Harlequin Duck Inventory of the Upper Skagit River Watershed:
Interim Data Report Year 1

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i. EXECUTIVE SUMMARY

In 2000, with funding from the Skagit Environmental Endowment Commission, we conducted an inventory of harlequin ducks in the upper Skagit River watershed. The study area was located in south-west British Columbia above the Ross Lake reservoir and included portions of the Skagit Valley and EC Manning Provincial Parks. This system was known to support harlequin ducks, however the extent of use of the watershed, the population and productivity were unknown. This information was necessary in order to propose methods of management and conservation compatible with current and future land use. Our objectives were: (1) to estimate the population of breeding pairs (2) estimate production, (3) identify important areas for breeding, (4) link the population to the marine zone, and (5) develop recommendations for accommodating harlequin duck conservation and land use. The results of this investigation indicated a requirement to gain more information on harlequin duck use of the system to better integrate its management within park use plans.

In 2001, with further funding from the Skagit Environmental Endowment Commission and the co-operation of many other agencies we began a three-year investigation. This study focused on the specific objectives of; (1) refining our knowledge of the number, survival rate, distribution, and site fidelity of breeding harlequin ducks in Upper Skagit River (2) estimating annual nesting success and productivity of known individual birds (3) promoting a resighting program to be used by parks staff or interested citizens (i.e. naturalist clubs) for long-term monitoring of the harlequin breeding population and (4) increasing our understanding of harlequin population dynamics, and provide preliminary indicators of population growth trends. This report summarises the data collected during the 2001 field season.

The results of 2001 were similar to our pilot year 2000 with respect to population size, temporal and spatial distribution of breeding harlequin ducks. This encouraged our ability to develop a protocol for implementation by volunteers. We have also achieved success recruiting volunteers for assisting with duck monitoring, and will be expanding on this facet of the project in future years. By using mark-resighting, we confirmed that our minimum visual estimate of 17 pairs in the system was conservative as we are 95% confident that the true population is between 36 and 40 pairs. We observed a minimum of 9 broods (comprised of 34 ducklings) supportive of the low productivity typical of this species of sea duck.

We encountered substantial human disturbance on some reaches, and speculate that this may have affected brood-rearing behaviour. Among other objectives, radio telemetry based investigations proposed for year 2002 and 2003 should help us to define nesting habitat and understand the influence of disturbance on broods.

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1.0 INTRODUCTION

The harlequin duck (*Histrionicus histrionicus*) is an important species in the Pacific Northwest, occupying a riverine habitat niche distinct from other waterfowl. The harlequin duck nests along fast flowing mountainous streams, and returns to the marine environment, where populations winter throughout the Georgia Straight and Puget Sound. The small Eastern North America population is currently listed as *endangered* in eastern Canada (COSEWIC 1990), and *threatened* in the state of Maine. In the Pacific Northwest, the status of the population is unknown, however recent evidence suggests a decline (Robertson and Goudie 1999, Cassirer *et al.* 1993), causing concern for its conservation.

The United States Forest Service has classified the harlequin duck as a sensitive species in Regions I (Northern Rocky Mountains) and IV (Pacific Northwest) and the states of Idaho, Montana and Oregon have designated the harlequin duck as a species of special concern while Washington has identified the harlequin duck as a priority habitat species (Cassirer *et al.* 1993). In British Columbia, the harlequin duck is considered a species at risk with a S4/YCMG listing (Anon. 1995) meaning:

- S4 - conservation concerns by the provincial Conservation Data Centre;
- Y - yellow list
- C - conservation species as listed by CDC;
- M - managed for hunting[1];
- G - global responsibility, i.e., > 20% of the species spend all or part of the year in B.C.

In 1996, the harlequin duck was added to the Yellow "A" list of endangered and threatened species in Alberta (Anon. 1996), meaning:

"sensitive species that are not currently believed to be at risk, but may require special management to address concerns related to naturally low populations, limited provincial distributions, or demographic/life history features that make them vulnerable to human-related changes to the environment."

Some of the impacts that may be contributing to the decline include habitat alterations from forest and hydro-electrical developments, increased recreation activities such as river rafting, incidental harvest or changing conditions in the marine environment. While much work has been conducted with the species in the marine environment, little has been conducted on the nesting habitats in British Columbia. A few inventories have been completed Freeman and Goudie (1998) inventoried the Nahatlatch Drainage while Wright (1998), and Wright and Goudie (2000) investigated the Bridge River. The Skagit River was known to support harlequin ducks, however the extent of use of the Skagit watershed, the population and productivity were unknown. This information is necessary in order to propose methods of management and conservation of the population in the

[1] The Canadian Wildlife Service is gathering public input into changing harvest limits for sea ducks, including Harlequin Ducks.

Skagit River watershed to ensure sustainable resource use especially related to human recreation and development.

1.1 Results of the Pilot Investigation

In 2000, with funding from the Skagit Environmental Endowment Commission, we conducted an inventory of harlequin ducks in the upper Skagit River watershed. More detailed results are provided in Freeman and Goudie (2001). The study area was located in south-west British Columbia above the Ross Lake reservoir and included portions of the Skagit Valley and EC Manning Provincial Parks.

Our objectives were:

1. to estimate the population of breeding pairs and production,
2. identify important areas for breeding,
3. link the population to the marine zone, and
4. develop recommendations for accommodating harlequin duck conservation and land use.

To accomplish these objectives we used a combination of pair and brood surveys, mark-resight techniques, and collection and description of habitat data.

From the combination of these methods we were able to establish that harlequin ducks occupied specific reaches throughout the system including most reaches in the Skagit River and the mid-reach of the Sumallo River. We suspect that all activities associated with breeding (mating, nesting and brood rearing) are conducted on these reaches. Additionally from observations of previously marked ducks, we were able to establish a linkage between the marine environment of the Puget Sound and the upper Skagit River watershed. We estimated a minimum of 20pairs in the system that produced a minimum of 7 broods including 24 ducklings, 20 of which we anticipated to fledge. The estimate of 35% of hens producing broods compares well with estimates from other inventories in the Pacific Northwest.

Additionally with the use of logistic regression analysis of the habitat data collected we developed a model for predicting the presence of breeding harlequin ducks in the system. We found that a combination of stream wet-width, gradient and invertebrate abundance was 85.7% accurate in predicting the presence or absence of harlequin ducks on a reach. This information could be used to develop a GIS based model to assist the regional inventory of harlequin duck breeding streams.

We noted some potential conflicts with recreational use, considering anticipated increases in some activities in the future. We recommended monitoring and educational programs be developed to proactively address these conservation concerns. Additionally we recommended taking advantage of the wildlife viewing opportunities of harlequin ducks by providing a controlled area and involving the public in future wildlife management directed programs.

The results of this work indicated the importance of the system to harlequin ducks and the requirement for attaining more information to successfully incorporate their management into parks management plans. In 2001, we began a three-year project to acquire this information.

1.2 Objectives

The specific objectives of this three-year project are to:

- Refine our knowledge of the number, survival rate, distribution, and site fidelity of breeding harlequin ducks in Upper Skagit River.
- Estimate annual nesting success and productivity of known individual birds.
- Promote a resighting program to be used by parks staff or interested citizens (i.e. naturalist clubs) for long-term monitoring of the harlequin breeding population.
- Increase our understanding of harlequin population dynamics, and provide preliminary indicators of population growth trends

2.0 STUDY AREA

We focused the investigation within the upper Skagit Watershed (Map 1) on reaches we had identified as producing harlequin ducks in the 2000 pilot study. Table 1 provides details of these reaches.

Table 1, Focal reaches for the 2001 investigation, and harlequin duck observations made during the April-May 2000 pair surveys.

Reach	Code	Length (km)	Surveys	No. of pairs/individuals observed[a]	Max observed density (pairs/km)[b]	Max observed density (HARD/km)[b]
Sumallo, upper	Su2	7.4	6	3/9	0.41	1.22
Skagit, Lower	Sk1	15.9	4	2/5	0.22	0.56
Skagit, Klesilkwa to 26mile Creek	Sk2	7.9	3	4/10	0.51	1.27
Skagit 26mile creek to Sumallo	Sk3	6.3	5	6/16	0.95	2.54
Skagit, upper to Skaist	Sk5	5.8	4	2/5	0.42	1.04
Average for reaches with HARD					0.50, sd=0.27	1.33, sd=0.73

[a] Maximum observed during 28 April to 4 May 2000 survey

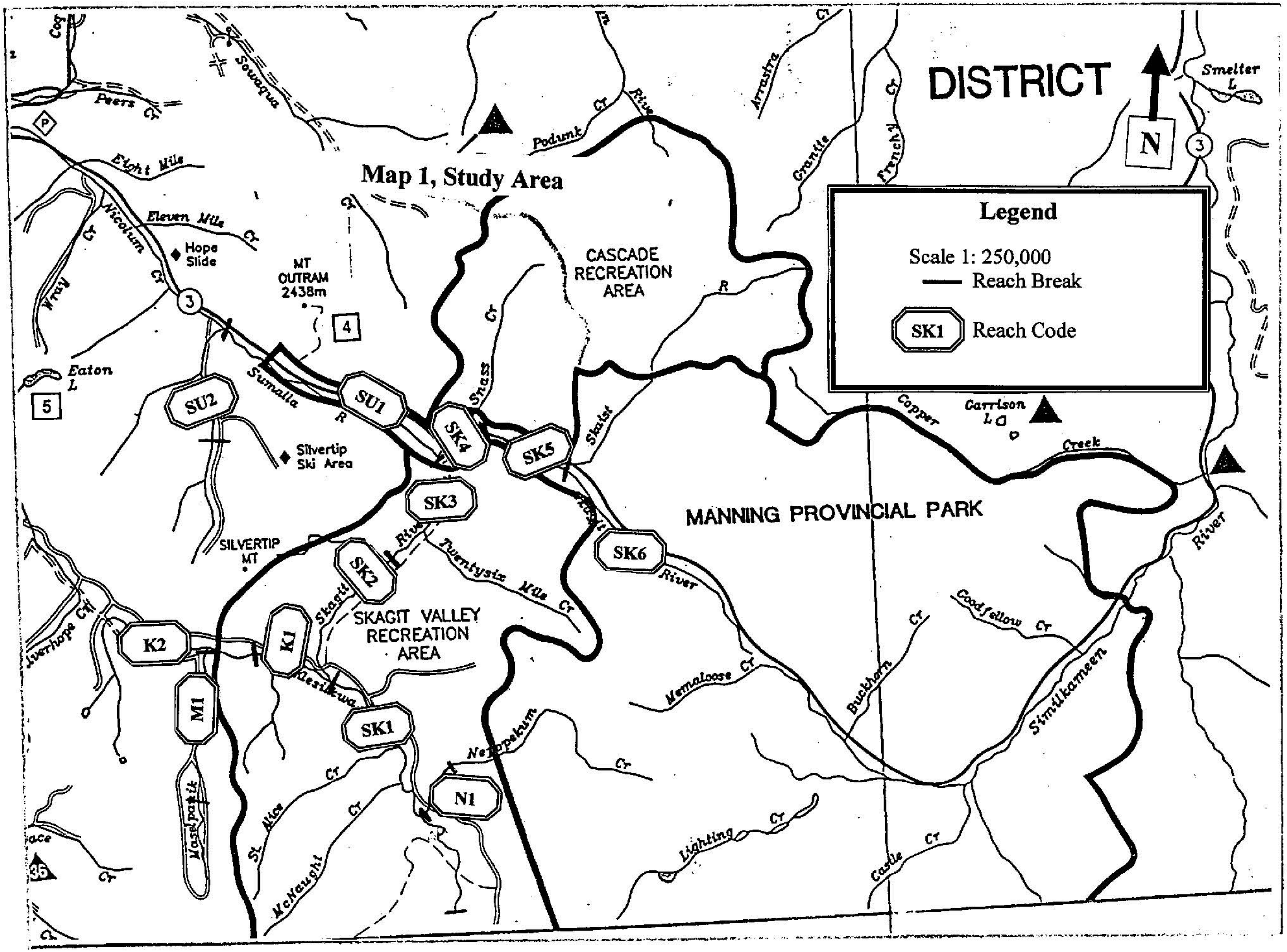
[b] Not extrapolated, based on surveyed distance.

