Uncovering the Connection:
Eastern Boreal Forest and the Atlantic Flyway

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2008 Report on Wetland and Waterfowl Mapping and Modelling in Quebec Boreal Forest

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Abstract

Forests of eastern North America are traditionnally known as wetland poor and waterfowl depauperate. However, wetlands and waterfowl abundance hotspots that this region undoubtly contains remain unknown and might become irreversibly altered if not previously identified and adequately managed. In this study, we present a deepwater and wetland habitats map as well as static, predictive models and maps of breeding waterfowl in Quebec forest-dominated lanscapes (517,000 km²; 5.3% of Canada). Habitat data came from the 1:20,000 provincial forestry maps whereas breeding waterfowl data came from the 1990-2005 Black Duck Joint Venture–Canadian Wildlife Service aerial survey in Quebec. For the eight most abundant waterfowl species and total waterfowl, we predicted breeding pair abundance based on negative binomial regression multi-model averaging and Akaike's information criterion. The map that we produced is the first thematic wetland map of Quebec forest-dominated landscapes, and may reveal extremely useful to land-use planners and resource managers. Potential applications of waterfowl predictive models include estimation of population exposed to threats and development of decision-support tools for wetland conservation programs. Waterfowl abundance hotspots may represent judicious areas where to concentrate investments for habitat conservation, restoration, and enhancement.

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Introduction

Forests of eastern North America are traditionnally known as wetland poor and waterfowl depauperate. However more than 20 Anatidae species need this ecosystem for breeding and despite low density, the vastness of this region translates into important waterfowl production. The vast forest landscapes of Quebec harbour the core of the breeding ranges of the American black duck (*Anas rubripes*) (Longcore et al., 2000) as well as the eastern population of the Barrow's goldeneye (*Bucephala islandica*) in North America (Robert et al., 2000), a population currently designated as special concern (COSEWIC, 2007). Some 18 other species of waterfowl also breed in Quebec forests.

In this study, we present static, predictive models of breeding waterfowl in Quebec forests. The methodology employed is adapted from a previous study on predictive distribution of Mallard *Anas platyrhynchos* pairs in five Great Lakes states of United States (Yerkes et al., 2007). The models are directly transferable into waterfowl numbers for defined areas, and were used to map predicted waterfowl density and hotspots. They could further be used to calculate waterfowl numbers included in defined areas $\geq$ 25 km². Species considered were the eight most abundant individual species, namely American black duck, Ring-necked Duck *Aythya collaris*, Common Goldeneye *Bucephala clangula*, Common Merganser *Mergus merganser*, American Green-winged Teal *Anas crecca carolinensis*, Mallard, Canada Goose *Branta canadensis*, and Hooded Merganser *Lophodytes cucullatus*, as well as total waterfowl (Anatidae family). In addition to the waterfowl models and maps, our study provides a wetland map readily usable at the scale of 1:20,000 for the entire study area (517,000 km²). This map, a premiere wetland map for Quebec's boreal forest, after having been used to build our waterfowl models, will continue to be useful to ecologists and land use planners, and will certainly help to increase waterfowl habitat protection.

Problem statement

Waterfowl in the eastern boreal is generally considered scarce because boreal forest are believed to be non optimal habitats. However, human activities potentially impacting wetlands and waterfowl are rapidly growing. Wetlands and waterfowl abundance hotspots – if any – remain unknown and might become irreversibly altered if not previously identified and adequately managed.

Methods

Study area

Our study area is the area covered by the Black Duck Joint Venture (BDJV)–Canadian Wildlife Service (CWS) aerial survey in Quebec, corresponding to the forest-dominated landscapes of Quebec (Fig. 1). This 517,000-km² area corresponds to the land managed for timber harvesting, located south of 52°N, but excluding the St. Lawrence and Lake St. Jean lowlands, Anticosti island, and the part of the Appalachians located south of 47° N. It extends northward from northern temperate deciduous forest to the boreal coniferous forest zone. The hydrographical network of this area is generally highly developed and includes numerous lakes, ponds, rivers and streams. Open water and wetlands (excluding wetlands with tree cover >25%) altogether encompass nearly 18% of the total area.

