

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

Supporting Information

Figure S1. H3 Bayes factor (BF) test for significant non-zero rates. A cutoff of BF = 3 was used. The darker the color indicates the higher BF (pink to red). The most significant route is Alaska → Oregon (Pacific flyway) with BF = 45.05.

Figure S2. H4 BF. The most significant route is Alberta → New Mexico (Central flyway) with BF = 21.14.

Figure S3. H6 BF. The most significant route is AB → OH (cross-flyways) with BF=1,654.

Figure S4. H8 BF. The most significant route is AK → CA (Pacific flyway) with BF = 29.04.

Figure S5. H11 BF. The most significant route is NJ → DE (Atlantic flyway) with BF=32,412.

Table S1. Log (ln) marginal likelihoods by HA type for strict and relaxed clock models.

Subtype	Strict Clock	Relaxed Clock
H3	-21,321.39	-18,737.71
H4	-9,541.91	-8,974.77
H6	-25,030.61	-24,195.84
H8	-8,300.93	-7,813.40
H11	-15,564.60	-14,947.28

Table S2. Bayes factor results for each subtype.

Subtype	Origin	Destination	Flyway	Bayes factor
H3	AK	OR	Pacific	45.06
	OH	MI	Mississippi	40.61
	TX	LA	Inter-flyways	37.49

1				
2				
3				
4	MN	SD	Inter-flyways	27.86
5				
6	CA	OR	Pacific	27.44
7				
8	SD	AK	Inter-flyways	22.61
9				
10	DE	AB	Inter-flyways	15.84
11				
12	LA	TX	Inter-flyways	14.45
13				
14	MS	DE	Inter-flyways	13.78
15				
16	NB	NS	Atlantic	13.04
17				
18	SD	ND	Central	12.7
19				
20	AB	SD	Central	11.51
21				
22	ND	TX	Central	10.54
23				
24	NM	ND	Central	10.43
25				
26	WI	IA	Mississippi	9.6
27				
28	WA	AB	Inter-flyways	8.67
29				
30	LA	MN	Mississippi	8.63
31				
32	SD	MN	Inter-flyways	8.53
33				
34	BC	CA	Pacific	8.5
35				
36	BC	AB	Inter-flyways	8.36
37				
38	IA	WI	Mississippi	7.45
39				
40	BC	WA	Pacific	7.38
41				
42	NS	NB	Atlantic	7.35
43				
44	MD	WA	Inter-flyways	7.07
45				
46	IL	MS	Mississippi	7.01
47				
48	WA	CA	Pacific	6.91
49				
50	WI	IL	Mississippi	6.88
51				
52	ND	NB	Inter-flyways	6.78
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				

1				
2				
3				
4	CA	SD	Inter-flyways	6.75
5				
6	AB	BC	Inter-flyways	6.61
7				
8				
9	MN	ND	Central	6.36
10				
11	OR	LA	Inter-flyways	5.94
12				
13	AB	CA	Inter-flyways	5.91
14				
15	NB	OH	Inter-flyways	5.66
16				
17	AB	OR	Inter-flyways	5.65
18				
19				
20	OR	ND	Inter-flyways	5.21
21				
22	OR	CA	Pacific	5.18
23				
24	WA	OR	Pacific	5.16
25				
26	NS	OH	Inter-flyways	4.72
27				
28				
29	SD	TX	Central	4.66
30				
31	NS	WI	Inter-flyways	4.6
32				
33	OR	BC	Pacific	4.6
34				
35	NB	MN	Inter-flyways	4.56
36				
37	WI	MO	Mississippi	4.41
38				
39				
40	NS	IA	Inter-flyways	4.26
41				
42	NB	SK	Inter-flyways	4.25
43				
44	NB	MD	Atlantic	4.18
45				
46				
47	WA	BC	Pacific	4.1
48				
49	BC	AK	Pacific	3.98
50				
51	AZ	MS	Inter-flyways	3.98
52				
53	OR	AZ	Pacific	3.92
54				
55				
56	IA	MS	Mississippi	3.79
57				
58	TX	MN	Inter-flyways	3.78
59				
60				
61				
62				
63				
64				
65				

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

ND	AB	Central	3.64
MO	MS	Mississippi	3.62
MO	IL	Mississippi	3.49
MN	MD	Inter-flyways	3.41
IL	IA	Mississippi	3.36
MI	OH	Mississippi	3.29
NS	SK	Inter-flyways	3.25
LA	MO	Mississippi	3.24
IA	NS	Inter-flyways	3.24
IL	WI	Mississippi	3.22
NS	MD	Atlantic	3.2

