1	1		2			2	0.17
YRWA	hedgerow		2			1	2		5			5	0.41
BTGW	hedgerow				1	1	1				1	1	0.08
COYE	hedgerow			7		1	7			9		9	0.74
WIWA	hedgerow		1			1	1		1			1	0.08
RSTO	hedgerow	7	9		1	3	17	11	10		1	22	1.82
SAVS	hedgerow			5		1	5			6		6	0.50
FOSP	hedgerow	2	1			2	3	2	1			3	0.25

Appendix 8. Continued

Species	Habitat	Number of counts when present: course BGR	PGR	SRY	TSA	number courses	total/120 counts	Number of birds in 30 counts: course BGR	PGR	SRY	TSA	total	Relative abundance (% of 1,348)
SOSP	hedgerow	14	17	14	2	4	47	27	32	27	2	88	7.27
WCSP	hedgerow	1		7		2	8	1		9		10	0.83
DEJU	hedgerow	17	14	9	5	4	45	100	49	51	11	211	17.44
RWBL	hedgerow			3		1	3			88		88	7.27
BRBL	hedgerow			2		1	2			46		46	3.80
BHCO	hedgerow		2		1	2	3		3		1	4	0.33
PUFI	hedgerow		1			1	1		1			1	0.08
HOFI	hedgerow	5	1	3		3	9	9	1	21		31	2.56
PISI	hedgerow	1	4			2	5	1	5			6	0.50
AMGO	hedgerow	2	1	4		3	7	4	1	7		12	0.99
EVGR	hedgerow	5				1	5	61				61	5.04
HOSP	hedgerow	1	2			2	3	1	4			5	0.41
Total		22	28	15	13	4	78	354	495	305	56	1210	100.00
GBHE	tree		2	1		2	3		2	2		4	0.30
BAEA	tree			6		1	6			8		8	0.59
COHA	tree		2			1	2		2			2	0.15
RTHA	tree	1	5	6		3	12	1	5	7		13	0.96
BTPI	tree		3			1	3		36			36	2.67
RBSA	tree	1			3	2	4	1			3	4	0.30
DOWO	tree	2	2	1		3	5	2	2	1		5	0.37
NOFL	tree	1	3	2		3	6	1	3	2		6	0.45
WWPE	tree		2			1	2		2			2	0.15
NWCR	tree	16	15	28	16	4	75	37	49	235	40	361	26.78
BCCH	tree	13	17	13	12	4	55	22	42	16	25	105	7.79
CBCH	tree				3	1	3				4	4	0.30
BUSH	tree	7	6	1	3	4	17	26	22	7	13	68	5.04
RBNU	tree				5	1	5				6	6	0.45
BRCR	tree		2		1	2	3		2		1	3	0.22
WIWR	tree		4	1		2	5		7	1		8	0.59
GCKI	tree	8	10	7	4	4	29	25	71	13	13	122	9.05
RCKI	tree	1	1		1	3	3	1	1		1	3	0.22
AMRO	tree	15	13	18	16	4	62	32	34	135	40	241	17.88
VATH	tree		7			1	7		12			12	0.89
CEWA	tree		1	3	4	3	8		1	5	6	12	0.89
EUST	tree	8	6	6	3	4	23	37	31	34	9	111	8.23
WAVI	tree		1			1	1		1			1	0.07
OCWA	tree			1		1	1			1		1	0.07
YEWA	tree			3		1	3			5		5	0.37
YRWA	tree		4		1	2	5		4		2	6	0.45
RSTO	tree		5			1	5		5			5	0.37
SOSP	tree	1	2	2	2	4	7	1	2	2	2	7	0.52
DEJU	tree	2	9	16	2	4	29	2	14	86	2	104	7.72
RWBL	tree	1				1	1	1				1	0.07
BHCO	tree		2		1	2	3		2		1	3	0.22
HOFI	tree	3	1	7	2	4	13	4	1	20	4	29	2.15
PISI	tree		8			1	8		14			14	1.04
AMGO	tree	4	4	3	3	4	14	6	7	3	3	19	1.41
EVGR	tree		1			1	1		3			3	0.22
HOSP	tree	1	3			2	4	4	10			14	1.04
Total		17	29	19	18	36	120	203	387	583	175	1348	100.00

Appendix 8. Continued

Species	Habitat	Number of counts when present: course BGR	PGR	SRY	TSA	number courses	total/120 counts	Number of birds in 30 counts: course BGR	PGR	SRY	TSA	total	Relative abundance (% of 1,348)
RTLO	water		1			1	1		1			1	0.02
DCCO	water				1	1	1				1	1	0.02
GBHE	water	6	1	2	14	4	23	6	4	2	17	29	0.60
CAGO	water	13		11	17	3	41	72		118	244	434	8.91
GWTE	water			1		1	1			2		2	0.04
MALL	water	25	8	22	22	4	77	537	15	375	999	1926	39.54
NOPI	water				1	1	1				1	1	0.02
BWTE	water				2	1	2				6	6	0.12
CITE	water				1	1	1				1	1	0.02
GADW	water	11			2	2	13	21			3	24	0.49
EUWI	water				4	1	4				4	4	0.08
AMWI	water	1			17	2	18	1			2314	2315	47.53
CANV	water	7				1	7	11				11	0.23
GRSC	water				1	1	1				1	1	0.02
COGO	water	4			2	2	6	5			2	7	0.14
BUFF	water	10	1	3	7	4	21	23	2	8	12	45	0.92
HOME	water	2	1		2	3	5	4	2		8	14	0.29
COME	water				4	1	4				13	13	0.27
RUDU	water				1	1	1				1	1	0.02
AMCO	water				3	1	3				4	4	0.08
GWGU	water	4			6	2	10	7			16	23	0.47
BEKI	water	5			3	2	8	5			3	8	0.16
Total		11	5	5	19	4	120	692	24	505	3650	4871	100.00
DCCO	flying		1			1	1		2			2	0.13
AMBI	flying		1			1	1		1			1	0.07
GBHE	flying		2	2		2	4		2	2		4	0.26
SNGO	flying				1	1	1				(800)[1]		
CAGO	flying	2		6		2	8	4		52		56	3.69
MALL	flying	3	3	5	1	4	12	4	7	22	3	36	2.37
BAEA	flying	2	3	1	6	4	12	2	3	1	8	14	0.92
SSHA	flying				1	1	1				1	1	0.07
COHA	flying		2			1	2		2			2	0.13
RTHA	flying	1	6	4	3	4	14	2	6	4	4	16	1.05
RLHA	flying				1	1	1				1	1	0.07
KILL	flying		2		3	2	5		2		4	6	0.39
GRYE	flying				1	1	1				1	1	0.07
MEGU	flying		1			1	1		12			12	0.79
GWGU	flying	12	13	5	11	4	41	20	33	15	54	122	8.03
RODO	flying		7	1		2	8		54	1		55	3.62
BTPI	flying		1			1	1		1			1	0.07
NOFL	flying	1	1			2	2	1	2			3	0.20
VGSW	flying	7	8	2	9	4	26	11	17	2	22	52	3.42
BNSW	flying	8	8	4	9	4	29	35	54	33	81	203	13.36
NWCR	flying	12	23	20	15	4	70	21	93	42	38	194	12.77
CORA	flying				2	1	2				2	2	0.13
AMRO	flying	6	8	6	8	4	28	13	18	49	11	91	5.99