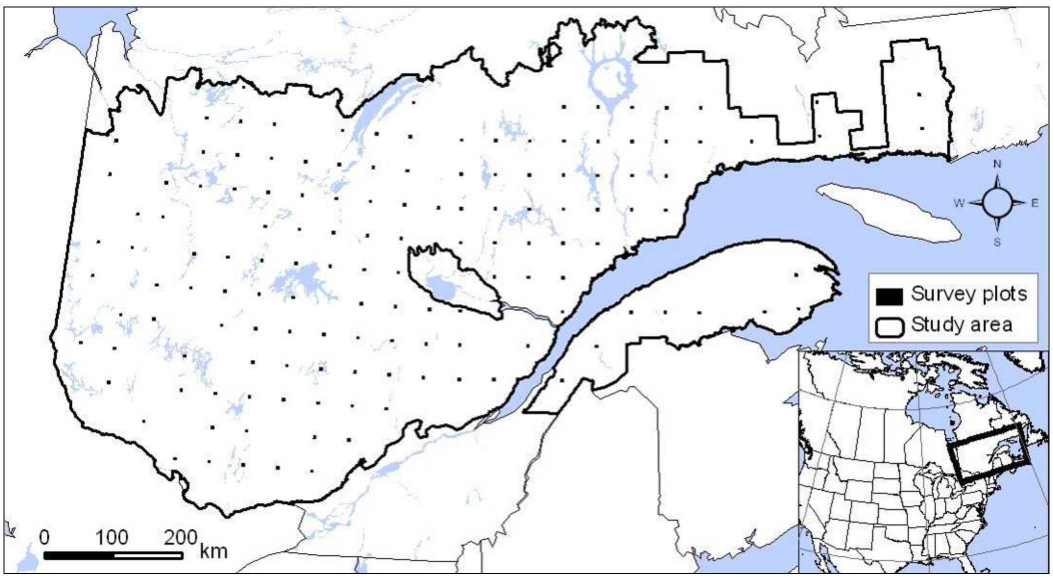


Figure 1 Study area (517,000 km²) and location of the 142 25-km² survey plots of the Black Duck Joint Venture–Canadian Wildlife Service aerial survey in Quebec used in the analysis.

Waterfowl data

Data came from the first 16 years (1990-2005) of the BDJV–CWS waterfowl aerial survey in Quebec (Fig. 1). The survey design has been modified over the years. From 1990 to 1992, 82 25-km², square plots were systematically distributed along 100-km intervals, were surveyed. The number of plots was reduced to 43 in 1993–1994, and to 35 in 1995. From 1996 to 2005, the number of plots was increased to 156; half of the plots were surveyed once annually in a rotating scheme (Bordage et al., 2003). From these 156 plots, 14 have been left out of the analyses since habitat data were not available.

Surveys were done by experienced observers in a helicopter (Bell 206L with bubble side-windows) that flew over every water body, watercourse and wetland within the plot. Depending on habitat and topography, flight altitude was 15–50 m above ground level and speed varied from 60–100 km/h. Although the survey was primarily designed to produce population trend and population size estimates of American black duck, all waterfowl species were also recorded. Surveys were timed to occur at the end of egg-laying and the beginning of the incubation period of the American black duck, an early nesting species, on average from 6–30 May. All analyses used breeding pair observations, which were determined following indicated breeding pair (IBP) criteria of the BDJV in eastern Canada (Bordage et al., 2003) (Appendix A). Indicated pairs are counts of pairs, lone drakes or small groups of single drakes, based on the premise that females may be at nest while males stay on waiting sites (Dzubin, 1969).

Over 20 waterfowl species have been observed in the survey, the eight most abundant ones being, in decreasing order of abundance, American Black Duck, Ring-necked Duck, Common Goldeneye, Common Merganser, Canada Goose, American Green-winged Teal, Hooded Merganser, and Mallard.

Deepwater and wetland data

The forest landscape in Quebec is vast and remote and no extensive wetland classification or inventory was available for this region. Therefore, wetland data were extracted from digital, 1:20,000 forestry maps that were obtained from the Quebec Ministry of Natural Resources and Wildlife (Lord and Faucher, 2003). Maps were available for the portion of Quebec primarily managed for timber harvesting. Minimum mapping area was 0.06 ha (0.15 acres) for open water bodies, 0.2 ha (0.5 acres) for watercourses, 1 ha (2.5 acres) for wetland areal features, and 0.01 ha (0.025 acres) for islands (MRNQ, 1999; Lord and Faucher, 2003). Streams, which were defined as all watercourses <0.2 ha, were mapped as linear features (Table 1).

Table 1 Aquatic and wetland features comprised in the forestry maps.