H4

AB	NM	Central	21.14
NM	TX	Central	19.63
TX	MN	Inter-flyways	18.62
WA	AK	Pacific	18.07
AK	WA	Pacific	14.5
CA	OR	Pacific	12.45
IL	IA	Mississippi	11.95
LA	IL	Mississippi	11.77
NB	OH	Inter-flyways	11.51
OR	CA	Pacific	10.82
IL	NS	Inter-flyways	10.07
WA	AB	Inter-flyways	9.77
TX	MB	Central	9.37

1				
2				
3				
4	IA	MO	Mississippi	8.13
5				
6	IA	NS	Inter-flyways	7.52
7				
8				
9	NS	MO	Inter-flyways	7.31
10				
11	NS	IA	Inter-flyways	7.12
12				
13	WI	OH	Mississippi	7.08
14				
15	OH	WI	Mississippi	6.95
16				
17	WI	MN	Mississippi	5.72
18				
19				
20	AB	TX	Central	5.65
21				
22	ND	NB	Inter-flyways	5.47
23				
24	TX	NM	Central	5.36
25				
26	LA	WI	Mississippi	5.22
27				
28				
29	MO	IA	Mississippi	5.19
30				
31	MB	MN	Inter-flyways	4.98
32				
33	ND	CA	Inter-flyways	4.88
34				
35				
36	NB	WI	Inter-flyways	4.71
37				
38	MB	SD	Central	4.49
39				
40	MN	WI	Mississippi	4.24
41				
42	MN	LA	Mississippi	3.99
43				
44				
45	IL	MO	Mississippi	3.94
46				
47	ND	LA	Inter-flyways	3.93
48				
49	MO	OH	Mississippi	3.83
50				
51	MN	SD	Inter-flyways	3.72
52				
53	MN	NM	Inter-flyways	3.64
54				
55				
56	AK	MO	Inter-flyways	3.63
57				
58	NM	MB	Central	3.56
59				
60				
61				
62				
63				
64				
65				

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

H6

NM	ND	Central	3.45
TX	SD	Central	3.32
WI	NB	Inter-flyways	3.27
OH	AB	Inter-flyways	3.24
MN	MB	Inter-flyways	3.19
OR	ND	Inter-flyways	3.18
MB	ND	Central	3.14
MB	TX	Central	3.06
ND	IL	Inter-flyways	3.01
AB	OH	Inter-flyways	1,653.79
DE	NJ	Atlantic	671.75
ON	OH	Mississippi	84.62
MD	ON	Inter-flyways	72.28
CA	NM	Inter-flyways	65.55
NJ	DE	Atlantic	52.83
IL	WI	Mississippi	32.17
ND	AB	Central	28.38
OH	MN	Mississippi	27.16
NM	WA	Inter-flyways	19.60
NJ	NY	Atlantic	16.52
MN	ND	Inter-flyways	16.20
MS	MO	Mississippi	16.05
WI	TX	Inter-flyways	15.72
NM	MN	Inter-flyways	13.81

1				
2				
3				
4	NY	GA	Atlantic	12.81
5				
6	MN	LA	Mississippi	11.88
7				
8	MO	MS	Mississippi	11.60
9				
10	MN	WI	Mississippi	10.65
11				
12	NS	MS	Inter-flyways	10.62
13				
14	WI	IL	Mississippi	10.30
15				
16	NS	MD	Atlantic	10.10
17				
18	MO	NS	Inter-flyways	9.53
19				
20	AK	CA	Pacific	9.01
21				
22	NM	IL	Inter-flyways	8.26
23				
24	ND	WI	Inter-flyways	8.21
25				
26	LA	WI	Mississippi	7.86
27				
28	NJ	GA	Atlantic	7.55
29				
30	ND	TX	Central	7.37
31				
32	WA	SD	Inter-flyways	7.33
33				
34	ND	CA	Inter-flyways	7.07
35				
36	GA	NY	Atlantic	6.80
37				
38	NY	PA	Atlantic	6.33
39				
40	MS	NS	Inter-flyways	6.23
41				
42	WA	CA	Pacific	6.04
43				
44	CA	WA	Pacific	5.89
45				
46	MO	MD	Inter-flyways	5.74
47				
48	PA	GA	Atlantic	5.52
49				
50	PA	AB	Inter-flyways	5.48
51				
52	ND	LA	Inter-flyways	5.36
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				