Appendix 8. Continued

Species	Habitat	Number of counts when present: course BGR	PGR	SRY	TSA	number courses	total/120 counts	Number of birds in 30 counts: course BGR	PGR	SRY	TSA	total	Relative abundance (% of 1,519)
CEWA	flying	1	1	4	3	4	9	3	2	12	4	21	1.38
EUST	flying	9	10	14	10	4	43	31	23	95	24	173	11.39
YEWA	flying			1		1	1			1		1	0.07
DEJU	flying		1	1		2	2		2	1		3	0.20
BRBL	flying			3		1	3			5		5	0.33
HOFI	flying	8	7	8	8	4	31	11	10	15	12	48	3.16
RECR	flying				2	1	2				4	4	0.26
PISI	flying	3	17	1	2	4	23	3	31	1	2	37	2.44
AMGO	flying	10	17	13	10	4	50	22	64	25	15	126	8.29
EVGR	flying	10	5	2	1	4	18	124	44	57	1	226	14.88
Total		16	24	20	21	4	120	307	485	435	292	1519	100.00

[1]800 Snow Geese were excluded from all totals and calculations.

Appendix 9. Text of turf care chemical - wildlife questionnaire.

GOLF COURSES AND WILDLIFE

The popularity of Golf has increased greatly in recent years, resulting in a growing number of proposals for new golf courses. During this same time there has been an increase in other forms of outdoor activities, particularly bird watching, and also an increase in public concern over environmental issues. In British Columbia, the areas receiving the greatest share of golf course developments tend to be near existing population centres, the lower mainland, south east Vancouver Island and the Okanagan. These regions are all facing problems with dwindling wildlife habitat and general urban encroachment. In the future, golf courses may become increasingly important as urban green spaces.

The Canadian Wildlife Service considers it important, that golf courses be studied more carefully with regard to their suitability as wildlife habitat and also from the perspective of their impact on wildlife using the surrounding areas. This study will examine golf course and wildlife interactions in two areas:

1. the golf course as a habitat for wildlife, specifically birds, and
2. the effects of turf care chemicals on birds feeding and nesting in and around golf courses.

The habitat study will document the wildlife found on golf courses. We will look at both the diversity (numbers of different species) and the densities (total numbers of birds) at golf courses throughout the lower mainland. At the same time we will examine the quality of habitat offered by golf courses. We want to know how birds use a golf course for food and for cover. Within the lower mainland we have golf courses on flatlands, on the sides of mountains, next to marshland and in forests. We have golf courses under construction and others that have been around for 75 years or more. By examining this diversity of habitats we will be more able to make suggestions beneficial to both wildlife and the desires of golfers.

The pesticide study will document the use of turf care chemicals and their effects on birds and other wildlife. This study will involve a questionnaire sent to the superintendents of most golf courses in British Columbia. The questionnaire will establish the usage patterns of both pesticides and fertilizers and determine areas of potential chemical - wildlife interactions. We will also select a sample of golf courses and measure the productivity of specific bird species by either setting up nest

boxes or locating nests. We will examine carcasses of any birds found dead in the vicinity of golf courses.

QUESTIONNAIRE

The following questionnaire contains two parts. The purpose of the first section is to get a rough idea of how wild animals and birds use golf courses. We are interested to know if there are specific times of year when certain wildlife species frequent golf courses and what types of habitats they are attracted to. This is not a test of your ability to identify these animals or birds. You may group species into general categories such as ducks, geese, songbirds, deer or squirrels etc. If you have a knowledge of wildlife, any additional details or information will be very useful.

The second section pertains to the use of turf care chemicals. We wish to determine the yearly usage patterns of all turf care chemicals. This questionnaire is fully endorsed by the Vancouver Island and the Lower Mainland chapters of the British Columbia Golf Course Superintendents Association. Information from individual golf courses will be treated as confidential. The usefulness of this study depends on the quality and the accuracy of the information we receive.

For each of the turf care chemicals (pesticides and fertilizers) used on your golf course please fill out the attached table (see example table following). Use the units of measure you are most comfortable with, but please specify all units (metric, imperial or U.S.). If you use a certain product for multiple targets or at different doses in different areas of your golf course, please, fill out a separate table for each use. If there are specific products which you have used extensively in the past, but no longer use, please include them in this study and indicate why you no longer use the product. Please be as specific as possible.

If you have any questions please call IAN MOUL or JOHN ELLIOTT at the CANADIAN WILDLIFE SERVICE at 946-8546 or 666-0143.

WILDLIFE ON GOLF COURSES

GOLF COURSE: _____ DATE :_____

SUPERINTENDENTS NAME: _____

1) Are there any particular times of year when you see more or less wildlife on your golf course? Please list time of year, species and location (greens, roughs, ponds, trees etc.).

2) List any animals, fish or birds you consider beneficial to your golf course (for insect control etc.).

3) Are there certain species of animals or birds you consider pests, and what problems do they cause?

4) Have these problems been increasing or decreasing over the years.

5) What measures do you use to get rid of these animals or birds?

6) What is the overall reaction of golfers to the wildlife on your golf course?

7) Do you encourage or discourage wildlife on your course?

8) How close is your golf course to a river or stream, or to a ditch leading to a river or stream.

9) Additional information or comments.

GOLF COURSE:_____ PAGE_____OF_____

SUPERINTENDENTS NAME:_____ DATE:_____

TRADENAME:	PCP REGISTRATION #:
# APPLICATIONS PER YEAR:	TYPICAL TIMES OF APPLICATION:
TARGET SPECIES:	TARGET AREA:
APPLICATION RATE OF PRODUCT:	DILUTION: Volume of product: Volume of water: Surface area covered:
AMOUNT OF IRRIGATION BEFORE OR AFTER USE OF THIS PRODUCT:	TOTAL AMOUNT OF PRODUCT USED PER YEAR:
HAVE YOU EVER NOTICED ANY CHANGES IN BEHAVIOUR OR DEATHS OF ANIMALS, BIRDS OR FISH FOLLOWING USE OF THIS PRODUCT:	
ADDITIONAL COMMENTS:	

Appendix 10. List of golf course superintendents who responded to the turf care chemical - wildlife questionnaire.

