SUPPLEMENTARY MATERIAL

Preparation of Data for Modeling *Limnonectes leporinus*

Species presence point is coordinate of every individual recorded using GPSmap 60CSx (GARMIN) during field samplings. The GPS reading were converted to decimal degree format saved in excel using comma-delimited (.csv) format. The presence point excel file will be generated in ArcGIS version 10.3 which only recognized information of the coordinates in decimal degree, requiring the X and Y be labeled as long_dd (longitude decimal degree) and lat_dd (latitude decimal degree). The formula to convert degree minute (DM) coordinates to decimal degree (DD) as following: =INT(A1)+(A1-INT(A1))/0.6

Species ID	Longitude	Latitude	Species	Lat_dd	Long_dd
Br01	03°43.413'	115°30.837'	Lleporinus	2.1301	113.0844
Br02	03°43.508'	115°30.107'	Lleporinus	2.13115	113.0842
Br03	03°45.400'	115°28.150'	Lleporinus	2.199083	113.0658
Br04	03°44.795'	115°28.899'	Lleporinus	1.049983	111.683
Mu01	04°03.030'	114°48.904'	Lleporinus	1.050033	111.6831
Mu02	04°03.045'	114°48.957'	Lleporinus	1.049967	111.6829
Mu03	04°03.076'	114°48.987'	Lleporinus	3.501117	113.825
Bt01	01°18.116'	112°04.604'	Lleporinus	3.484317	113.8314
Bt02	01°18.238'	112°04.444'	Lleporinus	3.48505	113.83
Bt03	01°18.155'	112°04.691'	Lleporinus	3.484633	113.8307
Bt04	01°14.358'	111°55.877'	Lleporinus	3.486517	113.8329
Bt05	01°14.357'	111°55.861'	Lleporinus	1.1612	110.2189
Bt06	01°18.178'	112°04.653'	Lleporinus	1.161217	110.2189
Bt07	01°18.281'	112°04.499'	Lleporinus	1.133717	110.2241
Bt08	01°18.161'	112°04.601'	Lleporinus	1.118367	110.211
Ka01	02°00.957'	112°56.381'	Lleporinus	1.141883	110.2165
Ka02	02°00.919'	112°56.375'	Lleporinus	1.715717	110.4459
Ka03	02°00.943'	112°56.369'	Lleporinus	1.714717	110.4438
Ka04	02°00.946'	112°56.362'	Lleporinus	4.136483	114.8947
Ka05	02°01.024'	112°56.245'	Lleporinus	4.1365	114.8956
Ka06	02°01.061'	112°56.459'	Lleporinus	4.060583	114.8717
Ma01	01°36.673'	110°09.828'	Lleporinus	4.037217	114.7458
Ma02	01°36.672'	110°09.819'	Lleporinus	4.04675	114.8352
Ma03	01°36.665'	110°09.835'	Lleporinus	1.744233	110.3187
Ma04	01°36.673'	110°09.925'	Lleporinus	1.302467	112.0764
Ma05	01°36.694'	110°09.754'	Lleporinus	1.308383	112.0803
Ma06	01°36.695'	110°09.755'	Lleporinus	1.607267	110.1943
Ma07	01°36.675'	110°09.888'	Lleporinus	3.72355	115.514
Ma08	01°36.660'	110°09.840'	Lleporinus	3.725133	115.5018
Ma09	01°36.679'	110°09.980'	Lleporinus	3.756667	115.4692
Ma10	01°36.698'	110°09.789'	Lleporinus	3.746583	115.4817
Ma11	01°36.701'	110°09.911'	Lleporinus	4.0505	114.8151