Class	Explanation	Feature geometry	Minimum mapping unit
Permanent stream	Stream <0.2 ha in size and <6 m in width with permanent flow	Line	150 m
Intermittent stream	Stream <0.2 ha in size and <6 m in width with intermittent flow		150 m
Lake	Water body	Polygon	0.06 ha
Hydropower reservoir	Waterbody with hydropower dam at outlet		0.06 ha
Isolated pond	Peatland pond		0.06 ha
River	Watercourse		0.2 ha
Small island	Island < 20 ha		0.01 ha
Open wetland	Vegetated wetlands with less than 25% tree cover, including meadow marshes, emergent marshes, riparian fens, bogs, etc.		1 ha
Shrub swamp	Mostly speckled alder (*Alnus rugosa*) stands		1 ha
Flooded swamp	Areas, either flooded or recently flushed, dominated by dead standing trees		1 ha
Rich hardwood swamp	Poorly drained, minerotrophic, forest site with hardwood stand at climax		4 ha
Rich mixed swamp	Poorly drained, minerotrophic, forest site with mixedwood stand at climax		4 ha
Rich conifer swamp	Poorly drained, minerotrophic, forest site with coniferous stand at climax		4 ha

Poor conifer swamp	Poorly drained, ombrotrophic, forest site with coniferous stand at climax and mineral soil		4 ha
Extremely poor conifer swamp	Poorly drained, ombrotrophic, forest site with coniferous stand at climax and organic soil		4 ha

Waterfowl habitat data

From the deepwater and wetland data contained in the forestry maps, a habitat classification system specifically adapted to waterfowl has been developed after the work of Lemelin (2007). Selected aquatic habitat variables were: lakes (water bodies >8 ha), ponds (water bodies ≤ 8 ha), rivers, and streams. Lake polygons were further divided into near-shore and offshore waters with a boundary set 50 m in-water from shorelines. In the absence of available bathymetric data, this zone criterion yields classes that are akin to the lacustrine littoral and limnetic subclasses of the Cowardin et al. (1979) classification used in the United States. For all these aquatic habitats, we also characterized linear shoreline types as either open wetland, shrub swamp, flooded swamp, small island or forest stand.

Additional habitat variables used in the predictive models included latitude and longitude (NAD83 geographic coordinate system and Quebec Lambert conformal conic projection) of plots centroids, mean plot elevation, and ecoregions (Fig. 2) of the ecological reference framework developed by the Quebec Ministry of Sustainable Development, Environment and Parks (MDDEPQ, 2002).

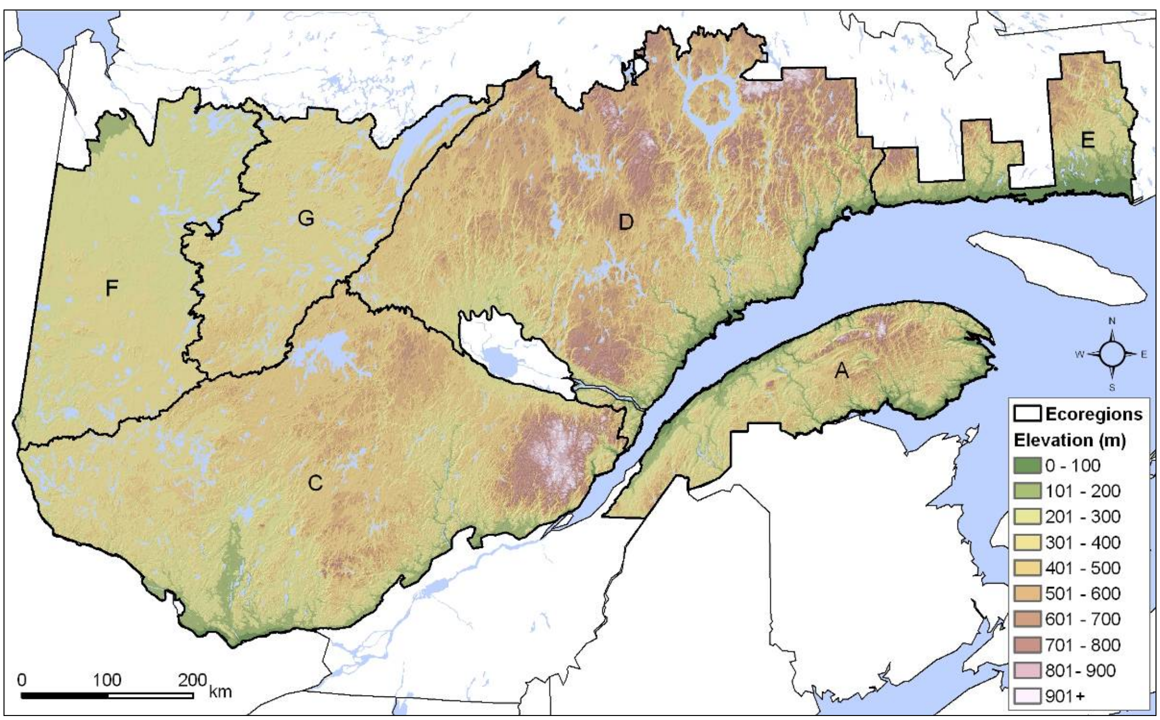


Figure 2 Elevation and ecoregions of the study area. Ecoregions are: Appalachians (A), Southern Laurentians (C), Central Laurentians (D), Lower North Shore Plateau (E), Abitibi and James Bay Lowlands (F), and Mistassini Highlands (G).