Course	Superintendents name	Location	Region
Arbutus Ridge	Jim Kay	Cobble Hill	ISL
Balfour	Larry Olson	Balfour	INT
Capilano	David L. Sullivan	West Vancouver	LFV
City of Prince Rupert	Lorne Horne	Prince Rupert	ISL
Cranbrook	Len Heyworth	Cranbrook	INT
Eagle Crest	Michael Riva	Parksville	ISL
Fairwinds	Jim Dafoe	Nanoose	ISL
Gallaghers Canyon	Ashley LeGeyt	Kelowna	INT
George Vale	Douglas Ferne	Victoria	ISL
Gleneagles	Ernest I. George	West Vancouver	LFV
Hazelmere	Corey Grant	Surrey	LFV
Kelowna	Craig Lewis	Kelowna	INT
Kelowna Springs	Barry Skabar	Kelowna	INT
Long Beach	John Norton	Tofino	ISL
Marine Drive	Peter Dotto	Vancouver	LFV
Mayfair Lakes	Darren Burns	Richmond	LFV
McCleery	Bob Giesbrecht	Vancouver	LFV
Mission Creek	John Welder	Kelowna	INT
Mount Brenton	Dave Sandulo	Chemainus	ISL
Mount Pauc	Rick McKinnon	Vernon	INT
Nanaimo	Gerth Sjolie	Nanaimo	ISL
Newlands	Gerry Brown	Langley	LFV
Nico Wynd	Ted Eitel	Surrey	LFV
Osoyoos	Mike Harrison	Osoyoos	INT
Point Grey	Colin P. Softly	Vancouver	LFV
Prince George	Wes Petkau	Prince George	INT
Quilchena	Gary Gilmore	Richmond	LFV
Saltspring Island	Colin Packham	Saltspring Island	ISL
Seymour	Jim McGarvey	North Vancouver	LFV
Shannon Lake	Bob Brown	Shannon Lake	INT
Story Creek	Reg Franklin	Campbell River	ISL
Sunshore	L. Barton	Chase	INT
Tall Timber	Marlene Lindberg	Langley	LFV
Tsawwassen	Michael Weatherby	Tsawwassen	LFV
Twin Lakes	Richard Shillitto	Penticton	INT
Vancouver	Bruce Thrasher	Coquitlam	LFV

Appendix 11. Codes used in Appendices 12 through 15.

G	granular		
L	liquid		
W	wettable powder		
J	January	JL	July
F	February	AU	August
MR	March	S	September
AP	April	O	October
MY	May	N	November
JN	June	D	December
e	early		
m	mid		
l	late		
-	to		
/	or		
Ap	aprons	Ar	approches
Fl	flowers	Fr	fairways
Gr	greens	Or	ornamentals
Pa	paths	Po	ponds
Ro	rough	Te	tees
Tr	trees		
BLA	black algae		
BRN	brown spot	Rhizoctonia salani	
COP	copper spot	Gloeoceropora sorghi	
DOL	dollar spot	Sclerotinia homaecorpa	
FUS	Fusarium	Fusarium sp.	
GSM	grey snow mould	Typhula incornata	
LEF	feaf spots	Helminthoporum sp.	
PSM	pink snow mould	Fusarium nivale	
PYT	Pythium blight	Pythium sp.	
RED	red thread		
SNO	snow mould		
BLA	black medich		
BLW	broad leaf weeds		
BUT	buttercup		
CHI	chicory		
CLO	clover		
DAI	daisey		
DAN	dandilions		
DOC	curley dock		
GRA	grasses		
PLA	plantain		

Appendix 12. Fungicide use on British Columbia golf courses.