Ma12	01°36.498'	110°09.501'	Lleporinus	4.05075	114.816
Ma13	01°36.557'	110°09.609'	Lleporinus	4.051267	114.8165
Ma14	01°36.623'	110°09.758'	Lleporinus	1.301933	112.0767
Ma15	01°36.688'	110°09.803'	Lleporinus	1.303967	112.0741
Ma16	01°36.711'	110°09.903'	Lleporinus	1.302583	112.0782
Ba01	01°20.852'	110°02.352'	Lleporinus	1.2393	111.9313
Ba02	01°21.395'	110°01.992'	Lleporinus	1.239283	111.931
Ba03	01°30.118'	110°09.970'	Lleporinus	1.302967	112.0776
Ba04	01°32.530'	110°10.955'	Lleporinus	1.304683	112.075
Ba05	01°32.650'	110°10.885'	Lleporinus	1.302683	112.0767
Ba06	01°19.895'	110°06.012'	Lleporinus	2.01595	112.9397
Ba07	01°19.997'	110°06.135'	Lleporinus	2.015317	112.9396
Ku01	01°36.678'	110°11.861'	Lleporinus	2.015717	112.9395
Ku02	01°36.669'	110°11.829'	Lleporinus	2.015767	112.9394
Ku03	01°36.653'	110°11.834'	Lleporinus	2.017067	112.9374
Ku04	01°36.697'	110°11.853'	Lleporinus	2.017683	112.941
Ku05	01°36.703'	110°11.858'	Lleporinus	1.611217	110.1638
Ku06	01°36.247'	110°09.000'	Lleporinus	1.6112	110.1637
Ku07	01°36.733'	110°11.030'	Lleporinus	1.611083	110.1639
Ku08	01°36.755'	110°11.975'	Lleporinus	1.611217	110.1654
Ku09	01°36.711'	110°11.873'	Lleporinus	1.611567	110.1626
Pa01	01°10.906'	110°15.566'	Lleporinus	1.611583	110.1626
Pa02	01°10.929'	110°15.550'	Lleporinus	1.61125	110.1648
Pa03	01°12.289'	110°16.062'	Lleporinus	1.611	110.164
Pa04	01°10.937'	110°15.544'	Lleporinus	1.611317	110.1663
Pa05	01°10.887'	110°15.596'	Lleporinus	1.611633	110.1632
Pa06	01°10.884'	110°15.607'	Lleporinus	1.611683	110.1652
Ga01	01°41.495'	109°50.927'	Lleporinus	1.6083	110.1584
Ga02	01°41.501'	109°50.899'	Lleporinus	1.609283	110.1602
Seb01	03°02.312'	113°54.701'	Lleporinus	1.610383	110.1626
Seb02	03°02.311'	113°54.706'	Lleporinus	1.611467	110.1634
Ka07	02°07.806'	113°05.066'	Lleporinus	1.61185	110.1651
Ka08	02°07.869'	113°05.053'	Lleporinus	1.347533	110.0392
Ka09	02°11.945'	113°03.946'	Lleporinus	1.356583	110.0332
Eng01	01°02.999'	111°40.981'	Lleporinus	1.501967	110.1662
Eng02	01°03.002'	111°40.983'	Lleporinus	1.542167	110.1826
Eng03	01°02.998'	111°40.976'	Lleporinus	1.544167	110.1814
Wil01	03°30.067'	113°49.500'	Lleporinus	1.331583	110.1002
Wil02	03°29.059'	113°49.886'	Lleporinus	1.333283	110.1023
Wil03	03°29.103'	113°49.799'	Lleporinus	1.6113	110.1977
Wil04	03°29.078'	113°49.843'	Lleporinus	1.61115	110.1972
Wil05	03°29.191'	113°49.973'	Lleporinus	1.610883	110.1972
Pa07	01°09.672'	110°13.133'	Lleporinus	1.611617	110.1976
Pa08	01°09.673'	110°13.134'	Lleporinus	1.611717	110.1976
Pa09	01°08.023'	110°13.445'	Lleporinus	1.604117	110.15
Pa10	01°07.102'	110°12.661'	Lleporinus	1.612217	110.1838

Pa11	01°08.513'	110°12.989'	Lleporinus	1.612583	110.1996
KUHE57303	01°42.943'	110°26.752'	Lleporinus	1.61185	110.1979
KUHE57304	01°42.883'	110°26.629'	Lleporinus	1.181767	110.2594
Mu02	04°08.189'	114°53.679'	Lleporinus	1.18215	110.2592
Mu05	04°08.190'	114°53.734'	Lleporinus	1.204817	110.2677
Mu07	04°03.635'	114°52.301'	Lleporinus	1.182283	110.2591
Mu01	04°02.233'	114°44.746'	Lleporinus	1.18145	110.2599
Mu04	04°02.805'	114°50.109'	Lleporinus	1.1814	110.2601
Ga01	01°44.654'	110°19.122'	Lleporinus	1.691583	109.8488
Ga02	01°41.551'	110°50.867'	Lleporinus	1.691683	109.8483
Ga03	01°41.413'	110°50.935'	Lleporinus	3.038533	113.9117
Ga04	01°41.971'	109°50.348'	Lleporinus	3.038517	113.9118
Bt08	01°18.148'	112°04.581'	Lleporinus	3.49585	113.8317
Bt09	01°18.503'	112°04.818'	Lleporinus	3.495733	113.8315
Pa11	01°36.436'	110°11.657'	Lleporinus	3.495767	113.8317

There were seven environmental variables selected based on the species ecological requirement which were used as predictor variables in the suitable habitat modeling in which the model was then used as resistance map to run Circuitscape. The predictor variables were obtained from websites as following with the downloaded datasets in form of shapefile and .tiff formats:

1. Slopes	https://globalmaps.github.io/	asia_pac_gsr.tif
2. Intact forest landscape	http://www.intactforests.org/	ifl_2016.shp
3. Population density	https://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-density-rev11	mys_pd_2020_1km_UNadj.tif
4. Water basins	https://datacatalog.worldbank.org/dataset/major-river-basins-world	major_basins_of_the world.shp
5. WorldClim temperature	https://www.worldclim.org/data/monthlywth.html	Wc2.1_2.5m_tmax_2019.tif
6. Elevation	https://datacatalog.worldbank.org/dataset/world-terrain-elevation-above-sea-level-ele-gis-data-global-solar-atlas	Wc2.1_2.5m-elev.tif
7. Land cover	https://www.gisresources.com/free-gis-data-land-cover-land-use-data/	Gm_lc>V1_1_2.tiff
8. Administrative boundary	https://www.diva-gis.org/gdata	MYS_adm2.shp

Prior to perform circuit theory using Circuitscape version 5.0, Julia interface was installed to allow the Circuitscape software generate data. The circuit analysis employed here was using

haplotype data of DNA sequences which was generated in DNA Sequence Polymorphism (DNASP) version 6.12.01 (Rozas et al., 2017). The haplotype groups were identified as node ID in the species column and GPS reading were labelled as N and E instead of long_dd and lat_dd.