Statistical analyses

We modeled density of the eight most abundant species as well as total waterfowl based on the waterfowl survey data and waterfowl habitat data. We then used the statistical models to predict waterfowl density outside the survey plots based on multi-model inference (Burnham and Anderson, 2002).

In the models, response variables were annual mean counts within the 142 25-km² survey plots. For each species, we articulated a set of 12 candidate models, each corresponding to an *a priori* plausible hypothesis (Appendices B and C). Explanatory variables were selected among our waterfowl habitat classes. To account for broad spatial patterns likely to shape waterfowl community structure in our vast study area, we treated two identical subsets differently. We added latitude, longitude, and elevation in the first subset (models 1 to 6), and ecoregions in the second subset (models 7 to 12). Full models were included in the analyses (models 0). We tried to keep candidate models as simple as possible by excluding all levels of interaction among explanatory variables.

We fitted the linear models using negative binomial regression. The negative binomial distribution is appropriate for biological count data because it can model frequencies decreasing monotically from a modal value of zero (White and Bennetts, 1996). Unlike the Poisson distribution, it does not require the assumption that mean equals the variance, a condition violated when contagion or overdispersion occur (Faraway, 2006) which is common in ecology (Richards, 2008).

The statistical approach used to predict waterfowl abundance was the state-of-the-art information-theoretic approach based on Akaike's information criterion (AIC) (Burnham and Anderson, 2002). To predict the abundance of each species, model averaging was used as it is recommended when prediction is the goal of modelling (Burnham and Anderson, 2002). Predictions obtained by model averaging are robust in the sense that they account for model selection uncertainty (Johnson and Omland, 2004). Therefore, each model prediction was weighted according to its small-sample AIC (AIC_c) weight (i.e. its probability of being the best model among the candidates set) and summed over all models. Predictions were applied within 25-km² hexagonal cells for complete study area coverage and species densities were reported in IBP/100 km² on the maps. All statistical analyses were performed with R software (The R Foundation for Statistical Computing, 2008) and mapping with ArcGIS (ESRI, 2005).

Results

Deepwater and wetland habitat mapping

For our entire 517,000-km² study area, we mapped deepwater and wetland habitats based on the 1:20,000 forestry maps (Fig. 3). This area totals 5.3 % of the Canadian territory.