This area was predominantly crown land, and includes portions of EC Manning Provincial Park and the Skagit Valley Provincial Park. While the majority of the study area remains forested, the area is heavily used for a variety of recreational activities both inside and outside the parks. Forest development continues outside the Provincial Park boundaries and the water levels of the Ross Lake and the reach of the Skagit River immediately upstream from the reservoir are influenced by the Skagit hydro-electrical project.

The study area lies within the Cascade Mountain Range and is ecologically classified as the Coast and Mountains Pacific Ecoprovince, Cascade Ranges Ecoregion and the Eastern Pacific Ranges Ecosection (Luttmerding *et al.* 1990). The elevation ranges from 480m to 2,180m and is represented by the Coastal Western Hemlock, Mountain Hemlock, Engelmann Spruce-Subalpine Fir and Alpine Tundra biogeoclimatic zones (Meidinger and Pojar 1991). The generalised geology of the area is represented by a combination of intrusive igneous rock and folded and faulted volcanic and sedimentary rock (Valentine *et al.* 1981). Streams are generally, clear, cold and fast flowing with coarse substrate, typical of coastal influence and geology of the mountainous Pacific Northwest.

This area has had substantial land use in the past, including mining, forestry, urban development, transportation and recreational development. Earlier in the last century, the Silver Daisy silver mine operated near the confluence of the Sumallo and Skagit Rivers. Impacts on the Skagit River proximate to its operations are still apparent on the river itself. The lower reaches of the upper Skagit River watershed were heavily developed for timber values early in the last century. Much of the riparian forest had been logged but has since regenerated to a young conifer or thick deciduous forest. Forest development continues in areas outside the Manning and Skagit Valley Provincial Parks. The Sunshine Valley resort development was established at the mid-reach of the Sumallo River. This development included houses and cottages, many directly on the bank of the Sumallo River. The community of Sunshine Valley currently is occupied by about 50 to 100 people, as full time or seasonal residents. The Hope-Princeton Highway (Highway 3), a main transportation corridor, parallels the lower Sumallo and upper Skagit river for nearly 30 km of their length. This corridor is heavily used and crosses rivers or parallels their banks in a number of locations.

As the study area is close to the heavily populated Lower Mainland of British Columbia, the parks receive a high level of use, currently estimated at 65,000 user days in the Skagit Valley (MoELP 1997). Activities include fishing (catch and release from 1 July to 31 October), hunting (Skagit Valley Provincial Park), hiking, backpacking, horseback riding, camping, and day use. Use is generally low prior to June, but increases dramatically during the summer months. This is exemplified by the parks use data which shows use of campgrounds and day-use areas in 1999 as 508 and 173 parties respectively in May, versus 2,556 and 2,022 parties in July.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Map 1, Study Area
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Scale 1: 250,000
Reach Break
SK1 Reach Code
CASCADE RECREATION AREA
MANNING PROVINCIAL PARK
SKAGIT VALLEY RECREATION AREA
MT OUTRAM 2438m
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Eaton L
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Peers Cr
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Memaloose Cr
Buckhorn
Goodfellow Cr
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Castle Cr
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McNaught Cr
Maselpanik
Klesilkwa
Silverhope Cr
Arrastra
Granite
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3.0 METHODS

To accomplish the objectives we used a combination of:

- pair and brood surveys,
- capturing, marking and resighting of individuals,
- population estimation by mark-resight methods

Methods adhered to terms of reference in parks use research permits LM0010261, and OK0010178 issued by the parks branch of British Columbia Ministry of Environment, Lands and Parks[2], and the scientific permit to capture and band migratory birds, permit number 10201 BK, issued by Environment Canada.

Harlequin ducks were captured by mist net from mid-April until early May. As in the pilot year 2000, each unbanded duck captured was banded with a black, individually encoded plastic leg band and a standard stainless steel leg band. Coding of leg bands was consistent with the markings used to identify other western North American populations, and has been approved by the International Harlequin Working Group. We used the "S" series in the alphanumeric code to identify Skagit ducks. Coding of individual ducks had a number of benefits including:

- resights of marked birds were the basis for the mark/resight population estimate,
- resights of marked individuals allowed us to assess the chronology of breeding
- resights of marked individuals linked these ducks to specific reaches of the watershed, and
- resights of marked individuals harlequin ducks nesting on the Skagit River to associated marine moulting and wintering area in the Puget Sound, Washington State or Strait of Georgia, British Columbia.

3.1 Pair Surveys

We conducted pair surveys along reaches between April and May 2001. Reaches were then surveyed on a weekly basis for three replicates. We conducted surveys by walking or with a combination of walking and vehicle surveys along the stream bank on a route established in the pilot year of the project. When possible surveys were conducted in an upstream direction.

Binoculars and 20-60X zoom spotting scopes were used to identify the band status of the ducks. Surveyors wore soft (e.g. wool or cotton) drab or camouflaged coloured clothing to enhance stealth while surveying. Surveyors recorded harlequin ducks in one direction along the stream (observations on the return where recorded as incidental), and on occasion when survey routes were split between surveyors, surveyors started at the same location mid-reach and surveyed in opposite directions to prevent double counting of ducks. The distance of each survey and duck observations were plotted on 1: 20,000 TRIM maps (British Columbia Ministry of Water, Land and Air Protection [MWLAP])

[2] In 2001 the BC Ministry of Environment was dissolved and divided into the Ministry of Water, Land and Air Protection and the Ministry of Sustainable Resource Management

4.0 RESULTS

The following is a summary of the results of the 2001 harlequin duck inventory project. Based on the last year's results we focused our survey efforts on the reaches identified as having harlequin ducks, specifically Skagit River reaches Sk1, Sk2, Sk3, Sk5, and Sumallo River reach Su2.

4.1 Pair Distribution and Population Estimates

The number of pairs observed, location, and chronology of use was very similar to last year. As with 2000, peak use appeared to be near the first of May (Figure 1 and 2). Table 2 shows the survey results and Table 3 identifies the observed harlequin duck density from our surveys, and Appendix I includes maps of duck locations. We captured and banded an additional 9 harlequin ducks, and identified another banded pair from Washington State (Yellow U3, U1). Table 4 summarises the capture results and Table 5 displays the morphometrics of the captured ducks. Between the two years we have now identified 25 banded ducks that have used the system. A pair banded at Sumallo Grove last year (Black SK and Black SL) was observed at Anderson Cove off Hornby Island March 12/13 2001, providing linkage to the Georgia Strait for this population as well. Few single drakes marked in 2000 returned this year, this could be an indicator of mortality or drakes pairing and following the hens to their natal streams. Of a pair banded last year (Black SH and SJ) we observed only the drake (Black SJ) return to his breeding reach. This drake was observed on two surveys, and no sign of the hen, possibly indicating her death. Additionally pair SK and SL, which had been observed off Hornby Island, were not seen during pair surveys, despite appearing in good shape on the marine environment just weeks prior to their anticipated arrival on the breeding stream.

We estimated a minimum 17 pairs from the sum of the maximum observed during a single survey (14 on Survey 2), and banded ducks not accounted for, specifically pair Yellow U1, U3, Black SS, and ST, and one incidental unbanded in SU2 (two banded pairs were observed during the survey). This is comparable to the minimum of 20 pairs estimated last year. We collated our maximum observations across river sections that indicated that 10 out of 46 observed harlequin ducks were marked. We estimated our marked (and released) sample as 23 representing 12 surviving from the 14 marked in 2000, 9 new bandings and 1 previously banded pairs (from coastal Washington). We confirmed that our visual estimate was quite conservative as our calculation using the Lincoln-Peterson index as modified by Chapman (1951) yielded 103 $\pm$ 18.3 SD individuals as 65 males $\pm$ 11.6 and 38 females $\pm$ 6.8. Therefore we are 95% confidant that the true breeding population (based on the number of females) is between 36 and 40 pairs.