Haplotype data generated in DNASP	Prepared excel file to compute in ArcGIS		
Hap_1: 1 [Ba07] Hap_2: 15 [Ku05 Pa03 Ma04 Ma06 Ma03 Ba02 Ba05 Ba01 Ba06 Ku03 Ku02 Ku01 Ma09 Ba04 Ba03] Hap_3: 1 [Pa04] Hap_4: 1 [Pa05] Hap_5: 1 [Ma01] Hap_6: 1 [Ma02] Hap_7: 1 [Pa01] Hap_8: 1 [Pa02] Hap_9: 1 [Ma05] Hap_10: 1 [Ku04] Hap_11: 8 [Pa07 Pa08 Pa09 Ga02 Pa10 Pa11 Ku06 Ku07] Hap_12: 2 [Ga01 Ga03] Hap_13: 2 [Eng01 Eng03] Hap_14: 1 [Eng02] Hap_15: 2 [Seb01 Seb02] Hap_16: 4 [Bt05 Bt04 Bt03 Ka02] Hap_17: 1 [Ka01] Hap_18: 1 [Bt06] Hap_19: 1 [Ka03] Hap_20: 2 [Ka05 Ka06] Hap_21: 1 [Ka04] Hap_22: 2 [Bt01 Bt02] Hap_23: 4 [Br01 Br03 Br02 Br04] Hap_24: 1 [Sa03] Hap_25: 1 [Sa01] Hap_26: 1 [Sa02] Hap_27: 4 [Mu03 Mu04 Mu05 Mu06] Hap_28: 1 [Mu01] Hap_29: 1 [Mu02] Hap_30: 1 [Bt09] Hap_31: 1 [Bt08] Hap_32: 1 [Ka09] Hap_33: 1 [Ka07] Hap_34: 6 [Ka08 Mulu05 Mulu07 Wil03 Wil02 Wil04] Hap_35: 1 [Mulu02] Hap_36: 1 [Wil01] Hap_37: 1 [Mulu01]	NodeID	N	E
	1	1.611917	110.1603
	1	1.604117	110.1858
	1	1.61115	110.1972
	1	1.610883	110.1972
	1	1.612067	110.1605
	1	1.612	110.1604
	1	1.611833	110.1602
	1	1.612317	110.1608
	1	1.367083	110.1688
	1	1.3672	110.1691
	1	1.36715	110.1689
	1	1.383517	110.1688
	1	1.61225	110.1607
	1	1.367167	110.169
	1	1.611083	110.1639
	1	1.611217	110.1654
	2	1.611483	110.1635
	3	1.133717	110.2241
	4	1.133833	110.2258
	5	1.61215	110.1606
	6	1.367317	110.1691
	7	1.611567	110.1626
	8	1.611617	110.1976
	9	1.611	110.164
	9	1.61165	110.1627
	9	1.611717	110.1976
	9	1.11825	110.2085
	10	1.383683	110.1688
	11	1.118367	110.211
	12	1.133517	110.2227
	13	1.133417	110.2227
	14	1.6112	110.1637
	15	1.611217	110.1638
	16	1.61125	110.1656
	17	1.30375	112.0739
	17	1.303917	112.074
	17	1.304	112.0741

	17	2.169183	112.052
	18	2.01595	112.9397
	19	1.302	112.0766
	19	1.301883	112.0768
	20	2.168983	113.0517
	21	2.16925	113.0521
	21	2.169167	113.0521
	22	1.308383	112.0803
	23	2.169267	113.0521
	24	1.301933	112.0767
	24	1.303967	112.0741
	25	3.72355	115.514
	25	3.724667	115.5142
	25	3.756667	115.4692
	25	3.7575	115.47
	26	4.0505	114.8151
	26	4.050583	114.815
	26	4.05065	114.8151
	27	3.038533	113.9117
	27	3.038517	113.9118
	28	1.049817	111.6829
	29	1.049983	111.683
	30	1.050033	111.6831
	31	2.16475	113.0856
	31	4.04675	114.8352
	31	4.037217	114.7458
	31	3.501083	113.8251
	31	3.484367	113.8315
	31	3.501117	113.825
	32	4.136333	114.8945
	33	3.484317	113.8314
	34	4.136483	114.8947

Dataset of DNA sequences used in this study:

>Ma01

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>Ma05

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>Ma02

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>Pa01

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>Ma04

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>Ma03

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>Pa04

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>Pa05

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>Pa02

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>Bt05

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>Bt04

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>Ba02

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>Ba05

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>Mu02

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>Bt09

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>Bt08

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>Pa07

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>Pa08

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>Pa09

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>Eng02

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>Eng01

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>Eng03

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>Ga01

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>Ga02

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>Ka07

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>Ka08

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>Ka09

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>Pa10

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>Ku06

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>Ku07

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>Mulu01

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>Mulu02

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>Mulu05

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>Mulu07

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>Seb01

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>Seb02

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>Wil03

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>Wil01

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>Wil02

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>Wil04

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List of aligned Haplotypes sequences