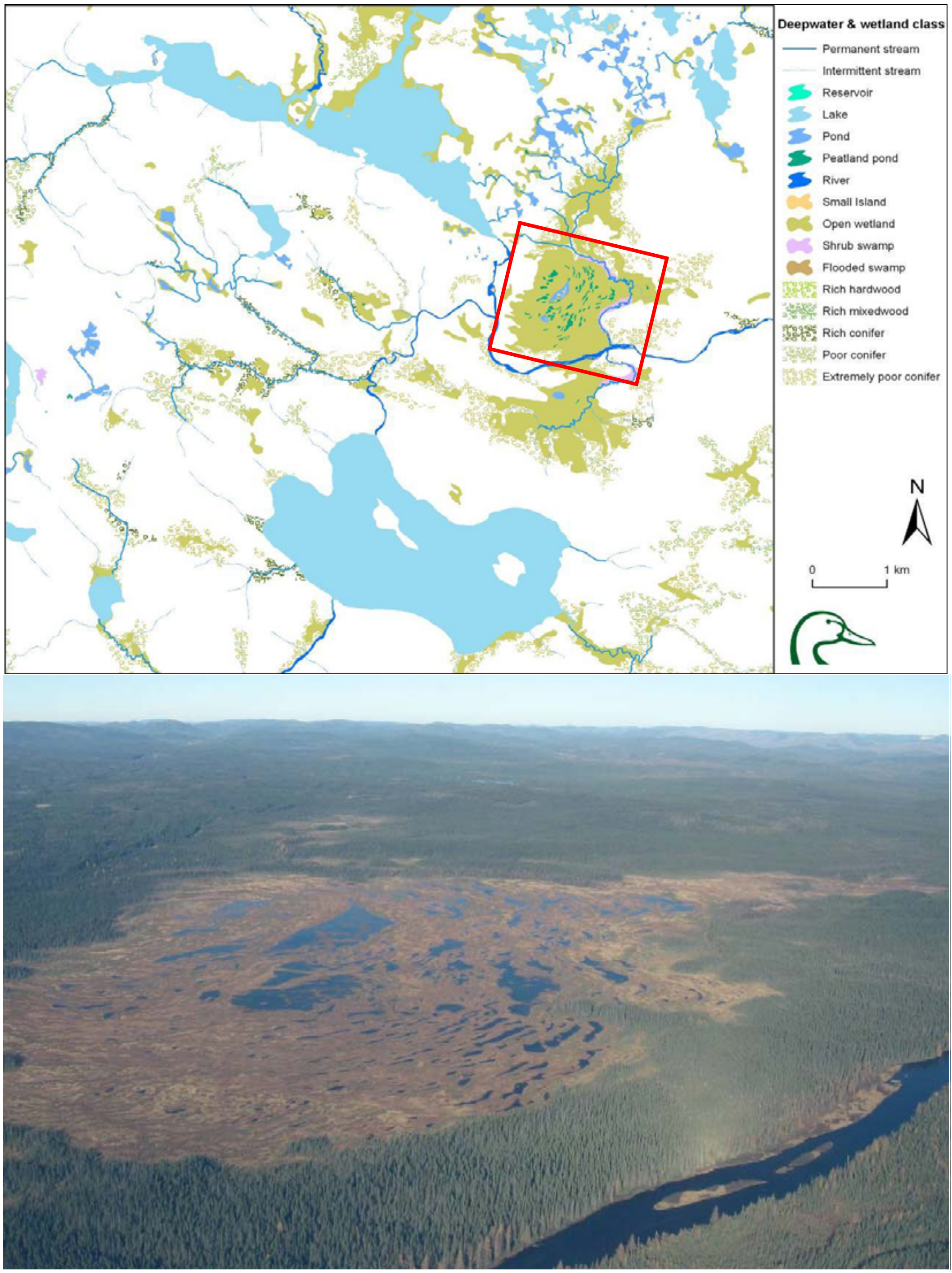
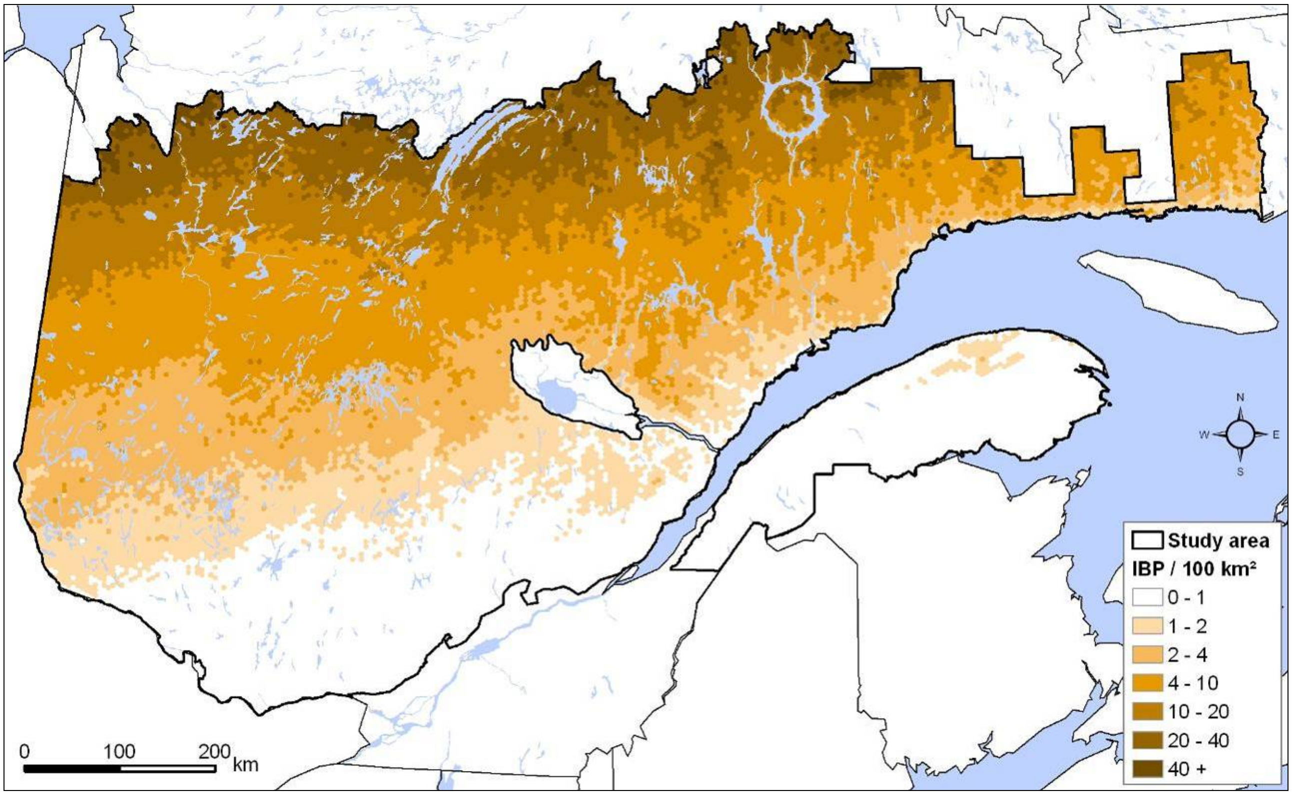


Figure 3 Example of the deepwater and wetland map (top) with an aerial photography reference (bottom).