Figure 1, Harlequin ducks observed during pair surveys
Period 1; 20-23 April, Period 2; 29April to 1 May, Period 3; 7-9 May

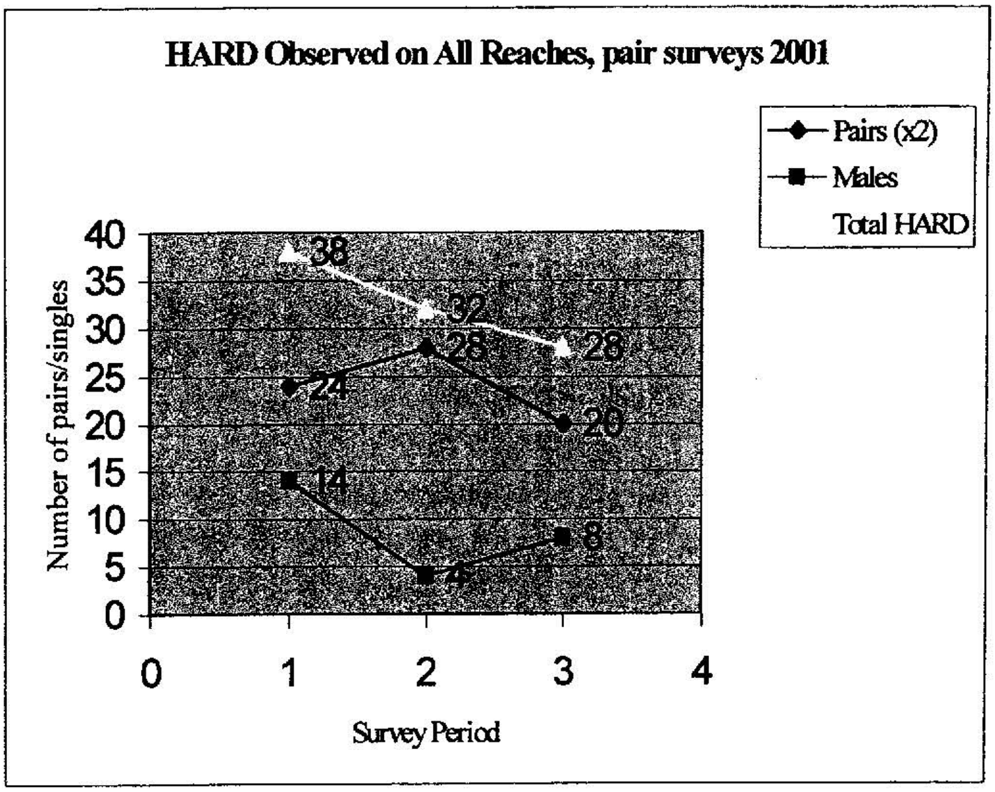

Figure 2, Harlequin duck pairs observed on specific reaches
Period 1; 20-23 April, Period 2; 29April to 1 May, Period 3; 7-9 May

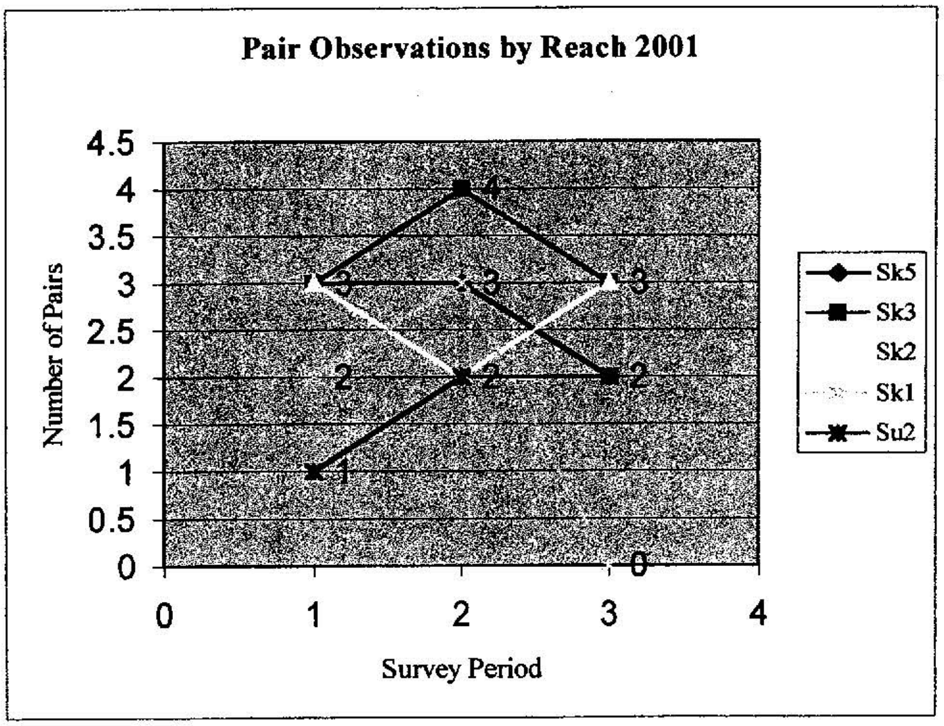

Table 2, River reaches and observations of harlequin ducks during pair surveys of the Skagit River watershed, April-May 2001

Date	*Survey type*	*Survey method*	*Reach*	*Surveyed Distance (Km)*	*Total length (Km)*	*Total Pairs*	*Total Males*	*Total Female*	*Number of Black Bands*	*Number of yellow Bands*	*Tot al Number of Bands*	*Number Not Banded*	*Unidentified Band Status*
4/22	Pair	vehicle/walk	Sk5	3.9	5.8	3	1	0	0	1	1	6	0
4/29	pair	vehicle/walk	Sk5	3.9	5.8	3	2	0	1	1	2	3	0
5/07	pair	vehicle/walk	Sk5	3.9	5.8	2	1	0	0	0	0	4	0
4/21	pair	walk	Sk3	7.3	7.3	3	3	0	0	0	0	5	4
4/30	pair	walk	Sk3	7.3	7.3	4	1	0	2	0	2	3	2
5/08	pair	walk	Sk3	7.3	7.3	3	5	0	2	0	2	4	2
4/23	pair	walk	Sk2	7.9	8.2	3	0	0	0	0	0	4	2
5/01	pair	walk	Sk2	7.9	8.2	2	0	0	0	0	0	3	1
5/09	pair	walk	Sk2	7.9	8.2	3	2	0	0	0	0	6	2
4/23	pair	vehicle/walk	Sk1	7.7	15.9	2	7	0	0	0	0	7	0
5/01	pair	vehicle/walk	Sk1	7.5	15.9	3	0	0	0	0	0	6	0
5/09	pair	vehicle/walk	Sk1	7.5	15.9	0	0	0	0	0	0	0	0
4/20	pair	walk	Su2	6.8	7.4	1	3	0	2	0	2	3	0
4/29	pair	walk	Su2	6.8	7.4	2	1	0	1	0	1	2	0
5/07	pair	walk	Su2	6.8	7.4	2	0	0	4	0	4	0	0

Table 3, River reaches and maximum harlequin duck density observed during pair surveys of the Skagit River watershed, April-May 2001

Reach	*Code*	*Length (km)*	*Surveys*	*Max density (pairs/km)*	*Max density (HARD/km)*
Sumallo, Upper	Su2	7.4	3	0.30	0.74
Skagit, Lower	Sk1	15.9	3	0.40	1.40
Skagit, Klesilkwa to 26mile Creek	Sk2	8.2	3	0.40	1.00
Skagit 26mile creek to Sumallo	Sk3	7.3	3	0.55	1.51
Skagit, upper	Sk5	5.8	3	0.77	2.10

Table 4, Harlequin ducks captured in the Skagit River watershed, April–May 2001

Band plastic	*Band Metal*	*Recapture?*	*Sex*	*Age*	*Status*	*Capture date*	*Longitude*	*Latitude*
SS Black	190517863	no	F	ATY	paired with ST	April 24/01	120°57.66'	49°11.67'
ST Black	190517864	no	M	ATY	paired with SS	April 24/01	120°57.66'	49°11.67'
SU Black	190517865	no	M	ATY	Single	April 24/01	120°57.66'	49°11.67'
SV Black	190517866	no	F	ATY	paired with SX	April 25/01	121°05.47	49°11.70'
SX Black	190517867	no	M	ATY	paired with SV	April 25/01	121°05.47	49°11.70'
SY Black	190517868	no	M	ATY	Single	April 25/01	121°05.47	49°11.70'
SZ Black	190517869	no	M	ATY	paired with S1	May 3/01	121°14.60	49°15.10
S1 Black	190517870	no	F	ATY	paired with SZ	May 3/01	121°14.60	49°15.10
S2 Black	190517871	no	M	ATY	Single	May 11/01	120°57.66'	49°11.67'
Recaptures								
U3 yellow	83527954	yes	M	ATY	Paired with U1	May 11/01	120°57.66'	49°11.67'
U1 yellow	83527958	yes	F	ATY	paired with U3	May 11/01	120°57.66'	49°11.67'
SE Black	190517853	yes	M	ATY	single	April 20/01	121°14.60	49°15.10
SJ Black	190517858	yes	M	ATY	single	April 20/01	121°14.60	49°15.10
SF Black	190517854	yes	M	ATY	Paired with SG	May 3/01	121°14.60	49°15.10
SG Black	190517855	yes	F	ATY	Paired with SF	May 3/01	121°14.60	49°15.10

Table 5, Morphometrics of the harlequin ducks captured in the Skagit River watershed, April-May 2001

Band plastic	*Tarsus (mm)*	*Culman(mm)*	*WingChord (mm)*	*Weight (g)*
SS Black	36.8	25.4	199	670
ST Black	37.9	26.9	215	605
SU Black	38.3	25.8	207	615
SV Black	39.6	27.7	206	695
SX Black	39	26.9	205	640
SY Black	39.2	29.3	210	590
SZ Black	39	26.5	210	660
S1 Black	37	26.5	201	580
S2 Black	37.1	26	201	570
Recaptures				
U3 yellow	37.3	27.1	200	570
U1 yellow	35.3	25.5	209	660
SE Black	37.5	25.9	210	640
SJ Black	37.2	25.7	211	615
SF Black	39.6	27.4	200	590
SG Black	36.2	27.8	199	630

4.2 Brood Distribution, Productivity Estimate, and Disturbance

We surveyed reaches identified as having harlequin ducks last year (2000), specifically Sk1, Sk2, Sk3, Sk5, and Su2. Productivity appeared comparable to last year, with a minimum estimate of 9 broods (the maximum number of broods observed during a single survey, Survey 2). When we compare the minimum brood estimate with the minimum pair estimate (17) achieved this spring, we estimated productivity of 52% of hens producing broods. The 9 broods included 34 ducklings. An alternate method of estimating productivity is to compare the number of banded hens we observed to have produced a brood (1 in 2001, Black S1) versus the number of banded hens in the system. We estimate 8 banded hens were in the system from the sum of the 4 hens marked this year and 4 hens we marked in 2000 that we expect to return (based the 79% anticipated annual survival of adult hens as observed by Cook and Robertson [1998], we rounded up the calculated 3.2 hens to 4). From this method we calculate productivity to be 12.5% of hens produced broods. The small sample of marked hens observed, in addition to the unknown number we are missing during surveys likely influenced these results. These sources of error will be addressed in the future years of this project.

The distribution of broods by age class and number of ducklings by age class for the survey period is provided in Figure 3 and 4 respectively. Based on survival rates estimated by Smith (2000), 19 of these ducklings are likely to survive to fledge. Table 6 provided the density estimates for the maximum observed broods and a summary of results for the survey and Appendix II includes maps of observed duck locations. This occurred during survey period two, July 23 to 26, 2001.

By back calculating hatch date from the mid-age of brood class for the broods observed, we estimate the mean hatch date to be between June 18 and 19 (sd=11.6days, n=14). This is quite comparable to the June 13 hatch date estimated during the 2000 brood surveys. The hatch date range observed was estimated to be between 2 June and 1 July. Incubation was therefor initiated approximately mid-May, corresponding well with our pair survey chronology. Our volunteer observer of reach Su2 informed us that the brood she was monitoring had left the reach between 12 August and 30 August, suggesting harlequin ducks have left the upper reaches by late August.