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Hap_1  ----GTCTACATTCTTATTCTACCTGGCTTCGGTATTATTTCACACGTTGTAGC-
TACTACTCCAGCAAAAAA---CCAT [ 80]

Hap_2  ----..................................................-
..................---.... [ 80]
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Hap_3  ----..................................................-
..................---.... [ 80]

Hap_4  ----.............................A....................-
..................---.... [ 80]

Hap_5  ----.................................................T..-
..................---.... [ 80]

Hap_6  ----..................................................-
..................---.... [ 80]

Hap_7  ----..................................................-
..................---.... [ 80]

Hap_8  ----..................................................-
..................---.... [ 80]

Hap_9  ----..................................................-
..................---.... [ 80]

Hap_10 ----......C.....................T.....................-
..................---.... [ 80]

Hap_11 ----..................................................-
..................---.... [ 80]

Hap_12 ----..................................................-
..................---.... [ 80]

Hap_13 ----..................................................-
..................---.... [ 80]

Hap_14 ----..................................................-
..................---.... [ 80]

Hap_15 ----..................................................-
..................---.... [ 80]

Hap_16 ----.....................................C..............-
..................---T... [ 80]

Hap_17 ----.....................................C..............-
..................---T.G. [ 80]

Hap_18 ----.....................................C..............-
..................---T... [ 80]

Hap_19 ----.....................................C..............-
..................---T... [ 80]

Hap_20 ----.....................................C..............-
..................---T... [ 80]

Hap_21 ----.....................................C..............-
..................---T... [ 80]

Hap_22 ----.....................................C..............-
..................---T... [ 80]

Hap_23 ----.....................................C..............-
..................---T... [ 80]

Hap_24 ----.....................................C..............-
..................---T... [ 80]
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Hap_25 ----.....................................C.............-
..................---T... [ 80]

Hap_26 ----.............................T........A.........G...-
..................---T... [ 80]

Hap_27 ----.....................................C.............-
..................---T... [ 80]

Hap_28 ----......C.....................T.......C.............-
..................---T... [ 80]

Hap_29 ----.............................T.......C.............-
..................---T... [ 80]

Hap_30 ----.....................................C.............-
..................---T... [ 80]

Hap_31 ----.....................................C.............-
..................---T... [ 80]

Hap_32 ----.....................................C.............-
..................---T... [ 80]

Hap_33 ----.....................................C.............-
..................---T... [ 80]

Hap_34 ----.....................................C.............-
..................---T... [ 80]

Hap_35 ----.....T...............................C.............-
..................---T... [ 80]

Hap_36 ----.....................................C.............-
..................---T... [ 80]

Hap_37 ----.....................................C.............-
..................---T... [ 80]


Hap_1  TCGGCTATAT---CATAGTCTGAGCCATATTATCAATTGGTC-
CCTTGGTTTTATTGTCTGAGCCCACCACATATTCACT [160]

Hap_2  ..........---.............................-
..................................... [160]

Hap_3  ..........---.............................-
..................................... [160]

Hap_4  ..........---.............................-
T.................................... [160]

Hap_5  ..........---.............................-
..................................... [160]

Hap_6  ..........---.............................-
..................................... [160]

Hap_7  ..........---.............................-
..................................... [160]

Hap_8  ..........---......T.....................-
..................................... [160]
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Hap_9  ..........---.............................-
.G.C.C.....................CA..... [160]

Hap_10 ..T.......---G...T.......................-
...............G..................... [160]

Hap_11 ..........---.............................-
..................................... [160]

Hap_12 ..........---.............................-
..................................... [160]

Hap_13 ..........---.............................-
..................................... [160]

Hap_14 ..........---.............................-
..................................... [160]

Hap_15 ..........---.............................-
..................................... [160]

Hap_16 .......C..---T...........T..............C.-
T........C.....T...........T........C [160]

Hap_17 .......C..---T...........T..............C.-
T........C.....T...........T........C [160]

Hap_18 .......C..---T...........T..............-
T........C.....T...........T........C [160]

Hap_19 .......C..---T...........T..............-
T........C.....T...........T........C [160]

Hap_20 .......C..---T...........T..............-
T........C.....T...........T........C [160]

Hap_21 .......C..---T...........T..............-
T........C.....T...........T........C [160]

Hap_22 .......C..---T...........T..............-
T........C.....T...........T..... [160]

Hap_23 ..........---T...........T..............-
T........C.....T.....T.............C [160]

Hap_24 ..........---T.....T.....T...........C....-
T........C.....T...........T........C [160]

Hap_25 ..........---T.....T.....T...........C....-
T........C.....T...........T........C [160]

Hap_26 ..........---T.....T.....T...C.......C....-
T........C.....T...........T........C [160]

Hap_27 ..........---............T..............C.-
T..............T.....T.....T........C [160]

