

Appendix 2 – Details of parameter values and distributions used in stochastic model of anthropogenic avian mortality in Canada.

Table A2.1 – Distributions used to describe species-group composition, age-group breakdown and seasonal distribution of anthropogenic avian mortality for each source, used in the stochastic model to convert stage-specific losses to a total loss of potential adult breeders. When all characteristics were known, no distributions were necessary (e.g. agricultural mortality was entirely measured in loss of eggs of landbirds, and therefore there was no uncertainty in species-, age- or seasonal-breakdown).

Parameter	Distribution	Central tendency		Variation or range of values		Source ⁺
		Type	Value	Type*	Values	
Cats						
Proportion landbirds	Uniform	Midpoint	0.99	Range	0.02	1
Proportion waterbirds	Uniform	Midpoint	0.005	Conditional range	0.00-0.02	1
Proportion waterfowl	Uniform	Midpoint	0.005	Conditional range	0.00-0.02	1
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random		1
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Buildings – Houses						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.42	Random		3
Buildings – Low- and mid-rise						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.565	Range, random	0.42-0.71	4
Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	4
Proportion waterbirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Proportion waterfowl	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Proportion shorebirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	4
Buildings – Tall						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.71	Random		3
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.1	3,5
Proportion waterbirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5
Proportion waterfowl	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5
Proportion shorebirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	3,5

Transportation - Road vehicle collisions

Kill: landbirds	Log-normal	Point est.	8743000	Standard deviation /mean	0.5	6
Kill: shorebirds	Log-normal	Point est.	197100	Standard deviation /mean	0.5	6
Kill: waterbirds	Log-normal	Point est.	187200	Standard deviation /mean	0.5	6
Kill: waterfowl	Log-normal	Point est.	218500	Standard deviation /mean	0.5	6
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.33	Range, random	0.167-0.5	7
Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7
Proportion waterfowl	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.033	Conditional range	0.0-0.2	7

Power – Electrocutation

Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random		8
Proportion landbirds	Multinomial	Mean	0.974	Random		8
Proportion waterbirds	Multinomial	Mean	0.008	Random		8
Proportion waterfowl	Multinomial	Mean	0.01	Random		8
Proportion shorebirds	Multinomial	Mean	0.008	Random		8

Power - Transmission line collisions

Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random		9
Proportion landbirds	Multinomial	Mean	0.045	Random		9
Proportion waterbirds	Multinomial	Mean	0.384	Random		9
Proportion waterfowl	Multinomial	Mean	0.408	Random		9
Proportion shorebirds	Multinomial	Mean	0.163	Random		9

Power - Line maintenance

Proportion landbirds	Multinomial	Mean	0.7007	Random		10
Proportion waterfowl	Multinomial	Mean	0.0806	Random		10
Proportion shorebirds	Multinomial	Mean	0.2187	Random		10

Power – Hydro reservoirs

Kill: non-waterfowl	Log-normal	Point est.	151707	Standard deviation /mean	0.5	6
Kill: waterfowl	Log-normal	Point est.	461	Standard deviation /mean	0.5	6

Proportion landbirds	Uniform	Midpoint	0.9	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.5	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.5	Conditional range	0.0-0.2	7
Oil and Gas - Marine - produced water						
Proportion juveniles in fall	Binomial	Mean	0.173	Random		11
Proportion subadults	Binomial	Mean	0.242	Random		11
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random		11,12
Oil and Gas – Marine - platform and vessel strandings						
Proportion juveniles impacted	Fixed	Value	1	None	0	13
Proportion of kill in fall/winter (i.e. including juveniles)	Fixed	Value	1	None	0	13
Fisheries - Marine bycatch						
Proportion adults - gill nets	Fixed	Value	1	None	0	13
Proportion of kill during breeding - gill nets	Fixed	Value	1	None	0	13
Proportion adults - long lines, otter trawls	Fixed	Value	1	None	0	13
Proportion of kill during breeding - long lines, otter trawls	Uniform	Midpoint	0.5	Range	0-1	7
Power - Wind energy						
Proportion juveniles in fall	Binomial	Mean	0.75	Random		2
Proportion of kill in fall/winter (i.e. including juveniles)	Uniform, binomial	Mean	0.33	Range, random	0.167-0.5	7
Agriculture - Pesticides						
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.1	7
Proportion waterbirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion waterfowl	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion shorebirds	Uniform	Midpoint	0.0167	Conditional range	0.0-0.1	7
Proportion of kill during breeding	Fixed	Value	1	None	0	14
Mining - Pits and quarries						
Proportion landbirds	Uniform	Midpoint	0.95	Range	0.2	7
Proportion waterbirds	Uniform	Midpoint	0.025	Conditional range	0.0-0.2	7
Proportion shorebirds	Uniform	Midpoint	0.025	Conditional range	0.0-0.2	7
Kill	Log-normal	Point est.	125529	Standard deviation /mean	1	6
Mining – Metals and minerals						
All landbird eggs						