1				
2				
3				
4	GA	PA	Atlantic	5.07
5				
6	WI	NJ	Inter-flyways	5.04
7				
8				
9	TX	NJ	Inter-flyways	4.86
10				
11	NM	SD	Central	4.86
12				
13	TX	MO	Inter-flyways	4.79
14				
15	TX	CA	Inter-flyways	4.77
16				
17	TX	AB	Central	4.74
18				
19				
20	WA	IL	Inter-flyways	4.59
21				
22	LA	TX	Inter-flyways	4.49
23				
24	OH	ON	Mississippi	4.48
25				
26	CA	MN	Inter-flyways	4.13
27				
28				
29	TX	MS	Inter-flyways	4.00
30				
31	SD	MN	Inter-flyways	3.97
32				
33	MS	MD	Inter-flyways	3.96
34				
35				
36	NM	ND	Central	3.90
37				
38	ON	MN	Mississippi	3.89
39				
40	GA	AB	Inter-flyways	3.78
41				
42	WA	AK	Pacific	3.64
43				
44	MD	OH	Inter-flyways	3.54
45				
46				
47	CA	SD	Inter-flyways	3.54
48				
49	IL	NS	Inter-flyways	3.46
50				
51	SD	NM	Central	3.44
52				
53	WI	SD	Inter-flyways	3.43
54				
55				
56	SD	WA	Inter-flyways	3.34
57				
58	OH	LA	Mississippi	3.33
59				
60				
61				
62				
63				
64				
65				

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

H8

SD	IL	Inter-flyways	3.25
AK	PA	Inter-flyways	3.22
LA	MN	Mississippi	3.14
LA	CA	Inter-flyways	3.09
AK	CA	Pacific	29.04
AB	AK	Inter-flyways	6.65
CA	AZ	Pacific	5.72
LA	AB	Inter-flyways	5.49
MN	IL	Mississippi	5.02
AB	LA	Inter-flyways	3.32
CA	MN	Inter-flyways	3.27

H11

NJ	DE	Atlantic	32,411.72
CA	AK	Pacific	412.94
DE	NJ	Atlantic	151.64
TN	AB	Inter-flyways	104.48
MO	CA	Inter-flyways	32.21
MD	NC	Atlantic	25.21
AB	NY	Inter-flyways	15.99
QC	NB	Atlantic	15.70
WA	MO	Inter-flyways	14.50
AK	MN	Inter-flyways	12.33
OH	QC	Inter-flyways	11.92
MD	OH	Inter-flyways	11.90

1				
2				
3				
4	AB	MN	Inter-flyways	11.67
5				
6	MN	NJ	Inter-flyways	11.31
7				
8	NY	MN	Inter-flyways	10.59
9				
10	AB	OH	Inter-flyways	7.79
11				
12	MO	AZ	Inter-flyways	7.38
13				
14	NY	OH	Inter-flyways	6.62
15				
16	NB	LA	Inter-flyways	6.29
17				
18	NC	QC	Atlantic	6.16
19				
20	AZ	MO	Inter-flyways	5.77
21				
22	AZ	NM	Inter-flyways	5.42
23				
24	MN	WA	Inter-flyways	5.36
25				
26	WA	AZ	Pacific	5.02
27				
28	LA	TN	Mississippi	4.78
29				
30	NC	OH	Inter-flyways	4.78
31				
32	MO	NL	Inter-flyways	4.65
33				
34	MO	WA	Inter-flyways	4.57
35				
36	NL	NM	Inter-flyways	4.49
37				
38	AZ	NL	Inter-flyways	4.48
39				
40	MD	QC	Atlantic	4.37
41				
42	OH	LA	Mississippi	4.32
43				
44	NM	NL	Inter-flyways	4.26
45				
46	WA	CA	Pacific	4.13
47				
48	MN	MD	Inter-flyways	3.99
49				
50	QC	OH	Inter-flyways	3.76
51				
52	MN	NY	Inter-flyways	3.67
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65

NY	WA	Inter-flyways	3.66
NY	NJ	Atlantic	3.65
AB	WA	Inter-flyways	3.52
OH	MD	Inter-flyways	3.50
AK	NM	Inter-flyways	3.23
LA	MD	Inter-flyways	3.21