Hap_28 ..T.......---....T......AT.............TC.-
T..............T.....T.....T........C [160]

Hap_29 ..T.......---....T.......T..............C.-
T..............T.....T.....T........C [160]

Hap_30 .......C..---T...........T..............-
T........C.....T...........T........C [160]
```

```
Hap_31 .......C..---T...........T.................-
T........C.....T...........T........C [160]

Hap_32 .......C..---T...........T..............C.-
T........C.....T...........T........C [160]

Hap_33 .......C..---T...........T.................-
T..............T...........T........C [160]

Hap_34 ..........---............T..............C.-
T..............T.....T.....T........C [160]

Hap_35 ..........---............T..............C.-
T..............T.....T.....T........C [160]

Hap_36 ..........---............T..............C.-
T..............T.....T.....T........C [160]

Hap_37 ..........---............T.................-
T..............T.....T.....T........C [160]


Hap_1  AC---TCTAAACGTTGACACACGAGCATATTTTACTTCAGCC-
CAATAATCATTGCTATTCCCACTGGTGT---AGTTTT [240]

Hap_2  ..---.....................................-
.............................---...... [240]

Hap_3  ..---.....................................-
.............................---...... [240]

Hap_4  ..---.....................................C...-
.............................---...... [240]

Hap_5  ..---.....................................-
.......................G..---...... [240]

Hap_6  ..---.....................................-
.............................---...... [240]

Hap_7  ..---.....................................-
.............................---...... [240]

Hap_8  ..---.....................................-
.............................---...... [240]

Hap_9  ..---.....................................-
.............................---...... [240]

Hap_10 ..---.....................................-
.............................---...... [240]

Hap_11 ..---.....................................-
.............................---...... [240]

Hap_12 ..---.....................................-
.............................---...... [240]

Hap_13 ..---.....................................-
.............................---...... [240]

Hap_14 ..---.....................................-
.............................---...... [240]
```

```
Hap_15 ..---.....................................-
.............................---...... [240]

Hap_16 ..---C....................................-
.........................C..---...... [240]

Hap_17 ..---C....................................-
.........................C..---...... [240]

Hap_18 ..---C....................................-
.......T.................C..---...... [240]

Hap_19 ..---C....................................-
.......T.................C..---...... [240]

Hap_20 ..---C....................................-
.........................C..---...... [240]

Hap_21 ..---C....................................-
.........................C..---...... [240]

Hap_22 ..---C....................................-
.........................C..---...... [240]

Hap_23 ..---C....................................-
.........................C..---...... [240]

Hap_24 ..---C....................................-
.........................C..---...... [240]

Hap_25 ..---C....................................-
.........................C..---...... [240]

Hap_26 ..---C....................................-
.........................C..---...... [240]

Hap_27 ..---C.......................C............-
.........................C..---...... [240]

Hap_28 ..---C.......................C............-
.........................C..---...... [240]

Hap_29 ..---C.......................C............-
.........................C..---...... [240]

Hap_30 ..---C....................................-
.........................C..---...... [240]

Hap_31 ..---C....................................-
.........................C..---...... [240]

Hap_32 ..---C....................................-
.........................C..---...... [240]

Hap_33 ..---C....................................-
.........................C..---...... [240]

Hap_34 ..---C.......................C............-
.........................C..---...... [240]

Hap_35 ..---C.......................C............-
.........................C..---...... [240]

Hap_36 ..---C.......................C............-
................C........C..---...... [240]
```

```
Hap_37 ..---C.....................................-
.........................C..---..... [240]


Hap_1  ----TGGCTGGCCACCATGCACGGCGGTGTTAT------AGAAG-
TCCAATATTGTGAGCATT---CTTCATTTTCTTAT [320]
Hap_2  ----.............................------.....-
...................---.............. [320]
Hap_3  ----.............................------.....-
...................---.............. [320]
Hap_4  ----.............................------.....-
...................---.............. [320]
Hap_5  ----.............................------.....-
C..C............C.---...T.......... [320]
Hap_6  ----.............................------.....-
...................---.............. [320]
Hap_7  ----.............................------.....-
...................---.............. [320]
Hap_8  ----.............................------.....-
...................---.............. [320]
Hap_9  ----.............................------.....-
...................---.............. [320]
Hap_10 ----.............................------.....-
...................---.............. [320]
Hap_11 ----.............................------.TG..-
...................---.............. [320]
Hap_12 ----.............................------.TG..-
.................C.---.............. [320]
Hap_13 ----..A..........................------.TG..-
...................---.............. [320]
Hap_14 ----..A..........................------.TG..-
...................---.............. [320]
Hap_15 ----.............................------.TG..-
...................---.............. [320]
Hap_16 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]
Hap_17 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]
Hap_18 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]
Hap_19 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]
Hap_20 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]
```

```
Hap_21 ----..AT....T........T..T..CA.C..------.....-
.......C.A........---......C....... [320]

Hap_22 ----..AT....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]

Hap_23 ----..A.....T..............A.C..------.....-
.......C.A........---......C....... [320]

Hap_24 ----..A.....T...........T...A....------.....-
.......C.A........---......C....... [320]