Agriculture – Haying

All landbird eggs

Transportation - Road maintenance

Proportion landbirds	Multinomial	Mean	0.7007	Random	15
Proportion waterfowl	Multinomial	Mean	0.0806	Random	15
Proportion shorebirds	Multinomial	Mean	0.2187	Random	15

Harvest – Migratory birds

Proportion juveniles: ducks	Beta	Mean	0.735	Standard deviation	0.104	16
Proportion juveniles: geese	Beta	Mean	0.30	Standard deviation	0.194	16
Proportion juveniles: snipe and woodcock	Beta	Mean	0.515	Standard deviation	0.099	16
Proportion juveniles: cranes, rails and coots	Beta	Mean	0.515	Standard deviation	0.099	17
Proportion juveniles: pigeons and doves	Beta	Mean	0.515	Standard deviation	0.099	17
Proportion juveniles: murre	Beta	Mean	0.5	Standard deviation	0.1	18
Proportion subadults: murre	Beta	Mean	0.3	Standard deviation	0.1	19

Communication – Tower collisions

Proportion juveniles in fall	Binomial	Mean	0.75	Random	2
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.75	Random	8
Proportion landbirds	Multinomial	Mean	0.974	Random	8
Proportion waterbirds	Multinomial	Mean	0.008	Random	8
Proportion waterfowl	Multinomial	Mean	0.01	Random	8
Proportion shorebirds	Multinomial	Mean	0.008	Random	8

Transportation - Chronic ship-source oil

Proportion juveniles in fall	Binomial	Mean	0.173	Random	11
Proportion subadults	Binomial	Mean	0.242	Random	11
Proportion of kill in fall/winter (i.e. including juveniles)	Binomial	Mean	0.5	Random	11,12

*Conditional ranges were values that were constrained by the requirement that the proportion of the kill assigned across species groups must sum to 1.

+ References for distributions: 1 – Blancher 2013; 2 – Canadian Migration Monitoring Network data from western Canada; 3 – Machtans et al. 2013; 4 – range between tall buildings and houses, no source; 5 – Fatal Light Awareness Program (www.flap.org; see Machtans et al. 2013); 6 – no data, wide distribution assigned; 7 – vague prior, no source; 8 – Longcore et al. 2012 (note that communication tower values were used for seasonal and species-composition of electrocutions); 9 – Rioux et al. unpublished manuscript, 10 – no data, assumed same distribution as road maintenance (Abraham et al. 2010; Appendix 1); 11 – Wiese et al. 2004; 12 – Fraser et al. 2006; 13 – Ellis et al. 2013; 14 – Mineau 2010 (Appendix 1); 15 – Abraham et al. 2010 (Appendix 1); 16 – National Harvest Survey data, 2000-2011; 17 – snipe and woodcock data from National Harvest Survey (2000-2011); 18 – Elliot 1991; 19 – Gaston and Robertson 2010 (band recovery data).

Table A2.2 – Demographic rates used in the stochastic model for anthropogenic avian mortality, to convert stage-specific losses for each of the five major species-groups to a total loss of potential adult breeders.