During the last survey, 10 August, 2001 we observed an aggregate brood of 11 Class III and an adult hen on reach Sk2. Additionally we observed a single drake, black band SU at Sk5 on the first survey and at Sk2 on the final survey. The drake was banded at Sk5 on 24 April 2001

During the surveys this year we attempted to quantify disturbance. Disturbance observed was mostly from fisherman. Its interesting to note that no broods were observed on Sk1, where there was the greatest concentration of fisherman. We observed 23 fisherman during our survey of this reach, averaging 7.7 fisherman days/day during the brood survey period. This suggests that a total of 693 fisherman days of disturbance may be encountered by harlequin ducks during a brood rearing period between July 1 and October 1 on this reach. Fortunately, the fishing effort appears greater during the later brood rearing period when broods are less vulnerable. As with our results from last year, this year we also noted use of areas least accessible to disturbance received more used by broods. Table 7 summarises the types and extent of disturbance encountered.

Table 6, Survey results for greatest number of broods observed (Survey 2, 23-26 July 2001)

Date	*Reach*	*Survey distance Km*	*% coverage*	*Single hens*	*Total broods*	*Total ducklings*	*Total adult hens*	*Total ducks*	*Brood density/Km*	*HARD density/Km*
July 25	Sk2	8.3	100	1	4	17	5	22	0.48	2.65
July 24	Sk3	7.2	100	2	2	9	4	13	0.28	1.81
July 23	Sk5	4.1	71	0	2	6	1	7	0.49	1.71
July 26	Sk1	7.3	47	0	0	0	0	0	0	0
July 23	Su2	7.2	97	1	1	2	2	4	0.14	0.56

Figure 3, Results of brood surveys, number of broods vs. survey period

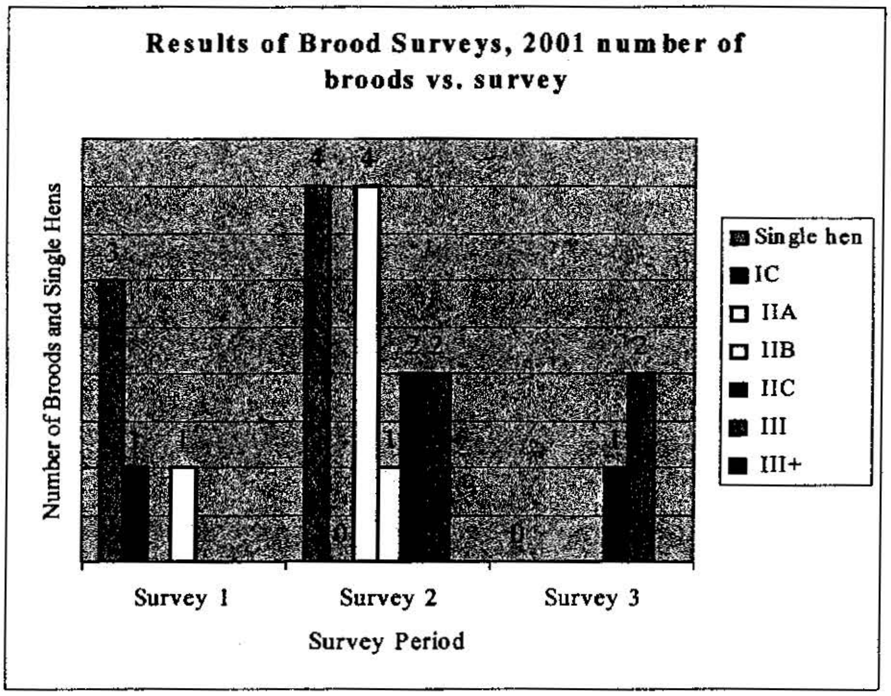

Figure 4, Results of brood surveys, number of ducklings vs. survey period

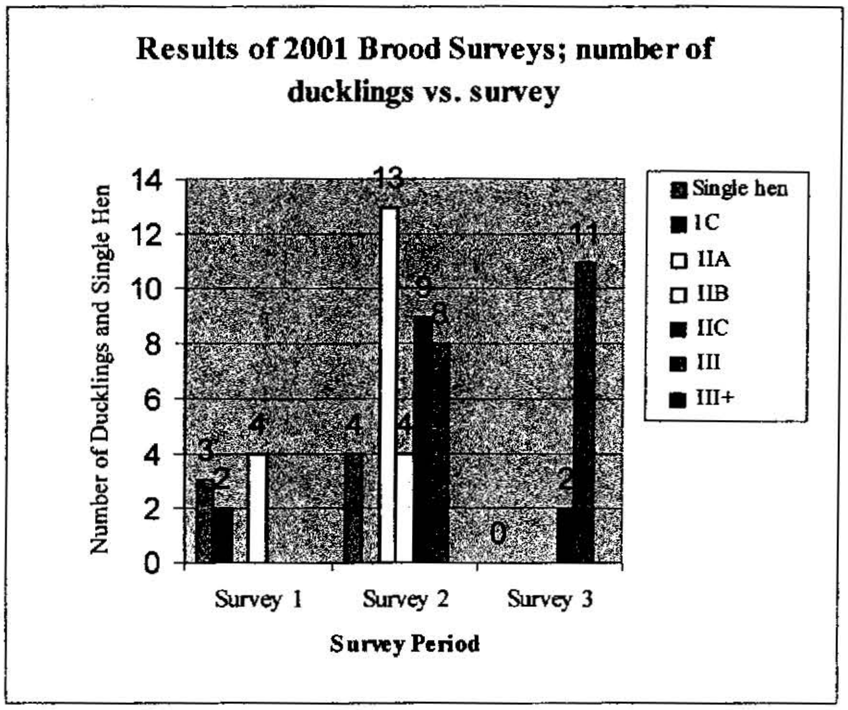

Table 7, Summary of disturbances observed during surveys (July-August 2001)

Fishermen (incidental [a])

	Sk1	Sk2	Sk3	Sk5	Su2
Survey 1	2 (2)	2	0	0	0
Survey 2	11 (0)	2	1 (2)	0	0
Survey 3	10 (0)	4 (10)	0 (3)	0	0
Total	23 (2)	8 (10)	1 (5)	0	0

[a] observed while walking back from survey

Total Dogs (number restrained [b])

	Sk1	Sk2	Sk3	Sk5	Su2
Survey 1	0	0	1	0	1
Survey 2	1	0	0	1(1)	0
Survey 3	0	3	0	0	1(1)
Total	1	3	1	1(1)	2 (1)

[b] total number of dogs on a leash. Number not in parenthesis represents number of dogs unrestrained.

Other Disturbances [c]

	Sk1	Sk2	Sk3	Sk5	Su2
Survey 1	0	0	2w	0	3w
Survey 2	1c	0	2w	2w	9w
Survey 3	2m	1t	0	0	2w
Total	3	1	4	2	14

[c] Disturbances are defined as follows: w= walkers, c= campsite, m= maintenance, t= trail building crew

5.0 DISCUSSION AND DIRECTION FOR YEAR TWO AND THREE

Results from both the pair and brood surveys have been quite similar to last year's (2000) results encouraging our ability to develop a survey protocol for volunteer use. Based on mark-resighting we confirmed that the population of Harlequin Ducks in the Upper Skagit River is larger than indicated by previous observations only. This result was expected and highlights the importance of establishing a marked population for subsequent study. In addition to the fieldwork, we have had success generating interest from volunteers. I gave an informal presentation at the 19th annual Bird Blitz in Manning Park. This is a three-day volunteer-based bird-monitoring event that attracted about 50 participants this year. A number of the participants showed great interest in volunteering to do harlequin surveys in future years. We have also recruited an individual who lives at Sunshine Village to volunteer with surveys along the Sumallo River (reach Su2). She continued to survey this reach until the ducks left in late August. We debriefed her to assess her thoughts on our initial volunteer protocol, and she felt that it was a personally rewarding experience and she would again like to participate in the spring 2002.

In year two and three we will begin attaching radio transmitters to harlequin ducks. Transmitter attachment employing anchors and sutures will best meet our objectives. In addition to identifying nesting sites and nesting success, we will also be attempting to correlate brood location with disturbance, i.e. is brood rearing influenced by increasing recreational pressure? This information will be useful for integrating wildlife management with recreational management in BC Parks.

Recommendations for management remain consistent with those identified in the pilot year (Freeman and Goudie 2001). Detailed management recommendations are beyond the scope of this data report, but will be provided after analysis of telemetry data and trend data in year two and three of the project. We have included the initial recommendations for managing harlequin ducks in parks from Freeman and Goudie (2001) to illustrate the continued basis of our direction in year two and three.

5.1 Managing Harlequin Ducks in Parks

The majority of the riverine habitat within our study area found to support harlequin ducks is under Provincial Park land tenure. Integrating recreational use with conservation of the species is thus the primary consideration of management. Generally, the Management Plan for the Skagit Valley Provincial Park (MoELP 1997) provides opportunities to integrate harlequin duck conservation with the conservation and recreation goals identified. The conservation goals for the park include maintaining a representation of the of the local ecology and preservation of representative features, while the recreation goals include providing a variety of river and valley related camping and outdoor experiences to meet the needs of regional recreation. These specific recreation experiences include river fishing, nature study and easy access river camping.

As the human population increases in the Lower Mainland of Greater Vancouver, greater use of the parks is expected. Berg (1994) identified recreation activities forecasted to increase by 2003 and beyond. Within the study area those activities which are expected to increase that we consider important to integrate with harlequin conservation include: bird watching, freshwater fishing, and canoeing/kayaking. These activities are forecasted to increase by 14%, 13% and 5.5 % participation respectively by 2003 (Berg 1994). He suggests that 22.7 % of the population will participate in bird watching, 34.1% in freshwater fishing, and 24.9% in canoeing/kayaking by 2003.

These activities can cause disturbance to breeding harlequin ducks, which can result in reduced feeding and increasing energetically costly behaviours (e.g. flying) as well as breakdown of pair bonds during the spring, or by disturbing incubation, fragmenting broods (increasing duckling mortality), or their feeding and loafing patterns. Such impacts on behaviour are hypothesised to negatively affect subsequent body condition and thereby survival.

We observed the greatest disturbance during July and August (and likely into September) when fisherman were wading the stream. This type of activity is particularly disturbing to broods at this time due to the lower water levels (and thus limited riparian cover). Additionally, the presence of domestic dogs accompanying fishermen was encountered in reach Sk1 and Sk2 near the Silvertipped Campground (an area identified as an Intensive Recreation Zone in the Skagit Management Plan [MoELP 1997]).

Initial strategies for limiting this disturbance to harlequin ducks should be educational and voluntary. This could include providing signs identifying the harlequin duck and potential concerns for disturbance, increasing visibility of the ecological reserve boundary and enforcing the no fishing policy within.