Hap_25 ----..A.....T...........T..CA.C..------.....-
.......C.A........---......C....... [320]

Hap_26 ----..A.....T...........T...A.C..------.....-
.......C.A........---......C....... [320]

Hap_27 ----..A.....T...........T...A.C..------.....-
.......C.A........---......C....... [320]

Hap_28 ----..A.....T...........T...A.C..------.....-
.......C.A........---......C....... [320]

Hap_29 ----..A.....T...........T...A.C..------.....-
.......C.A........---......C....... [320]

Hap_30 ----..AT....T........T..T..CA.C..------.TG..-
.......C.A........---......C....... [320]

Hap_31 ----..AT....T...........T..CA.C..------.TG..-
.......C.A........---T.....C....... [320]

Hap_32 ----..AT....T...........T..CA.C..------.TG..-
.......C.A........---......C....... [320]

Hap_33 ----..AT....T...........TT.CA.C..------.TG..-
.......C.A........---......C....... [320]

Hap_34 ----..A.....T...........T...A.C..------.TG..-
.......C.A........---......C....... [320]

Hap_35 ----..A.....T...........T...A.C..------.TG..-
.......C.A........---......C....... [320]

Hap_36 ----..A.....T...........T...A.C..------.TG..-
.......C.A........---......C....... [320]

Hap_37 ----..A.....T...........T...A.C..------.TG..-
.......C.A........---......C....... [320]


Hap_1  TCACCATC-----CCTAACCGGCATTGTTCTCGCCAACTCCTC-
ATCGATATTGTTCTTCACGACACCTACTACGTAGTC [400]

Hap_2  ........-----..............................-
..................................... [400]

Hap_3  ........-----..............................-
..................................... [400]

Hap_4  ........-----..............................-
..................................... [400]
```

```
Hap_5  ........-----.................T...........-
.................................T... [400]

Hap_6  ........-----.................................-
..................................... [400]

Hap_7  ........-----.................................-
..................................... [400]

Hap_8  ........-----.................................-
..................................... [400]

Hap_9  ........-----.................................-
..................................... [400]

Hap_10 ........-----G................................-
..................................... [400]

Hap_11 ........-----.................................-
..................................... [400]

Hap_12 ........-----.................................-
..................................... [400]

Hap_13 ........-----.................................-
..................................... [400]

Hap_14 ........-----.................................-
..................................... [400]

Hap_15 ........-----.................................-
..................................... [400]

Hap_16 .T......-----.................T...........-
.....................T.............T [400]

Hap_17 .T......-----.................T...........-
.....................T.............T [400]

Hap_18 .T......-----.................T...........-
.....................T.............T [400]

Hap_19 .T......-----.................T...........-
..T.................T.............T [400]

Hap_20 .T......-----.................T...........-
.....................T..A..........T [400]

Hap_21 .T......-----.................T...........-
.....................T.............T [400]

Hap_22 .T......-----.................T...........-
.....................T.............T [400]

Hap_23 .T......-----.................T...........-
.................T..T.............T [400]

Hap_24 .T......-----.................T...........-
.....................T.............A [400]

Hap_25 .T......-----.................T...........-
.....................T.............A [400]

Hap_26 .T......-----.................T...........-
.....................T.............A [400]
```

```
Hap_27 .T.....-----.................T...........-
.................T.............G..T [400]

Hap_28 .T.....-----.................T...........-
..........G......T.............G..T [400]

Hap_29 .T.....-----.................T...........-
.................T.............G..T [400]

Hap_30 .T.....-----.................T...........-
...................T.............T [400]

Hap_31 .T.....-----.................T...........-
...................T.............T [400]

Hap_32 .T.....-----.................T...........-
...................T.............T [400]

Hap_33 .T.....-----.................T...........-
...................T.............T [400]

Hap_34 .T.....-----.................T...........-
.................T.............G..T [400]

Hap_35 .T.....-----.................T...........-
.................T.............G..T [400]

Hap_36 .T.....-----.................T...........-
.................T.............G..T [400]

Hap_37 .T.....-----.................T...........-
.................T...............T [400]


Hap_1  GCCCATTTCCACTATGTATTATCAATAG---
CCGTTTTTGCTATCATAGCCGGATTTGTTCACTGATTCCC--------- [480]

Hap_2  ............................---
....C.................................--------- [480]

Hap_3  ................A.TA.T....---
....C.................................--------- [480]

Hap_4  ............................---
....C.................................--------- [480]

Hap_5  ............................---
.A..C.................................--------- [480]