Active ingrediant	Form	Course code	Provincial code	Applications per year	Time of application	Location	Amount per year	Target
Anilazine	W	L	INT	2.5	AP-MY	Gr Ap	4.00 kg	BRN LEF
Benomyl	W	AC	INT	1	mN	Te	5.00 kg	PSM
Benomyl	L	P	ISL	1	mAU-mS	Gr Ar	8.60 kg	melting out FUS
Benomyl	W	A	LFV	5	AU-F	Gr	12.00 kg	
Benomyl	G	K	LFV	3	MY S O	Gr		
Benomyl	G	K	LFV	3	AU S O	Gr		
Benomyl	W	N	LFV	1	Fa	Gr	2.00 kg	PSM DOL
Benomyl	W	S	LFV	1.5	S-O MR/AP	Gr	9.00 kg	PSM
Benomyl	W	AB	LFV	1	S	Gr	6.00 kg	PSM earthworms
Benomyl	W	AH	LFV	2	Sp Fa	Gr	32.00 kg	PSM
Chloroneb	G	D	INT	1	D	Gr		SNO
Chloroneb	L	Q	INT	1		Gr	0.78 kg	GSM MPA
Chloroneb	G	Y	INT	1	N	Gr	4.75 kg	GSM
Chloroneb	G	Y	INT	1	N	Gr	4.75 kg	GSM
Chloroneb	W	AC	INT	1	mN	Gr & Te	26.00 kg	GSM
Chloroneb	G	AI	INT	1	O	Gr	4.64 kg	GSM
Chloroneb	G	AI	INT	1	O	Gr	4.64 kg	GSM
Chloroneb	G	AD	ISL	1	F	Gr	4.25 kg	GSM
Chloroneb	L	A	LFV	2	AU	new Gr	2.60 kg	BRN GSM PYT
Chloroneb	W	AH	LFV	1.5	lFa	Gr	15.60 kg	GSM
Chlorothalonil	L	M	INT	2	lAP eJN	Gr & Te	20.00 kg	SNO melting out
Chlorothalonil	L	X	INT	1	Su	Gr		LEF
Chlorothalonil	L	P	ISL	1	Fa Wi	Gr Ap & Ar	11.25 kg	FUS
Chlorothalonil	L	AA	ISL	3	AP MY JN S	Gr	30.00 kg	FUS
Chlorothalonil	L	G	LFV	varies	Sp-Su	Gr	15.35 kg	FUS RED Antheronose
Chlorothalonil	L	N	LFV	2	Su Fa	Gr	16.00 kg	DOL FUS melting out
Iprodione	L	D	INT	2	AP O	Gr		LEF SNO
Iprodione	W	M	INT	2	eFa eSp	Gr & Te	12.00 kg	SNO melting out
Iprodione	L	X	INT	1.5	JL AU/S O	Gr	3.63 kg	FUS LEF
Iprodione	W	Y	INT	1	S	Gr	10.00 kg	PSM
Iprodione	W	AC	INT	1	mN	Gr & Te	10.00 kg	PSM
Iprodione	L	P	ISL	3	Fa Wi	Gr Ap & Ar	8.90 kg	LEF
Iprodione	L	W	ISL	2.5	Sp Fa	Gr & Te	1.88 kg	DOL SNO
Iprodione	L	G	LFV	varies	Sp Su	Gr	1.53 kg	FUS RED
Iprodione	L	R	LFV	1.5	Su Wi	Gr & Te	3.00 kg	DOL SNO
Iprodione		AH	LFV	2	AP O	Gr	4.00 kg	
Mancozeb	W	D	INT	4	Sp Fa	Gr & Te(once)	0.00 kg	LEF SNO
Mancozeb	W	M	INT	2	lFa eSp	Gr & Te	25.60 kg	SNO
Mancozeb	G	V	ISL	4.5	Sp Fa	Gr	20.80 kg	Fungi
Mancozeb	W	AA	ISL	3	AP MY-JN S	Gr	20.40 kg	PSM
Mancozeb	W	AJ	ISL	1.5	S N F	Gr Te Ap	22.72 kg	PSM
Mancozeb	W	AJ	ISL	1.5	S N F	Gr Te Ap	21.30 kg	PSM
Mancozeb	L	A	LFV	4	AU F	Gr	52.80 kg	BRN COP LEF PSM
Mancozeb	W	B	LFV	2	J D	Gr & Te	16.35 kg	DOL FUS
Mancozeb	W	I	LFV	3	J MR N	Gr Te Ap	72.00 kg	fungus diseases
Mancozeb	G	AB	LFV	3	MR JN AU	Gr	36.80 kg	BLA
Mancozeb	W	AB	LFV	2	AU N	Gr	27.20 kg	BLA
Mancozeb	W	AH	LFV	4	MR MY S O	Gr	38.40 kg	PSM
Maneb	L	P	ISL	1	Sp Fa Wi	Gr Ap		FUS
Metalaxyl	L	A	LFV	2	AU S	new Gr & sod	0.48 g	PYT
Quintozene	G	C	INT	2	lS mO	Gr	23.10 kg	DOL GSM LEF PSM
Quintozene	G	D	INT	2	eSp N D			SNO
Quintozene	G	F	INT	2	lFa lWi	Gr Te	24.46 kg	PSM
Quintozene	W	M	INT	1	lFa	Fr	17.03 kg	PSM
Quintozene	L	Q	INT	1		Gr		PSM
Quintozene	G	X	INT	2	O-D	Gr Te	19.84 kg	PSM
Quintozene		Y	INT	2				
Quintozene	G	AG	INT	2.5	Su Fa	Gr	75.00 kg	FUS
Quintozene	G	AG	INT	1.5	Su seed	Gr	34.02 kg	PYT
Quintozene	G	AI	INT	1	N	Gr	9.78 kg	GSM PSM
Quintozene	W	E	ISL	3	O-MR	Gr	7.65 kg	FUS
Quintozene	G	E	ISL	1	O-MR	Gr		FUS
Quintozene	G	H	ISL	1	N-D	Gr	44.66 kg	FUS PSM
Quintozene	G	J	ISL	4	MR-N	Gr Ap	78.23 kg	DOL PSM
Quintozene	G	P	ISL	3	Fa Wi	Gr Ap	73.32 kg	Fungus

Appendix 12 continued.

Active ingrediant	Form	Course code	Provincial code	Applications per year	Time of application	Location	Amount per year	Target
Quintozene	W	P	ISL	2	lSu Fa Sp	Gr Ap	13.50 kg	FUS
Quintozene	G	V	ISL	3.5	Sp Fa	Gr	68.64 kg	Fungi
Quintozene	G	AA	ISL	2	lO-J	Gr Te		FUS
Quintozene	G	AD	ISL	2	Wi Fa Sp	Gr	48.90 kg	PSM
Quintozene	G	AF	ISL	2	N J	Gr	34.93 kg	FUS
Quintozene	G	AJ	ISL	2	O J	Gr Te Ap	54.44 kg	PSM
Quintozene	W	A	LFV	4	AU-F	Gr	38.93 kg	BRN DOL LEF PSM
Quintozene	G	A	LFV	3	Fa-eSp	Gr		DOL GSM PSM
Quintozene	G	B	LFV	3	lS O N	Gr Te	88.01 kg	BRN DOL PYT SNO Rust Smut
Quintozene		I	LFV	3	F O D	Gr Te	134.44 kg	FUS
Quintozene	G	K	LFV	4	O-N	Gr	6.64 kg	
Quintozene	W	N	LFV	2	Sp Su	Gr	6.83 kg	DOL FUS
Quintozene	G	O	LFV	2	O D	Gr	47.63 kg	SNO
Quintozene	G	S	LFV	2.5	S O N	Gr Te	84.70 kg	PSM
Quintozene	G	T	LFV	1	lO	Gr	31.42 kg	GSM PSM
Quintozene	G	U	LFV	2.5	N D F	Gr	80.85 kg	FUS
Quintozene	G	Z	LFV	3.5	lFa Wi	Gr Te	85.59 kg	DOL GSM LEF PSM
Quintozene	G	AB	LFV	1	N	Gr	14.57 kg	PSM
Quintozene	W	AB	LFV	4	lA/MY JL O	Gr & occ.Te	23.18 kg	FUS
Thiophanate-methyl	G	C	INT	2	mMY lS	Gr	4.07 kg	BRN DOL FUS
Thiophanate-methyl	G	F	INT	2	lFa	Gr	3.10 kg	FUS
Thiophanate-methyl	G	F	INT	1	eSp	Gr	1.54 kg	FUS PSM
Thiophanate-methyl	G	X	INT	1.5	Sp or Su	Gr	3.72 kg	DOL FUS LEF
Thiophanate-methyl	G	AI	INT	1	mS	Gr	0.93 kg	PSM
Thiophanate-methyl	G	H	ISL	1	S-O	Gr	2.82 kg	FUS
Thiophanate-methyl	G	V	ISL	2	Sp Fa	Gr	3.17 kg	Fungi
Thiophanate-methyl	G	AD	ISL	2	Wi	Gr & occ.Te		PSM
Thiophanate-methyl	G	AA	ISL	2	lAP m-lAU	Gr Te	3.11 kg	BRN DOL FUS PSM
Thiophanate-methyl	G	A	LFV	6	O-F	Gr		BRN COP DOL PSM
Thiophanate-methyl	G	B	LFV	2	F MR	Gr Te	3.76 kg	BRN COP DOL
Thiophanate-methyl	G	B	LFV	1	mAU	Gr Te	3.72 kg	BRN DOL FUS
Thiophanate-methyl	G	G	LFV	varies	Sp Su	Gr	1.54 kg	FUS RED Antharacnose
Thiophanate-methyl	G	K	LFV	1	Fa	Te	0.20 kg	BRN DOL PSM fungus blight
Thiophanate-methyl	G	K	LFV	3	MY S O	Gr		
Thiophanate-methyl	G	K	LFV	1	Fa	Te	0.20 kg	BRN DOL PSM fungus blight
Thiophanate-methyl	G	O	LFV	2	MR AU	Gr	3.17 kg	FUS
Thiophanate-methyl	G	Z	LFV	2	eSp lSu	Gr Te	6.19 kg	BRN DOL FUS
Thiophanate-methyl	G	Z	LFV	4	Sp Su Fa	Gr Te	0.78 kg	BRN COP DOL
Thiophanate-methyl	G	AB	LFV	1	S-O	Gr	2.03 kg	BRN DOL
Thiophanate-methyl	G	AG	INT	1	Su	Gr	3.97 kg	BRN FUS
THiophanate-methyl	G	AH	LFV	2	lFa-J	Gr		SNO
Triforine	L	S	LFV	3.5	AP MY JN JL	Roses		Roses
?	W	AH	LFV	2	MY O	Gr	5.60 kg	PSM