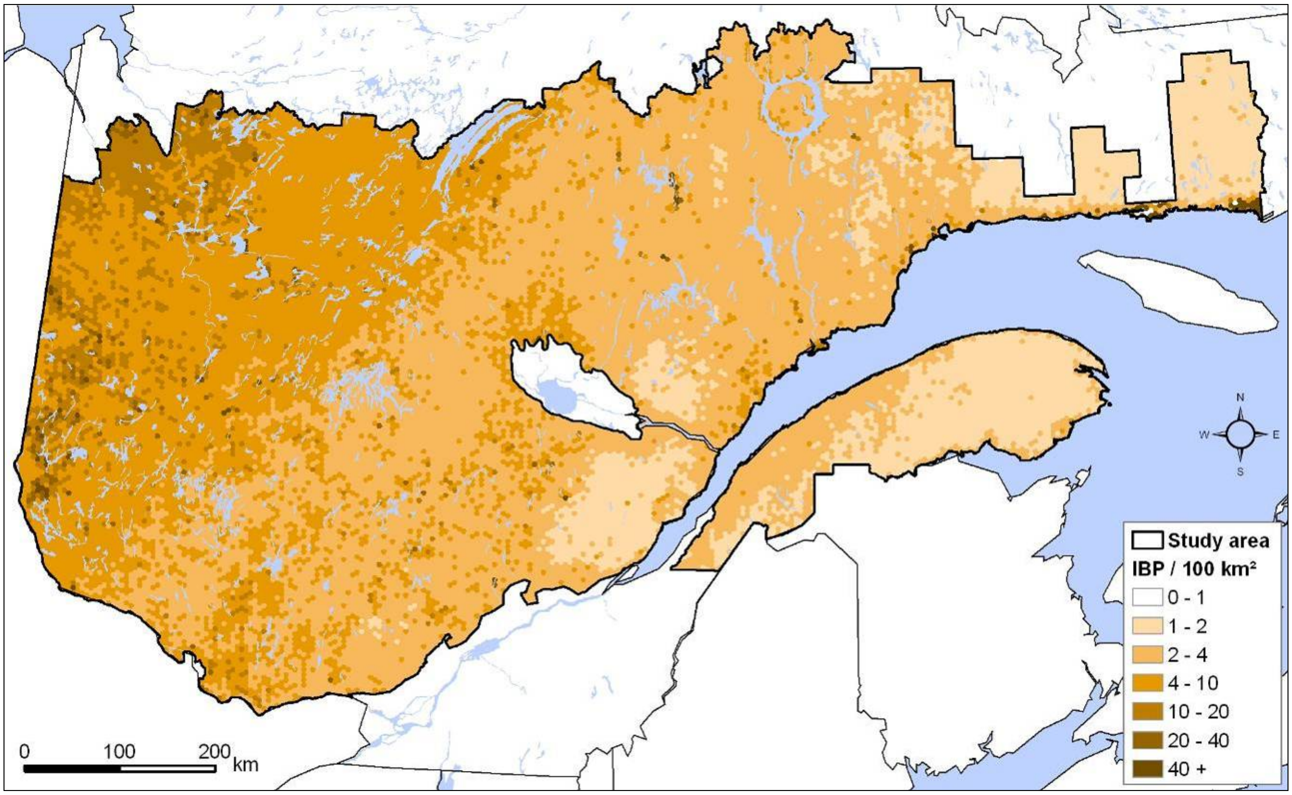
Predictive models and maps

For each species and total waterfowl, the 12 candidate models were fitted with negative binomial regression. Our statistical analysis resulted in models with generally high predictive power, as shown by scatter plots of observed vs. fitted IBP densities of the best AICc model for each species (Appendix D).