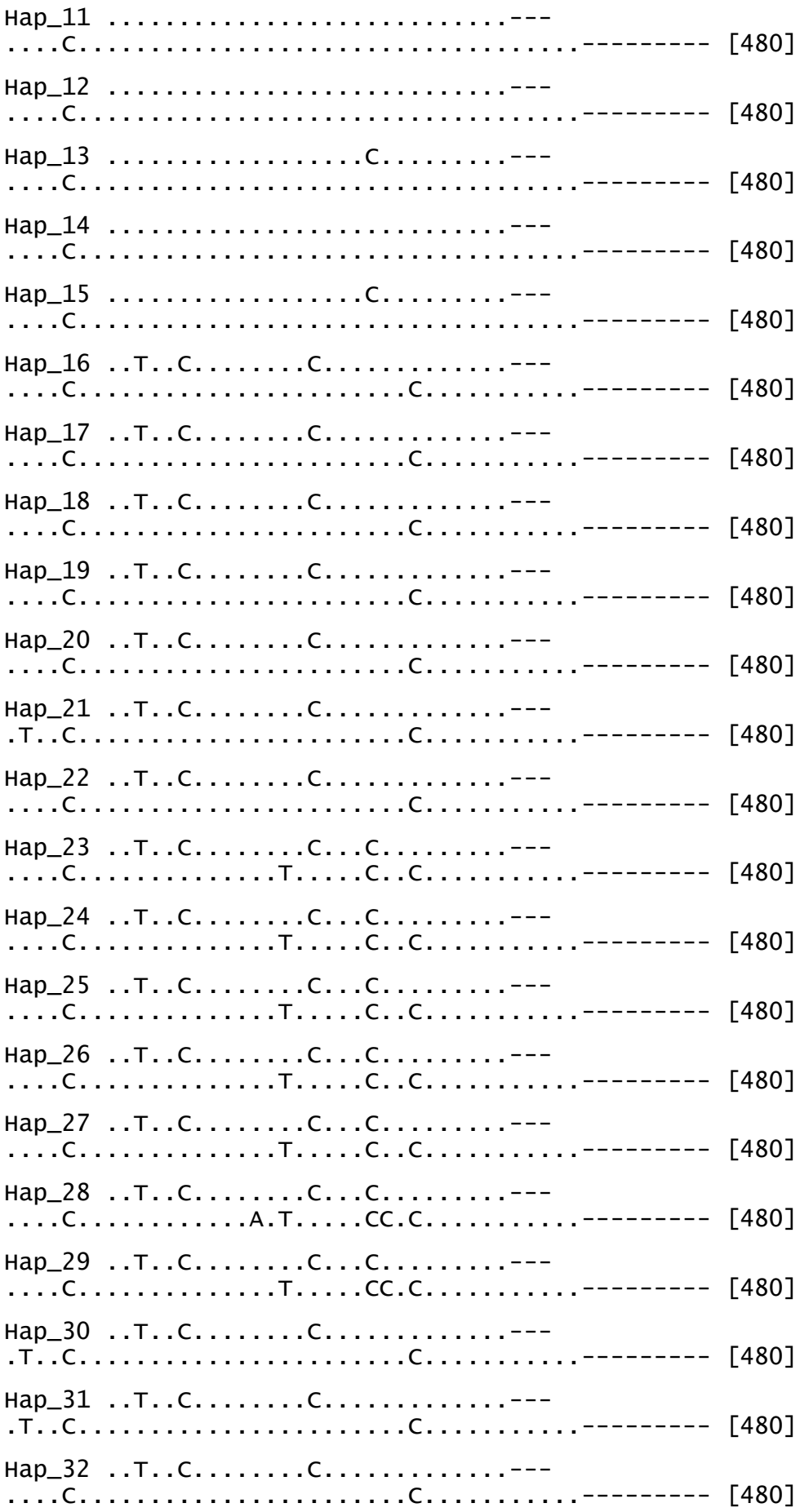
Hap_6  ............................---
.A..C.................................--------- [480]

Hap_7  ..............T..........---
....C...........A.....................--------- [480]

Hap_8  ............................---
....C.................................--------- [480]

Hap_9  ............................---
....C.................................--------- [480]

Hap_10 ............................---
....C.................................--------- [480]
```


Hap_11 ---
---------- [480]
Hap_12 ---
---------- [480]
Hap_13 ---
---------- [480]
Hap_14 ---
---------- [480]
Hap_15 ---
---------- [480]
Hap_16 ---
---------- [480]
Hap_17 ---
---------- [480]
Hap_18 ---
---------- [480]
Hap_19 ---
---------- [480]
Hap_20 ---
---------- [480]
Hap_21 ---
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Hap_24 ---
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Hap_25 ---
---------- [480]
Hap_26 ---
---------- [480]
Hap_27 ---
---------- [480]
Hap_28 ---
---------- [480]
Hap_29 ---
---------- [480]
Hap_30 ---
---------- [480]
Hap_31 ---
---------- [480]
Hap_32 ---
---------- [480]

```
Hap_33 ..T..C........C.............---
....C.......................C..........--------- [480]

Hap_34 ..T..C........C...C.........---
....C..............T.....C..C..........--------- [480]

Hap_35 ..T..C........C...C.........---
....C..............T.....C..C..........--------- [480]

Hap_36 ..T..C........C...C.........---
....C..............T.....C..C..........--------- [480]

Hap_37 ..T..C........C...C.........---
....C..............T.....C..C..........--------- [480]


Hap_1  ---- [484]

Hap_2  ---- [484]

Hap_3  ---- [484]

Hap_4  ---- [484]

Hap_5  ---- [484]

Hap_6  ---- [484]

Hap_7  ---- [484]

Hap_8  ---- [484]

Hap_9  ---- [484]