Vital rate	Distribution	Central tendency		Variation or range of values		Source ⁺
		Type	Values	Type	Values	
Waterfowl						
Clutch size (C)	Uniform	Midpoint	4.55	Range	1	1
Hatchability/hatch success (H)	Beta	Mean	0.91	Std. deviation	0.05	1
Nest survival/nest success (N)	Beta	Mean	0.13	Std. deviation	0.075	1
Survival to fledge (S_y)	Beta	Mean	0.39	Std. deviation	0.11	1
Nesting attempts (B)	Beta	Mean	2.77	Std. deviation	0.25	1
Juvenile overwinter survival (S_o)	Beta	Mean	0.8	Std. deviation	0.051	1
Adult overwinter survival (S_a)	Beta	Mean	0.8	Std. deviation	0.051	1
Shorebirds						
Fecundity ($C*N*H*S_y$)	Random draws	Mean of vector	0.357	Values	0.26, 0.49, 0.65, 0.05, 0.14, 0.55	2,3
Juvenile overwinter survival (S_o)	Random draws	Mean of vector	0.4095	Values	0.367, 0.452	2,3
Adult overwinter survival (S_a)	Random draws	Mean of vector	0.86	Values	0.85, 0.87	2,3
Waterbirds						
Fecundity ($C*N*H*S_y$)	Uniform	Midpoint	1.6	Range	0.5 to 2.7	4,5
Juvenile overwinter survival (S_o)	Beta	Mean	0.273	Std. deviation	0.273×0.5	5
Adult overwinter survival (S_a)	Uniform	Midpoint	0.823	Range	0.727 to 0.918	4,5
Landbirds (except upland game)						
Clutch size	Random draws	Mean / Median	4.31 / 4.00	Values	(see source 6, Appendix 1)	6,7
Nest success	Random draws	Mean / Median	0.515 / 0.463	Values	(see source 6, Appendix 1)	6,7
Survival to fledge (S_y)	Random draws	Mean / Median	0.442 / 0.395	Values	(see source 6, Appendix 1)	6,7
Juvenile overwinter survival (S_o)	Complementary beta	mean	0.32	Minimum range	0.18	8*
Adult overwinter survival (S_a)	Complementary beta	Mean	0.53	Minimum range	0.29	8
Upland game birds						
Juvenile overwinter survival (S_o)	Random draws	Mean of vector	0.441	Values	(0.366, 0.337, 0.486, 0.473, 0.518, 0.578, 0.505, 0.354, 0.565, 0.46, 0.71, 0.279, 0.014, 0.38, 0.51, 0.48, 0.48)	9-13
Adult overwinter survival (S_a)	Random draws	Mean of vector	0.441	Values	(0.366, 0.337, 0.486, 0.473, 0.518, 0.578, 0.505, 0.354, 0.565, 0.46, 0.71, 0.279, 0.014, 0.38, 0.51, 0.48, 0.48)	9-13

Seabirds

Juvenile overwinter survival (S_o)	Beta	Mean	0.52	Std. deviation	0.52×0.05	14
Adult overwinter survival (S_a)	Beta	Mean	0.91	Std. deviation	0.91×0.05	14
Age of first breeding	None	Median	5	None	0	14
Immature survival ($S_o * S_a^3$)	Uniform	Midpoint	0.1988	Range	0.086-0.316	15*

⁺References for vital rates: 1 – Hoekman et al. 2002; 2 – Gratto-Trevor 2000; 3 – Lowther et al. 2001; 4 – Tacha et al. 1992; 5 – Vennesland and Butler 2011; 6 – Hobson et al. 2013; 7 – Van Wilgenburg et al. 2013; 8 – Johnston et al. 1997; 9 – Gutierrez et al. 2003; 10 – Devers et al. 2007; 11 – Jones et al. 2008; 12 – Skrip et al. 2011; 13 – Harrison 2001; 14 – Wiese et al. 2004; 15 – Huntington et al. 1996

* Estimated using the other vital rates available, assuming a stable population ($S_o = (1 - S_a)/F$), where S_a is adult survival and F is fecundity

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