Additionally, monitoring the number of fisherman, the number of dogs and their behaviour as well as compliance with recommendations is required. Dependent upon compliance and use of the area by fishermen, future management strategies may include restraining or not permitting dogs in these areas, or creating additional harlequin duck refuges in reaches Sk1, Sk2, and Sk3. An alternate approach may include delaying the fisheries opening. Based on estimate of average hatching date, (mid-June) broods are still at age class I, and quite vulnerable during the early part of July. Opening the river to fishing two weeks later (July 15) and extending the opening by two weeks to provide the same opportunities to fisherman (provided other ecological considerations are compatible) would allow the majority of broods to develop to age class II. Older broods would be less vulnerable to disturbance. This may be a consideration if recreational fishing increases.

While we observed little disturbance during the pairing activity (April-May), forecasted increases in activities such as bird watching and canoeing/kayaking may provide management challenges in the future. During these months, the use of the trail seems to have little effect on duck behaviour at the current recreational use levels. Keeping with the objectives of the Skagit Valley Management Plan, potential exists to promote wildlife viewing and education opportunities, particularly in April and May. Caution would be required and early emphasis on having observers staying on the trail or using viewpoints should be promoted. "Harlequin Duck" viewpoints where ducks are active are already available at campsites along the trail between Sumallo Grove and Silvertipped campsite and where the trail comes close to the river. These could be promoted by the inclusion of interpretative signs, and providing benches/blinds, where observers would be encouraged to quietly sit and watch for harlequin ducks.

Future management of development is consistent with the Parks management objectives, including: Avoid increasing trail through the riparian, and future trail relocation should stay away from paralleling the edge of the creek (50m is sufficient to provide cover and limit disturbance in most cases), but instead, switch back to the stream for brief sections.

Additional opportunities for involving the public in recreational and wildlife viewing activities, which will contribute to the management of the species, include developing a protocol for volunteer monitoring of the population. Long-term monitoring is essential to identify the status of the population and as there are a number of factors that can effect annual productivity and nesting success (i.e. weather conditions, variation in stream flow, marine conditions, etc.) long–term monitoring is required to confidently establish trends. Developing a protocol which can be successfully implemented by volunteers could allow for collecting these data annually, permitting managers an opportunity to assess trends. Additionally this activity would have both recreational and educational values for those participating in the program. If this type of program is successful, it may be expanded beyond the study area or to other species.

6.0 ACKNOWLEDGEMENTS

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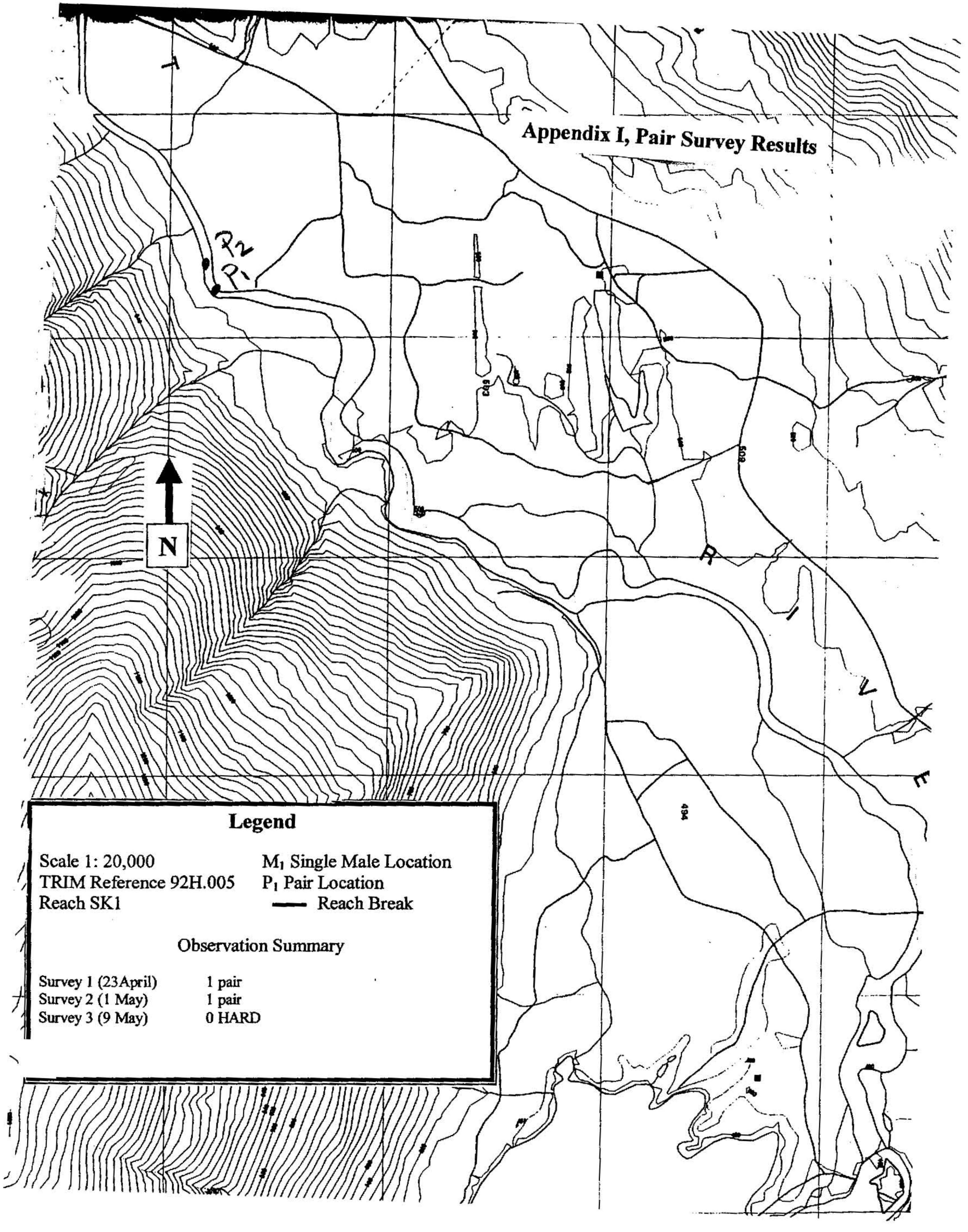
Appendix I, Maps of Harlequin Duck Locations during Pair Surveys

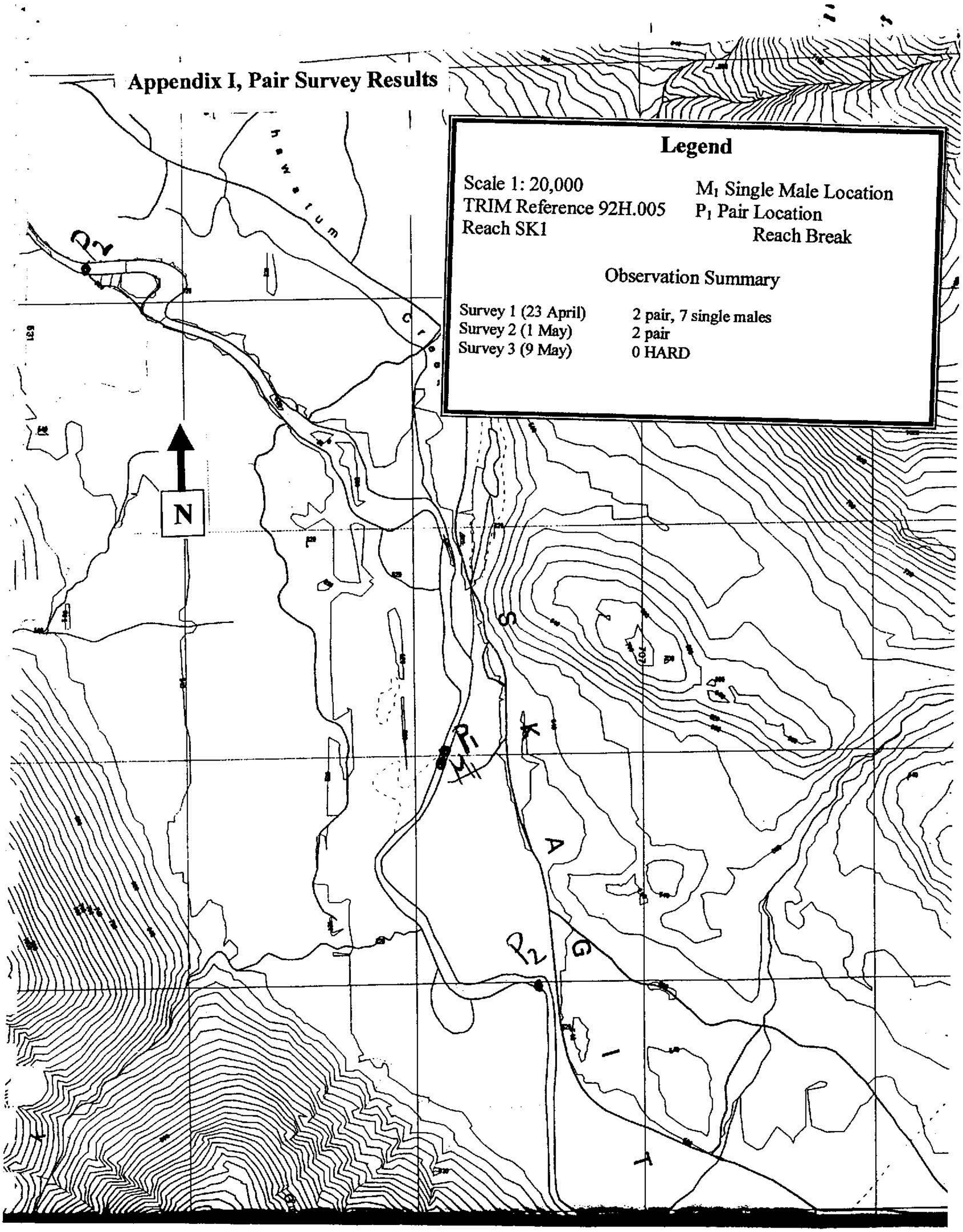
Maps are 1: 20,000 scale copies from TRIM maps available from BC MWLAP.

Locations are described with a prefix for identifying P (pair), M (single male) C (capture location) with a subscript referencing the survey number, 1 for survey 1, 2 for survey 2 etc. An example, P_1 would indicate a pair was observed at that location during the first survey of that reach. For clarity, multiple observations at the same location (e.g. 2 single males together) receive only one label. Only reaches with harlequin ducks are included.