Hap_10 ---- [484]

Hap_11 ---- [484]

Hap_12 ---- [484]

Hap_13 ---- [484]

Hap_14 ---- [484]

Hap_15 ---- [484]

Hap_16 ---- [484]

Hap_17 ---- [484]

Hap_18 ---- [484]

Hap_19 ---- [484]

Hap_20 ---- [484]

Hap_21 ---- [484]

Hap_22 ---- [484]

Hap_23 ---- [484]

Hap_24 ---- [484]

Hap_25 ---- [484]

Hap_26 ---- [484]
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Hap_27 ---- [484]
Hap_28 ---- [484]
Hap_29 ---- [484]
Hap_30 ---- [484]
Hap_31 ---- [484]
Hap_32 ---- [484]
Hap_33 ---- [484]
Hap_34 ---- [484]
Hap_35 ---- [484]
Hap_36 ---- [484]
Hap_37 ---- [484]
;
end;
```

Table Characteristics of a microhabitat checklist (Inger's Habitat Code in Heyer et al. 1994; Zainudin et al 2017; Zulkeifli & Zainudin 2022)

Characteristics	Code	Acronym	Notes
Habitat:	1	VA	Primary rain forest, hilly
Vegetation type	2	VB	Primary rain forest, flat
	3	VC	Decidous dipterocarp
	4	VW	Peat swamp
	5	VK	Kerangas
	6	VRF	Riverine Forest
	7	VAgr	Agriculture
	8	VS	Marsh
	9	VE	Edge MDF
	10	VF	Large clearing (camp etc)
	11	VG	Secondary growth, immature or regenerating forest
	12	VH	Gallery forest
	13	VJ	Selectively logged forest
	14	VR	Rubber or oil palm planting
	15	VT	Oak/chestnut montane forest

Microhabitat: Horizontal position	16	HPA	Permanent stream: in stream, i.e., actually in water
	17	HPB	Permanent stream: midstream on bar, rock or snag
	18	HPC	Permanent stream: on bank (distance to water),
	19	HPD	Intermitten stream: in stream, actually in water
	20	HPE	Intermitten stream, midstream on bar, rock or snag
	21	HPF	Intermitten stream, on bank (distance to water),
	22	HPG	Distant from any body of water, distance (m) to nearest stream
	23	HPH	In dried bed of intermitten stream
	24	HPJ	Temporary pond, in water
	25	HPK	Temporary pond, on bank, distance (m) from water
	26	HPL	Temporary pond, on vegetation
	27	HPM	Permanent stream, on exposed bed, distance from water
	28	HPN	Permanent pond
	29	HPP	Permanent swamp
	30	HPQ	On or in building
	31	HPR	Permanent pond, on bank, distance (m) to water
	32	HPS	Permanent swamp, in water
	33	HPT	Permanent stream, on vegetation
	34	HPU	Permanent drainage, in plantation, on bank
	35	HPV	Permanent drainage, in plantation, in water

Characteristics	Code	Acronym	Notes

Microhabitat	36	VPA	Under surface of soil: depth (cm)
Vertical position	37	VPB	In or under dead leaves
	38	VPC	Under rock, maximum dimension (cm) of rock
	39	VPD	Under log (diameter (cm) of log)
	40	VPE	In log (diameter (cm) of log)
	41	VPF	On surface of bare soil
	42	VPG	On surface of leaf litter or dead leaves
	43	VPH	On rock (maximum dimension (cm) of rock)
	44	VPJ	On log (diameter (cm)of log)
	45	VPK	On seedling or herbaceous plant (< 1 m tall)
	46	VPL	On shrub or young sapling (plant,1-7 m): height (m) above ground
	47	VPM	On tree or large vine (plant >7m) height (m) above ground or water, at breast height (DBH) for woody plant
	48	VPN	On dead stump height (m) above ground
	49	VPO	In crown of fallen dead shrub or tree height (m) above ground
	50	VPQ	On grass blade height (m) above ground
	51	VPP	In grass
Microhabitat:	52	SA	Leaf of plant maximum dimensions (cm) of leaf
Substrate	53	SB	Stem or branch of herbaceous plant
	54	SC	Twig or branch of woody plant, diameter (cm) of perch
	55	SD	Trunk of shrub or tree
	56	SE	In epiphyte
	57	SF	Under bark of log, stump or tree
	58	SG	Bank mud
	59	SH	Bank sand or gravel
	60	SJ	Bank rock

The notion is that for every frogs encountered a single notation for each element will describe that microhabitat (Inger in Heyer et al. 1994).

The six elements that were recorded for each observation are as follows:

1. Date and time of observation (24 hr clock)
2. General location, vegetation type, and elevation
3. Horizontal position, with reference to bodies of water, shade casting vegetation and shore. Each position needs to be qualified in detail (Table 3.1)
4. Vertical position.
   In relation to terrestrial environment, vertical position refers to subsurface, at soil surface exposed, or in water. In deep rivers, vertical position is defined as depth.
5. Substrate
   Substrate usually refers as mineral soil, dead leaves, log, rock or vegetation. Each substrate often requires finer subdivision (Table 3.1).