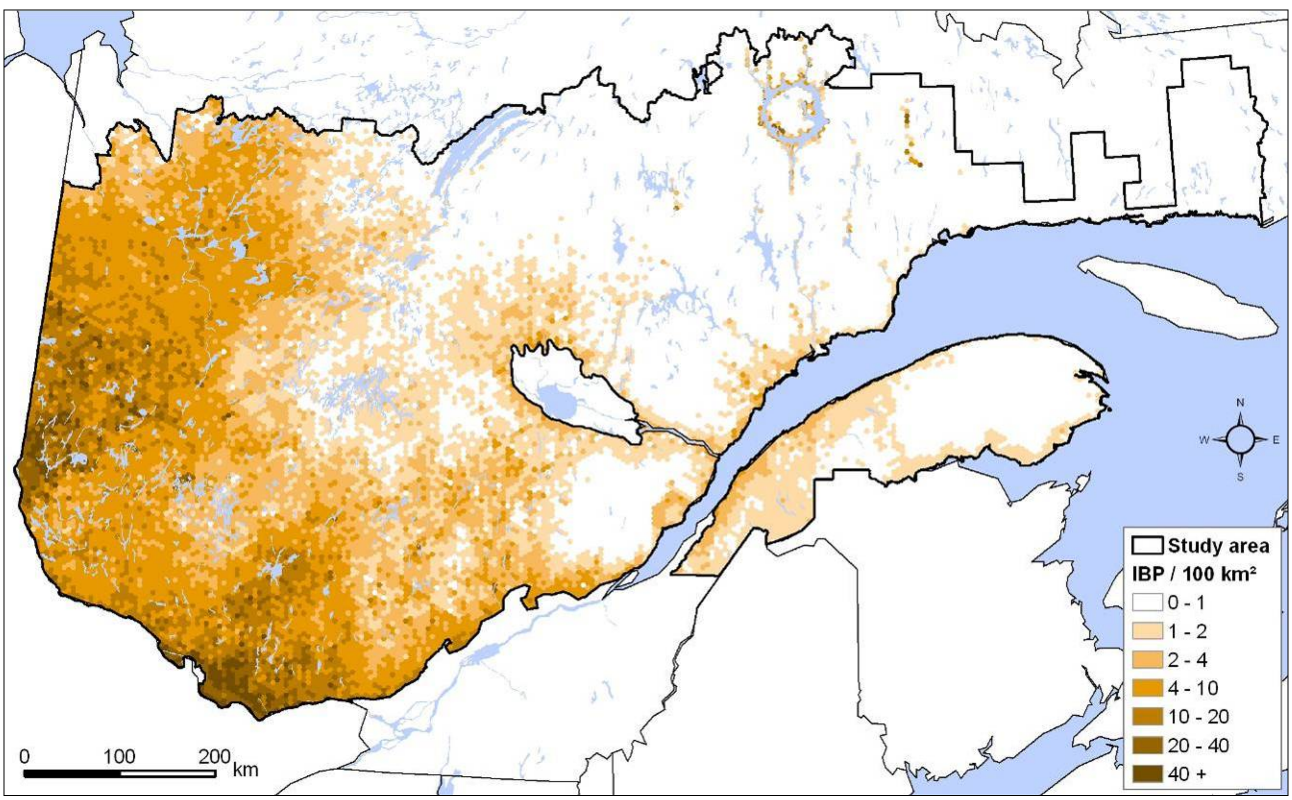
Canada Goose



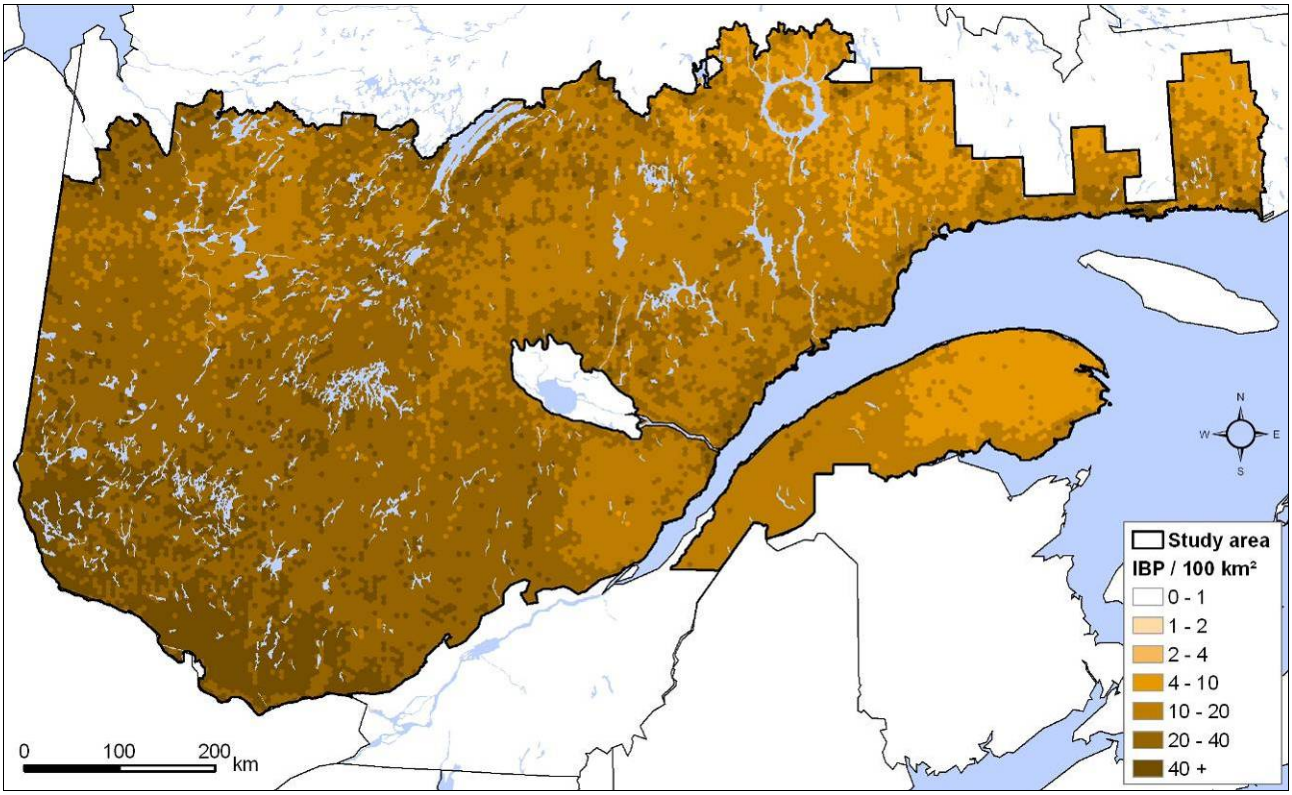