Appendix 13. Herbicide use on British Columbia golf courses.

Active ingrediant	Form	Course code	Provincial code	Applications per year	Time of application	Location	Amount per year	Target
2,4-D	L	C	INT	0.6	mMY eS	Fr Ro		BLW
2,4-D	L	D	INT	1	AP MY	Fr Ro		BLA CHI CLV DAN PLA
2,4-D	L	L	INT	1	lSp	Fr Ro	3.46 kg	BLW DAN
2,4-D	L	Y	INT	0.2	Sp Fa	Fr Ro	7.60 kg	BLW
2,4-D	L	AC	INT	1	mS	spot spray	0.71 kg	DAN PLA
2,4-D	L	AG	INT	1	mMy	spot spray	1.29 kg	BLW
2,4-D	G	AG	INT	1	mMY	Fr	36.60 kg	CLV DAN
2,4-D	L	E	ISL	2	AP-S	Club & Parking	0.06 kg	weeds
2,4-D	G	J	ISL	1	JN	Fr Ro	40.51 kg	BLW DAN
2,4-D	G	W	ISL	varies	Sp	Ap Gr		BLW false DAN
2,4-D	L	AD	ISL	1	Sp Su	Ap Fa Gr Te	87.57 kg	BLW
2,4-D	L	AJ	ISL	2	Sp Su	Fr	1.88 kg	
2,4-D	L	A	LFV	1	AU	Ap Gr Ro Te	2.81 kg	BLA BUT CHI CLV DAN PLA
2,4-D	G	B	LFV	1	m-l JN	Fr	34.31 kg	CHI CLV DAI DAN DOC PLA
2,4-D	G	G	LFV	0.5	Sp	Fr Ro	16.59 kg	weeds
2,4-D	L	I	LFV	0.3	Su	Fr Ro	2.53 kg	CLV weeds
2,4-D	L	R	LFV	1	lMY JN eJL	Fr Ro	11.88 kg	CLV
2,4-D	L	T	LFV	0.5	MY	Fr Ro		BLW
2,4-D	G	Z	LFV	0.5	lSp eSu	Fr Ro	15.43 kg	Dicot weeds
Chlorthal	G	Y	INT	0.2	Sp Fa	Fr Ro	60.00 kg	veronica
Chlorthal	W	A	LFV	1	MY	as required	4.05 kg	BLW GRA veronica
Dicamba	L	C	INT	0.6	mMY eS	Fr Ro		BLW
Dicamba	L	D	INT	1	AP MY	Fr Ro		BLA CHI CLV DAN PLA
Dicamba	L	L	INT	1	lSp	Fr Ro	0.33 kg	BLW DAN
Dicamba	L	Y	INT	0.2	Sp Fa	Fr Ro	0.72 kg	BLW
Dicamba	L	AC	INT	1	mS	Fr	0.96 kg	CLV
Dicamba	G	AG	INT	1	mMy	Fr	2.43 kg	CLV DAN
Dicamba	L	E	ISL	2	AP-S	Club & Parking	0.01 kg	weeds
Dicamba	G	J	ISL	1	JN	Fr Ro	2.69 kg	BLW DAN
Dicamba	L	P	ISL	1	AP-MY	Fr Ro		DAI
Dicamba	G	W	ISL	varies	Sp	Ap Gr		BLW false DAN
Dicamba	L	AD	ISL	1	Sp Su	Ap Fr Gr Te	4.26 kg	BLW
Dicamba	L	AJ	ISL	2	Sp Su	Fr	1.92 kg	red CLV
Dicamba	L	A	LFV	1	AU	Ap Gr Ro Te	0.27 kg	BLK BUT CHI CLV DAN PLA
Dicamba	G	B	LFV	1	m-l JN	Fr	2.28 kg	CHI CLV DAI DAN DOC PLN
Dicamba	L	I	LFV	0.3	Su	Fr Ro	0.24 kg	CLV weeds
Dicamba	G	G	LFV	0.5	Sp	Fr Ro	1.10 kg	weeds
Dicamba	L	R	LFV	1	lMY JN eJL	Fr Ro	1.68 kg	CLV
Dicamba	L	R	LFV	1	lMY JN eJL	Fr Ro	1.13 kg	CLV
Dicamba	G	Z	LFV	0.5	lSp eSu	Fr Ro	10.24 kg	BLW
Diquat	L	L	INT	1	as needed	Po		aquatic weeds
Diquat	L	Y	INT	1	JN	Po	12.00 kg	aquatic weeds
Diquat	L	AJ	ISL	3	AP JN AU	Po	5.40 kg	algae
Diquat	L	B	LFV	3	JN JL AU	Po	17.28 kg	aquatic algae & weeds
Diquat	L	R	LFV	1.5		Po	0.30 kg	milfoil
DIquat	L	S	LFV	1	MY-JN	Po	0.30 kg	water weeds
Glyphosate	L	D	INT	1		Pa	0.18 kg	weeds
Glyphosate	L	L	INT	1	l Sp	Pa fences	1.42 kg	total vegetation control
Glyphosate	L	Y	INT	2	lSp Su	Pa Tr	2.67 kg	all green vegetation
Glyphosate	L	AG	INT	varies	Sp Su	Pa	0.53 kg	BLW GRA
Glyphosate	L	H	ISL	varies	as needed	Pa Tr sand		unwanted vegetation
Glyphosate	L	V	ISL	1	Sp	Pa Tr	1.78 kg	grasses and weeds
Glyphosate	L	AJ	ISL	1	Su	sand	2.14 kg	all vegetation
Glyphosate	l	R	LFV	varies	as needed	Fr Ro	0.36 kg	GRA weeds
Glyphosate	L	T	LFV	1	AP	Tr	0.71 kg	BLW GRA
Glyphosate	L	U	LFV	1	MY	Tr	1.42 kg	GRA
Glyphosate	L	Z	LFV	2.5	mSp lSu	Tr	1.82 kg	GRA weeds
Mecoprop	L	C	INT	0.6	mMY eS	Fr Ro		BLW
Mecoprop	L	D	INT	1	AP MY	Fr Ro		BLA CHI CLV DAN PLA
Mecoprop	L	L	INT	1	l Sp	Fr Ro	1.82 kg	BLW DAN
Mecoprop	L	Y	INT	0.2	Sp Fa	Fr Ro	4.00 kg	BLW
Mecoprop	L	AC	INT	1	m S	spot spray	0.75 kg	DAN PLA
Mecoprop	G	AG	INT	1	mMY	Fr	36.60 kg	CLV DAN
Mecoprop	L	E	ISL	2	AP S	Club & Parking	0.03 kg	weeds