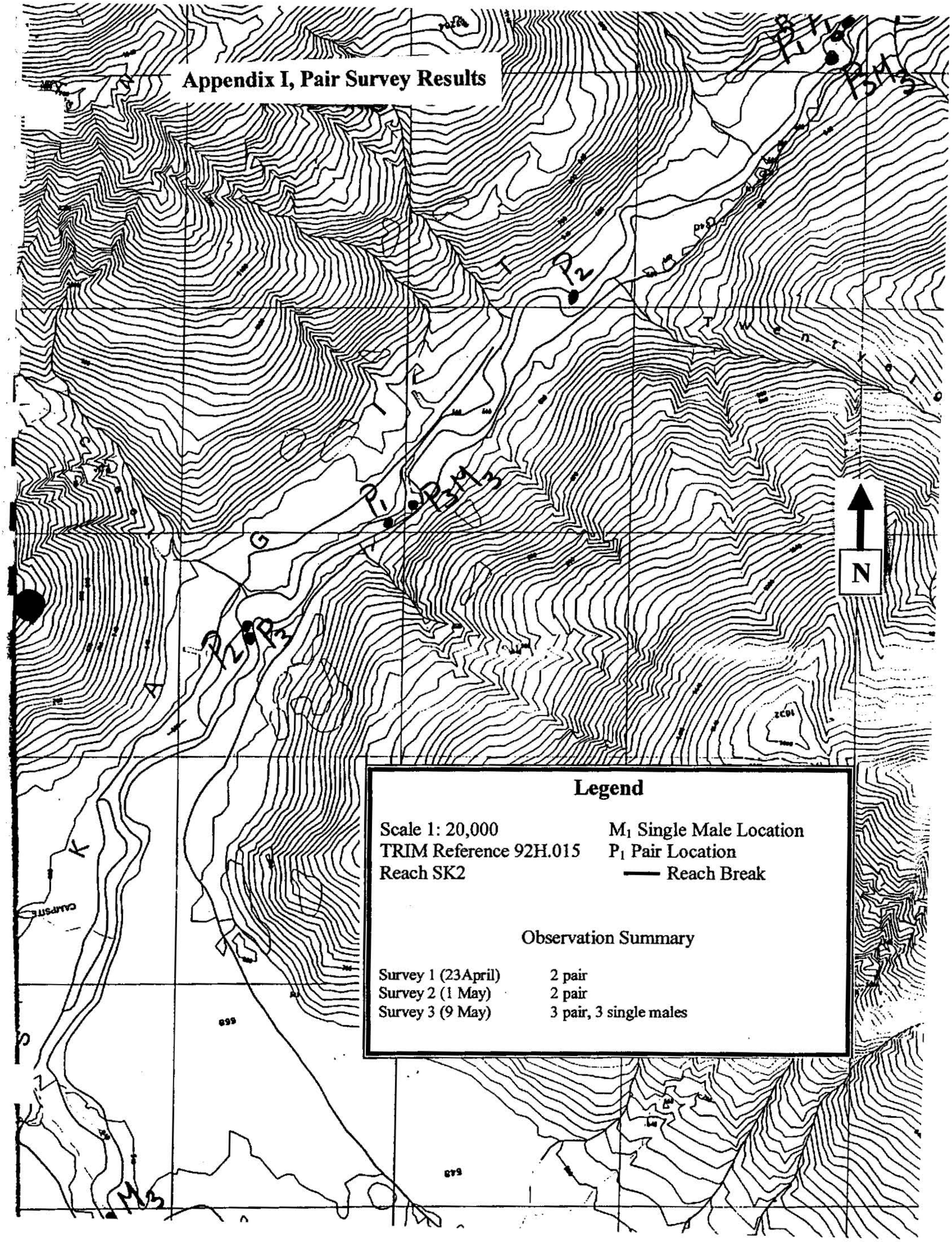
Appendix I, Pair Survey Results



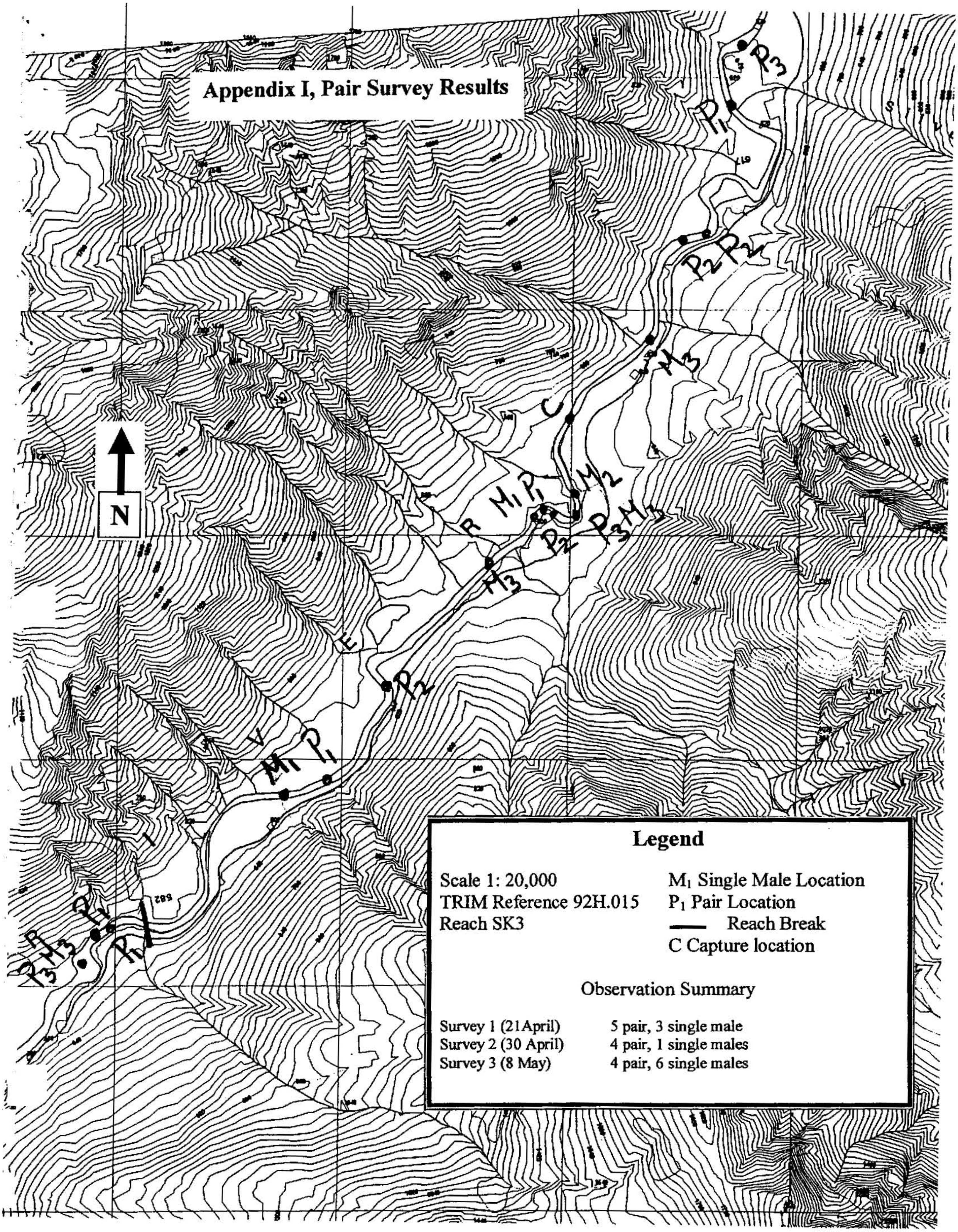
Appendix I, Pair Survey Results



Appendix I, Pair Survey Results



Appendix I, Pair Survey Results



Legend

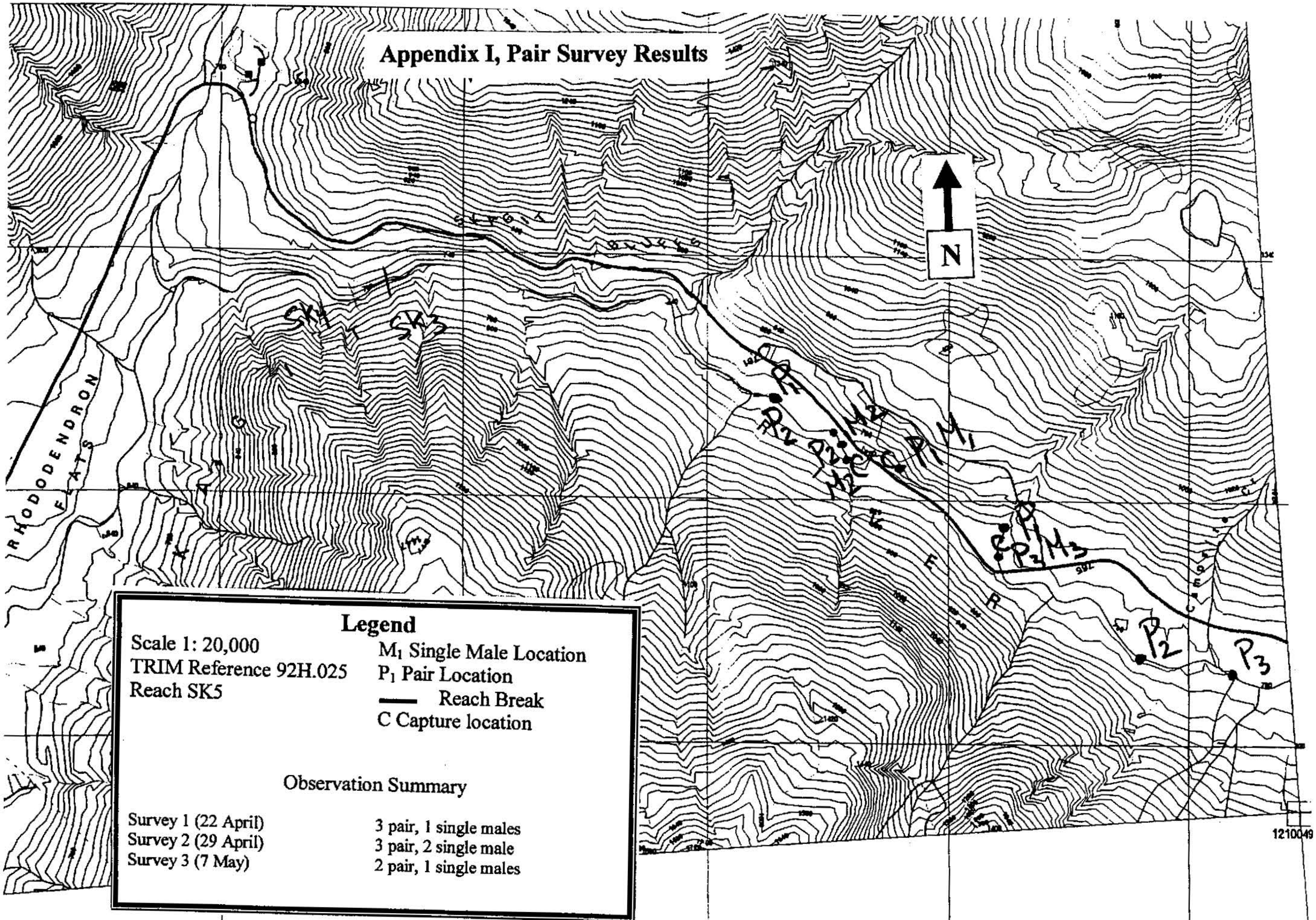
Scale 1: 20,000
TRIM Reference 92H.015
Reach SK3