Appendix 13. Continued.

Active ingrediant	Form	Course code	Provincial code	Applications per year	Time of application	Location	Amount per year	Target
Mecoprop	G	J	ISL	1	JN	Fr Ro	40.51 kg	BLW DAN
Mecoprop	L	P	ISL	1	Sp	Fr Ro		DAI
Mecoprop	L	V	ISL	1	Sp	Fr	6.00 kg	CLV DAI
Mecoprop	L	AD	ISL	1	Sp Su	Ap Fr Gr Te	17.05 kg	BLW
Mecoprop	L	A	LFV	1	AU	Ap Gr Ro Te	1.48 kg	BLA BUT CHI CLV DAN PLA
Mecoprop	L	A	LFV	1	AU	Ap Gr Ro Te	3.15 kg	CLV
Mecoprop	G	B	LFV	1	m-l JN	Fr	34.31 kg	CHI CLV DAI DAN DOC PLA
Mecoprop	G	G	LFV	0.5	Sp	Fr Ro	16.59 kg	weeds
Mecoprop	L	I	LFV	0.3	Su	Fr Ro	1.33 kg	CLV weeds
Mecoprop	L	R	LFV	1	lMY JN eJL	Fr Ro	6.25 kg	CLV
Mecoprop	L	T	LFV	0.5	MY	Fr Ro		BLW
Mecoprop	G	Z	LFV	0.5	lSp eSu	Fr Ro	15.43 kg	BLW
Mecoprop	L	AH	LFV	2	MY JN	Ro	3.75 kg	CHI CLV PLA
Paraquat	L	Y	INT	2	Sp	Tr	1.00 kg	all green vegetation
Paraquat	L	B	LFV	2	MY JL	Tr	0.90 kg	GRA weeds

Appendix 14. Insecticide use on British Columbia golf courses.

Active ingrediant	Form	Course code	Provincial code	Applications per year	Time of application	Location	Amount per year	Target
Bacillus thuringiens	L	AB	ISL	2	AP MY	Tr		tent caterpillers
Carbaryl	L	AA	ISL	1.5	e-lMR lFa	Fr	11.52 kg	earthworms
Carbaryl	L	I	LFV	1	Fa	Fr Te	44.65 kg	earthworms
Carbaryl	L	S	LFV	2	MY O	Fr	312.56 kg	cranefly larva
Carbaryl	L	S	LFV	2	MY O	Fr	336.00 kg	cranefly larva
Diazinon	L	D	INT	varies	as needed	Tr		insects
Diazinon	L	L	INT	varies	as needed	Tr	4.55 kg	tent caterpillers
Diazinon	G	J	ISL	1	eAP	Fr Gr Te	5.51 kg	cranefly larva
Diazinon	L	P	ISL	2	MY O	Ap Gr	3.15 kg	cranefly larva
Diazinon	L	W	ISL	2	MY JN O	Gr	3.30 kg	cranefly larva
Diazinon	L	AB	ISL	1	JN	Gr	2.00 kg	cranefly larva
Diazinon	L	AJ	ISL	varies	Su	wasp nests	0.25 kg	yellow jackets (wasps)
Diazinon	L	B	LFV	1	MY	Tr	1.15 kg	aphids, caterpillers, mites
Diazinon	L	N	LFV	1	eMY	Gr	2.00 kg	cranefly larva
Diazinon	L	S	LFV	varies	MY	Blue Spruce	3.00 kg	aphids
Dimethoate	L	S	LFV	1	MY	Tr		aphids
Malathion	L	AG	INT	1	lSp	Tr	0.75 kg	insects & caterpillers
Malathion	L	S	LFV	1	MY	Blue Spruce	4.00 kg	aphids
Metaldehyde	G	AJ	ISL	2	Sp Su	Fl	0.09 kg	slugs

Appendix 15. Fertilizer use on British Columbia golf courses.

Formulation	Amount used each year (kg)			Course code	Applications per year	Time of application	location
	Nitrogen	Phosphorus	Potassium				
14-3-3	338.44	72.52	72.52	B	3	lSe O N	Gr Te
15-0-30	181.26	0.00	362.52	B	4	JA F MR S	Gr Te
19-26-5	91.42	125.11	24.06	B	varies	all year	seeded areas
19-0-17	130.77	0.00	117.00	B	1	eAP	Ge Te
19-26-5	162.51	222.38	42.77	B	1	lAP	Gr Te Ap
22-0-16	106.35	0.00	77.35	B	3	lJN JL	Ge Te
25-0-12	140.92	0.00	67.64	B	1	mAU	Ge Te
30-0-0	89.90	0.00	0.00	B	1	MY	Ge Te
31-3-10	122.73	11.88	39.59	B	2	MY JN	Ge Te
34-4-3	2273.36	267.45	200.59	B	1	m-l JN	Fr
Total	3637.67	699.34	1004.04				
14-3-3	88.83	19.04	19.04	C	2	lS mO	Gr
19-7-11	3389.19	1248.65	1962.16	C	3	mAP JN AU	Fr Te
25-0-12	117.42	0.00	56.36	C	2	mMY lS	Gr
Total	3595.44	1267.68	2037.56				
19-26-5	126.95	173.72	33.41	G	varies	Sp Fa	new turf
22-0-16	1575.66	0.00	1145.94	G	3	Sp Su Fa	Gr
34-3-7	2278.31	201.03	469.06	G	1	mJN	Ap Fr Te Ro
34-4-3	1099.37	129.34	97.00	G	0.5	Sp	Fr Ro
Total	5080.29	504.08	1745.41				
14-3-3	188.02	40.29	40.29	O	2	O D	Gr
15-0-30	195.96	0.00	391.92	O	2	AU S	Gr
19-19-19	2083.33	2083.33	2083.33	O	1	AP	Fr Ro Te
19-26-5	67.69	92.63	17.81	O	1	MY	Gr
19-0-17	218.51	0.00	195.51	O	1	AP	Gr Te
22-0-16	236.33	0.00	171.87	O	2	JL AU	Gr
22-0-12	88.15	0.00	48.08	O	1	JN	Gr
23-3-3	122.30	15.95	15.95	O	1	JL	Gr
25-0-12	120.41	0.00	57.80	O	2	MR AU	Gr
32-4-8	2254.55	281.82	563.64	O	2	JN S	Fr Te
34-0-0	3500.00	0.00	0.00	O	1	Sp	Fr Ro Te
Total	9075.25	2514.02	3586.21				
6-0-36	35.64	0.00	213.86	P	1	Sp	Gr
14-3-3	281.95	60.42	60.42	P	3	Fa Wi	Gr Ap
16-16-16	62.37	62.37	62.37	P	1	Sp Su Fa	Gr Ap
19-0-17	345.81	0.00	309.41	P	2	Sp	Te
21-0-0	748.40	0.00	0.00	P	Gr2 Te1	Sp Su	Te Gr Ap
21-52-0	32.62	80.78	0.00	P	2	Sp	Gr Ap
22-0-16	460.90	0.00	335.20	P	3	Su	Gr Ap
22-0-16	173.34	0.00	126.06	P	1	Su	Te
25-4-10	224.39	35.90	89.76	P	2	Sp Su	Te Fr
31-3-10	234.50	22.69	234.50	P	2	Su	Gr Ap
Total	2599.93	262.16	1431.58				
14-3-3	329.14	70.53	70.53	Z	3.5	lFa Wi	Gr Te
15-0-30	119.52	0.00	239.04	Z	2	lWi lSu	Gr Te
19-26-5	134.34	183.83	35.35	Z	1	eSp	Gr Te
19-0-17	131.09	0.00	117.29	Z	1	Sp	Gr Te
21-4-21	1095.65	208.70	1095.65	Z	1	Fa	Fr Ro
22-3-10	1747.96	238.36	794.53	Z	1	lSu	Fr Ro
22-0-12	98.71	0.00	53.84	Z	1	Sp	Gr Te
22-0-16	283.57	0.00	206.23	Z	2	Su	Gr Te
25-0-12	234.85	0.00	112.73	Z	2	eSp lSu	Gr Te
29-3-3	149.51	15.47	15.47	Z	1	Sp	Gr Te
31-3-10	203.61	19.70	65.68	Z	3	mSu	Gr Te

Appendix 15. continued - Fertilizer use on British Columbia golf courses.

Formulation	Amount used each year (kg)			Course code	Applications per year	Time of application	Location
	Nitrogen	Phosphorus	Potassium				
34-4-3	1022.17	120.26	90.19	Z	0.5	lSp eSu	Fr Ro
34-3-7	1690.97	149.20	348.14	Z	1	Sp	Fr Ro
34-3-7	354.91	31.32	73.07	Z	3	Sp eSu	Te
Total	7596.02	1037.36	3317.75				
14-3-3	56.02	12.00	12.00	AB	1	N	Gr
25-0-12	58.68	0.00	28.17	AB	1	SE-O	Gr
14-3-3	188.02	40.29	40.29	AD	2	Wi Fa Sp	Gr
14-3-3	134.31	28.78	28.78	AF	2	N JA	Gr
14-3-3	296.10	63.45	63.45	AG	2.5	Su Fa	Gr
14-3-3	134.31	28.78	28.78	AG	1.5	Su seeding	Gr
25-0-12	150.55	0.00	72.26	AG	1	Su	Gr
32-4-3	2399.48	299.94	224.95	AG	1	mMY	Fr
14-3-3	37.60	8.06	8.06	AI	1	N	Gr
0-0-6	0.00	0.00	308.47	AJ	2	O JA	Gr Te Ap
0-0-6	0.00	0.00	38.25	E	1	O-MR	Gr
16-4-4	333.33	83.33	83.33	E	2	MY-S	1 Fr
14-3-3	94.04	20.15	20.15	F	2	lFa lWi	Gr Te
25-0-12	58.41	0.00	28.04	F	1	eSp	Gr
14-3-3	171.74	36.80	36.80	H	1	N-D	Gr
25-0-12	106.87	0.00	51.30	H	1	SE-O	Gr
14-3-3	516.99	110.78	110.78	I	3	F O D	Gr Te
14-3-3	300.84	64.47	64.47	J	4	MR-N	Gr Ap
34-4-3	2684.09	315.77	236.83	J	1	JN	Fr Ro
14-3-3	25.52	5.47	5.47	K	4	O-N	Gr
25-0-12	7.50	0.00	3.60	K	1	Fa	Te
14-3-3	325.71	69.80	69.80	S	2.5	S O N	Gr Te
14-3-3	120.81	25.89	25.89	T	1	lO	Gr
14-3-3	310.91	66.62	66.62	U	2.5	N D F	Gr
14-3-3	263.94	56.56	56.56	V	3.5	Sp Fa	Gr
25-0-12	120.41	0.00	57.80	V	2	Sp Fa	Gr
14-3-3	76.28	16.34	16.34	X	2	O-D	Gr Te
25-0-12	140.92	0.00	67.64	X	1.5	Sp/ Su	Gr
14-3-3	?	?	?	Y	2	?	?
14-3-3	?	?	?	A	3	Fa-eSp	Gr
14-3-3	?	?	?	AA	2	lO-JA	Gr Te
0-0-50	?	?	?	AH	?	?	Gr Te Ap Ro
21-0-0	?	?	?	AH	?	?	Gr Te Ap Ro
?	?	?	?	AI	6	?	Te
?	?	?	?	AI	3	?	Fr Ro
?	?	?	?	AI	8	?	Gr
?	?	?	?	C	4	MY JN JL	Gr
?	?	?	?	C	2	AP S	Gr
0-0-6	0.00	0.00	0.00	D	2	eSp N D	?
15-0-30	?	0.00	?	D	2	S O	Gr
21-53-0	?	?	0.00	D	1	AP	Gr
22-0-16	?	0.00	?	D	5	JN JL AU	Gr
32-3-10	?	?	?	D	2	MY AU	Fr Te
?	?	?	?	I	?	?	?
?	?	?	?	I	?	?	?
?	?	?	?	I	?	?	?
trace elements	?	?	?	O	1	Sp	GR
Gypsum	?	?	?	P	1	Fa	Gr Ap
?	?	?	?	P	8	Su	Gr Ap
?	?	?	?	W	varies	Sp	Gr Ap