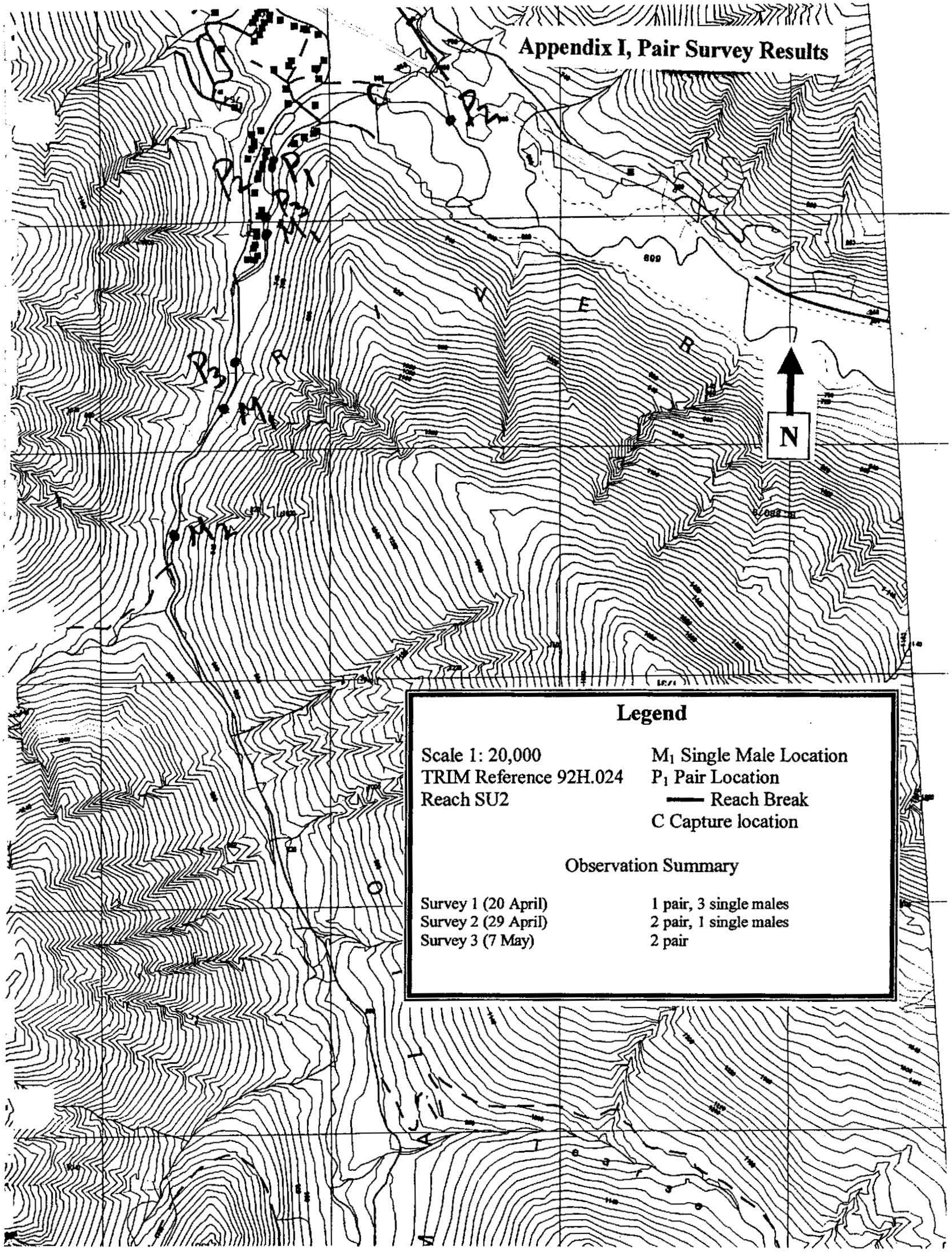
M_1 Single Male Location
P_1 Pair Location
Reach Break
C Capture location

Observation Summary

Survey 1 (21April)	5 pair, 3 single male
Survey 2 (30 April)	4 pair, 1 single males
Survey 3 (8 May)	4 pair, 6 single males

Appendix I, Pair Survey Results



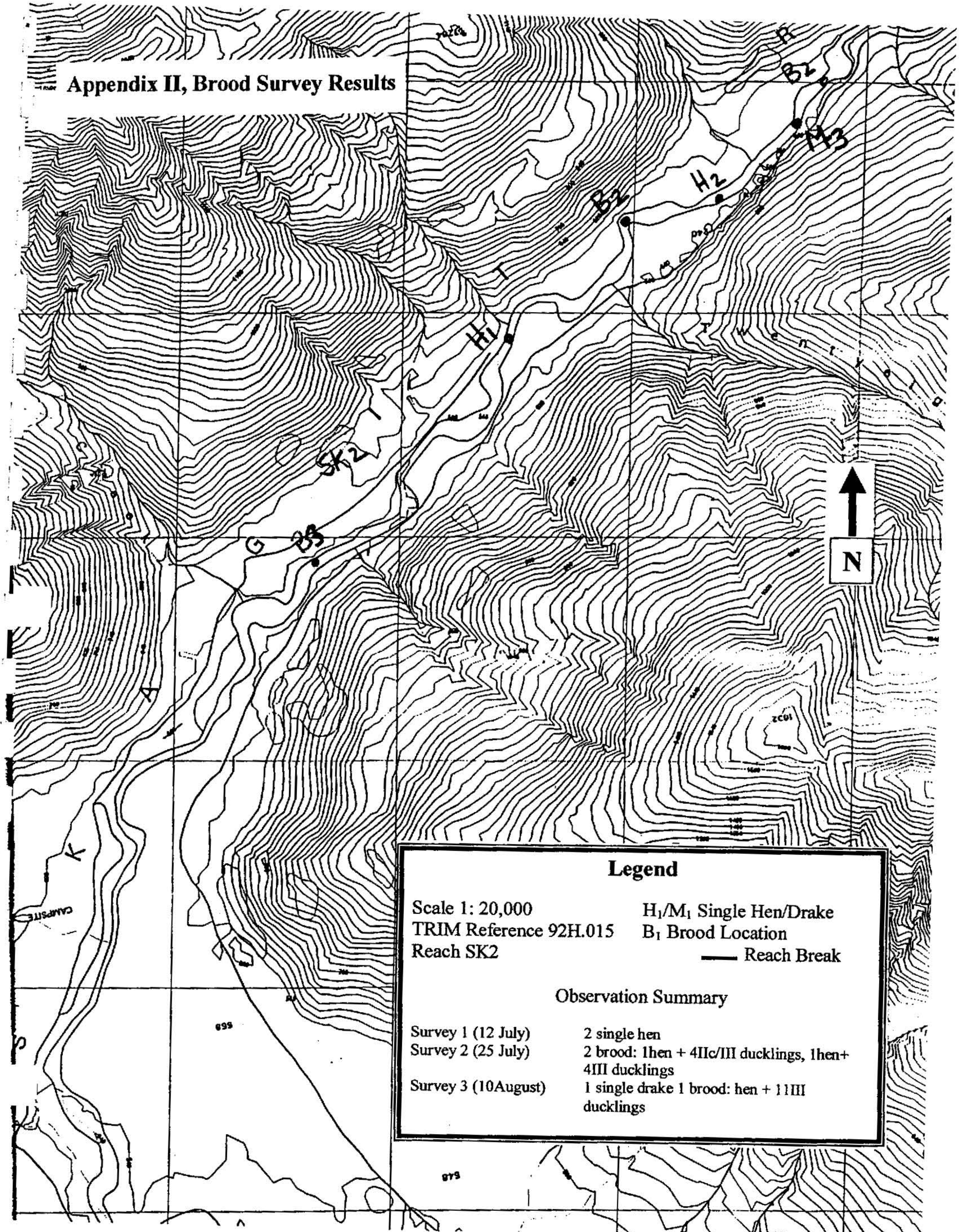

Appendix I, Pair Survey Results
N
Legend
Scale 1: 20,000
TRIM Reference 92H.024
Reach SU2
M1 Single Male Location
P1 Pair Location
Reach Break
C Capture location
Observation Summary
Survey 1 (20 April) 1 pair, 3 single males
Survey 2 (29 April) 2 pair, 1 single males
Survey 3 (7 May) 2 pair

Appendix II, Maps of Harlequin Duck Locations during Brood Surveys

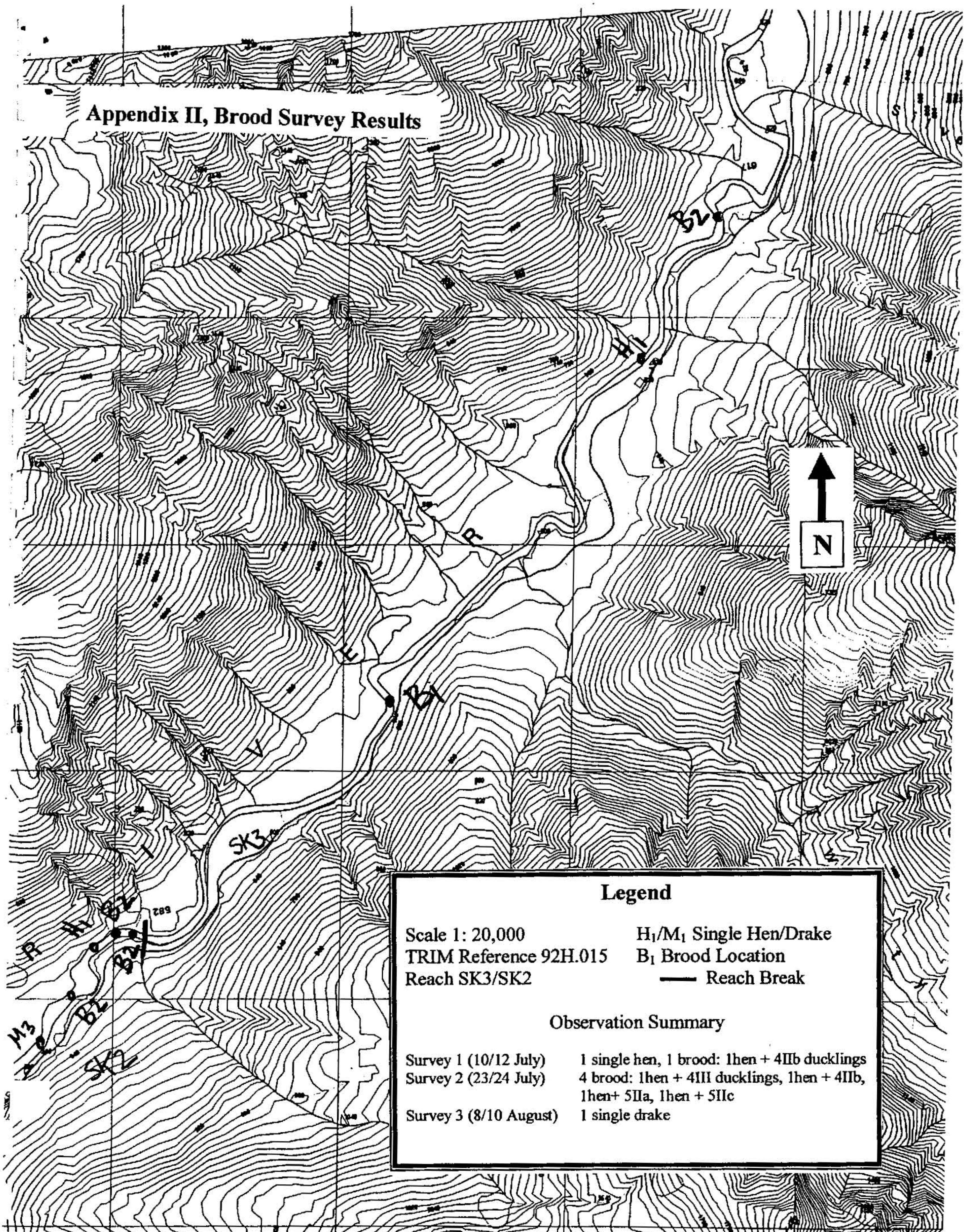
Maps are 1: 20,000 scale copies from TRIM maps available from BC MWLAP.

Locations are described with a prefix for identifying B (brood), H (single hen), M (single drake) with a subscript referencing the survey number, 1 for survey 1, 2 for survey 2 etc. An example, B_1 would indicate a brood was observed at that location during the first survey of that reach. For clarity, multiple observations at the same location (e.g. 2 single hens together) receive only one label. Only reaches with harlequin ducks are included.

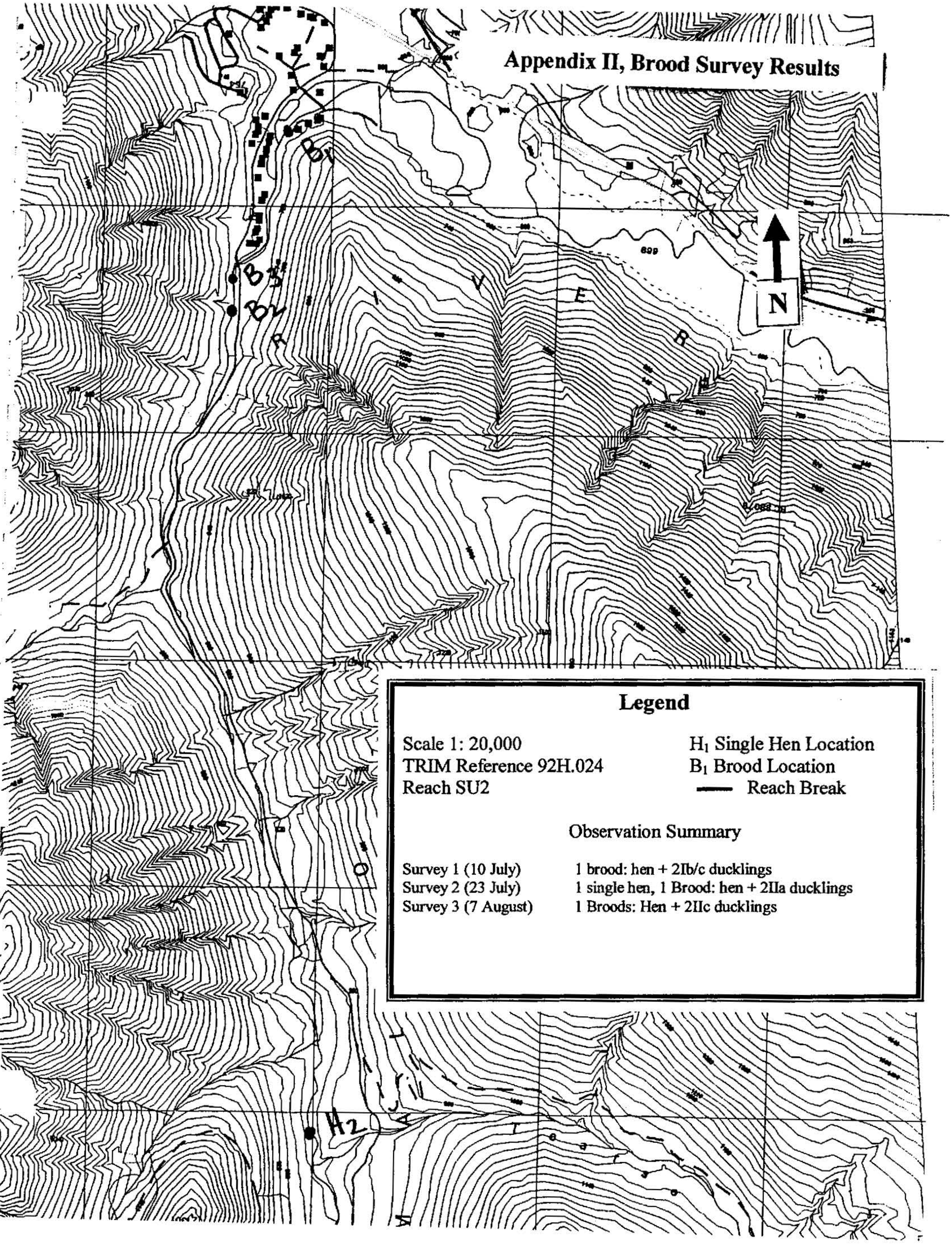
Appendix II, Brood Survey Results



Appendix II, Brood Survey Results



Appendix II, Brood Survey Results



Legend

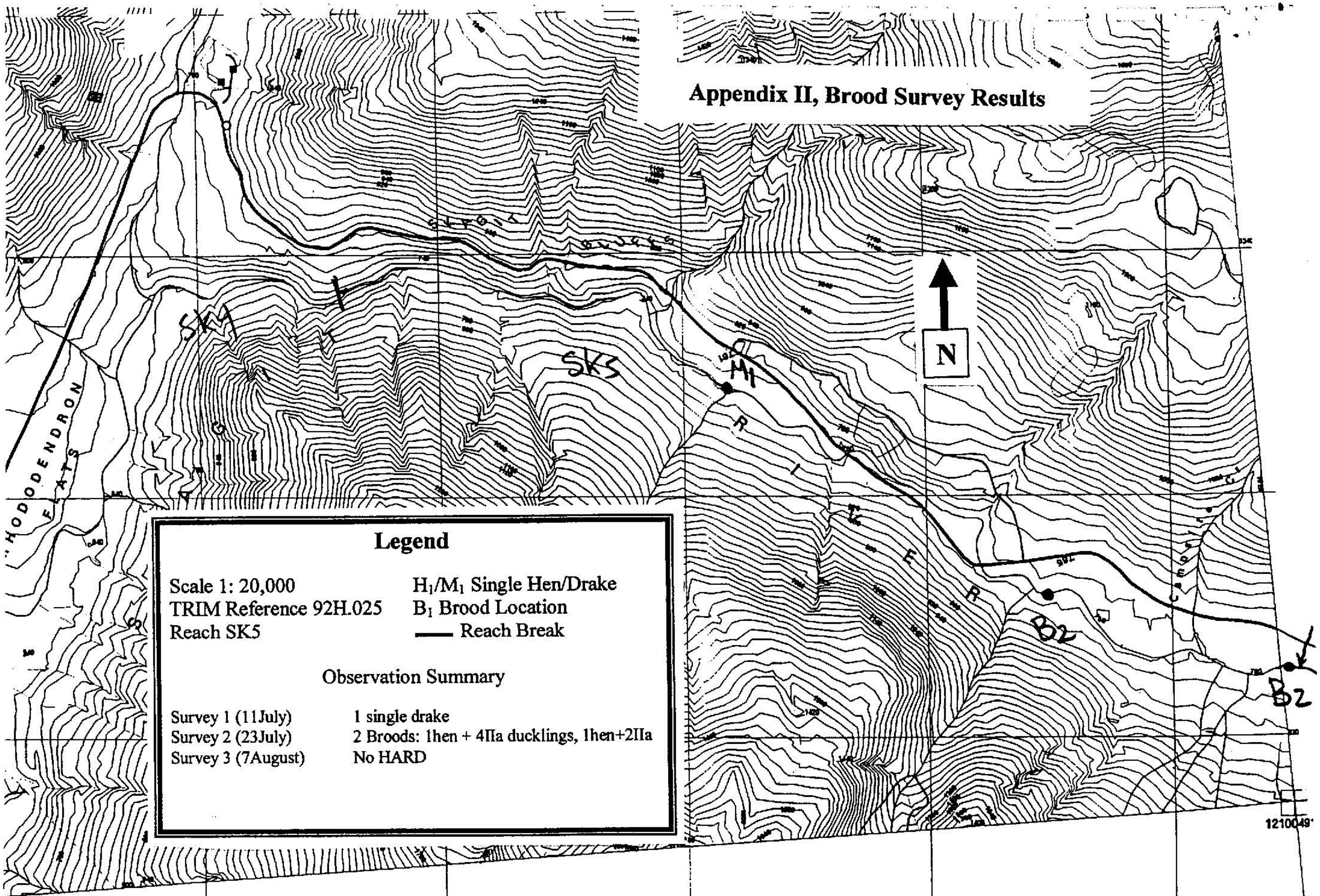
Scale 1: 20,000
TRIM Reference 92H.024
Reach SU2

H_1 Single Hen Location
B_1 Brood Location
—— Reach Break

Observation Summary

Survey 1 (10 July) 1 brood: hen + 2Ib/c ducklings
Survey 2 (23 July) 1 single hen, 1 Brood: hen + 2IIa ducklings
Survey 3 (7 August) 1 Broods: Hen + 2IIc ducklings

Appendix II, Brood Survey Results



Legend

Scale 1: 20,000
TRIM Reference 92H.025
Reach SK5

H_1/M_1 Single Hen/Drake
B_1 Brood Location
—— Reach Break

Observation Summary

Survey 1 (11July)	1 single drake
Survey 2 (23July)	2 Broods: 1hen + 4IIa ducklings, 1hen+2IIa
Survey 3 (7August)	No HARD