Appendix 16. Toxicities of fungicides used on British Columbia golf courses.

Active ingredient	Species	Toxicity	Source
Anilazine	rabbits	LD_{50} 460 mg/kg	Worthing 1987
	fish	toxic	Adams 1987
Benomyl	Japanese Quail	LC_{50} >5,000 mg/kg	Hill and Camardese 1986
	mallard ducklings	LC50 (8d) >500 mg/kg diet	Worthing 1987
	fish	toxic	Adams 1987
Chloroneb	Bobwhite Quail	LD50 >5000 mg/kg	Worthing 1987
	Mallard	LD50 >5000 mg/kg	Worthing 1987
Chlorthalonil	Bobwhite Quail	LC50 (8d) 5,200 mg/kg diet	Worthing 1987
	Mallard ducklings	LC50 (8d) >21,500 mg/kg diet	Worthing 1987
	Rainbow Trout	LC50 (?) 0.25 mg/l water	Worthing 1987
	fish	toxic	Adams 1987
Iprodione	Bobwhite Quail	LD_{50} 930 mg/kg	Worthing and Hance 1991
	Mallard	LD_{50} 10,400 mg/kg	Worthing 1987
	honeybees	practically non-toxic	Worthing 1987
Mancozeb	Japanese Quail	LC_{50} >5,000 mg/kg diet	Hill and Camardese 1986
	carp	LC50 (48h) 4.0 mg/l water	Worthing 1987
	tadpoles	LC50 (48h) 3.5 mg/l water	Worthing 1987
Maneb	Japanese Quail	LC_{50} >5,000 mg/kg diet	Hill and Camardese 1986
	mallard ducklings	LC50 (8d) >10,000 mg/kg diet	Worthing
	carp	LC50 (48h) 1.8 mg/l water	Worthing 1987
Metalaxyl	bees and birds	practically non-toxic	Worthing 1987
	rainbow trout	LC50 (96) >100 mg/l water	Worthing 1987
	carp	LC50 (96) >100 mg/l water	Worthing 1987
Quintozene	Mallard	LC_{50} >5,000 mg/kg diet	EPA 1987
	Bobwhite Quail	LC_{50} >5,000 mg/kg diet	EPA 1987
Thiophanate-methyl	Japanese Quail	LD_{50} >5,000 mg/kg	Worthing and Hance 1991
	fish	toxic	Adams 1987
Thiram	Japanese Quail	LC_{50} >5,000 mg/kg diet	Hill and Camardese 1986
	trout	LC_{50} (48h) 0.13 mg/l water	Worthing 1987
	carp	LC_{50} (48) 4.00 mg/l water	Worthing 1987
Triforine	Bobwhite Quail	LD_{50} >5000 mg/kg	Worthing 1987

Appendix 17. Toxicities of herbicides used on British Columbia golf courses.

Active ingredient	Species	Toxicity	Source
Dicamba	Japanese Quail	LC_{50} >5,000 mg/kg	Hill and Camardese 1986
	pheasant	LD_{50} 673-800 mg/kg	Adams 1987
	trout	LC_{50} (48h) 35 mg/l water	Adams 1987
Diquat	Japanese Quail	LC_{50} 1,227 mg/kg	Hill and Camardese 1986
	Mallard	LD_{50} 564 mg/kg	Adams 1987
Glyphosate	Japanese Quail	LC_{50} >5,000 mg/kg diet	Hill and Camardese 1986
	quail	LD_{50} 3,850 mg/kg	Adams 1987
	trout		
	adult	LC_{50} (96h) 38-97 mg/l water	Adams 1987
	fingerling	LC_{50} (96h) 1.3-42 mg/l water	Adams 1987
Mecoprop	Japanese Quail	LC_{50} >5,000 mg/kg diet	Hill and Camardese 1986
Paraquat	Japanese Quail	LC_{50} 948 mg/kg diet	Hill and Camardese 1986
	rainbow trout	LC_{50} (96h) 32 mg/l water	Worthing 1987
2,4-D	Japanese Quail	LC50 >5,000 mg/kg diet	Hill and Camardese 1986

Appendix 18. Toxicities of insecticides used on British Columbia golf courses.

Active ingredient	Species	Toxicity (ppm)	Source
Carbaryl	Japanese Quail	LC_{50} >10,000 mg/kg diet	Hill and Camardese 1986
	Mallard	LD_{50} 2,180 mg/kg oral	Adams 1987
	pheasant	LD_{50} 2,000 mg/kg oral	Adams 1987
	trout	LC_{50} (96) 4.38 mg/l water	Adams 1987
Diazinon	Japanese Quail	LC_{50} 167 mg/kg diet	Hill and Camardese 1986
	Mallard	LD_{50} 3.5 mg/kg oral	Adams 1987
	pheasant	LD_{50} 4.3 mg/kg oral	Adams 1987
	Rainbow Trout	LC_{50} (96) 2.6-3.2 mg/l water	Worthing 1987
	salmon	LC_{50} (96) 3 mg/l water	Adams 1987
	honeybees	toxic	Worthing 1987
Dimethoate	Mallard	LD_{50} 41.7 mg/kg oral	Adams 1987
	trout	LC_{50} (96) 9 mg/l water	Adams 1987
Malathion	Mallard	LD_{50} 1,485 mg/kg oral	Adams 1987
	salmon	LC_{50} (96) 0.043 mg/l water	Adams 1987