American Green-winged Teal



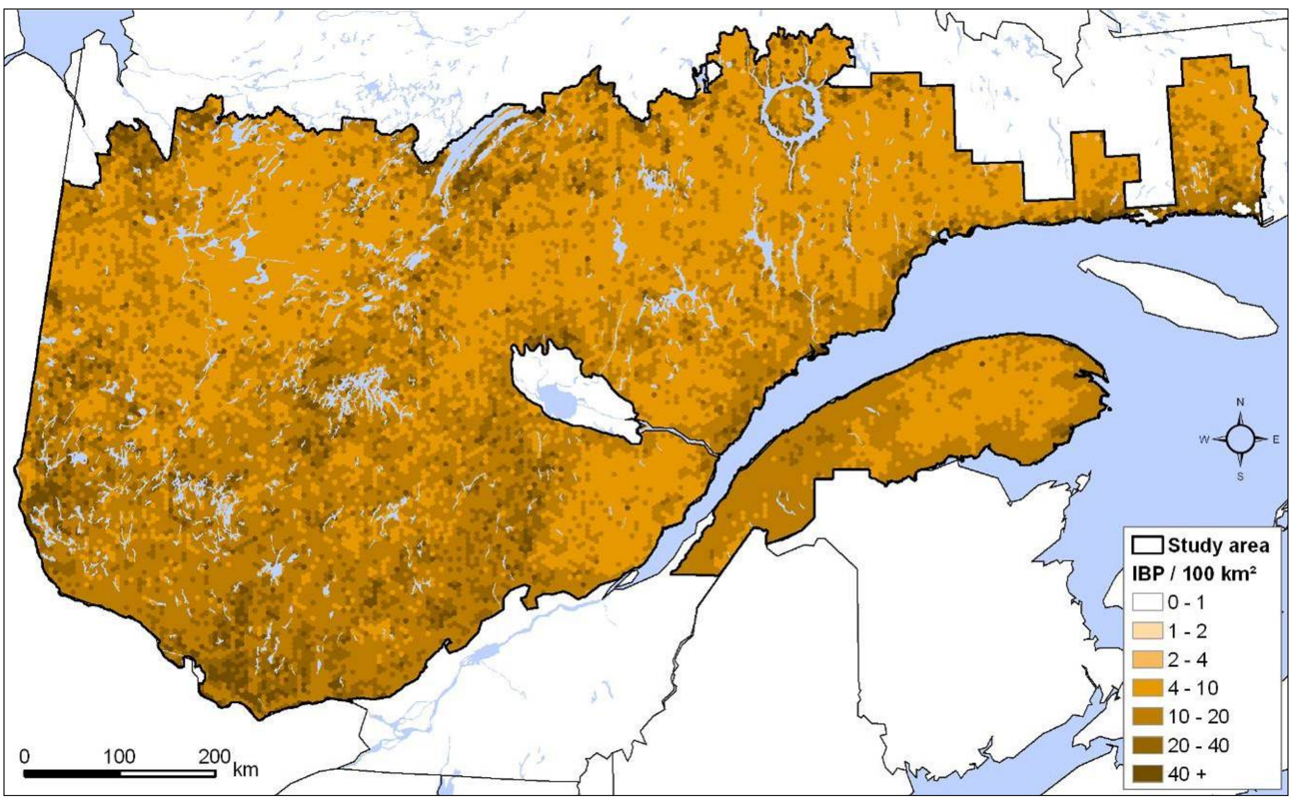
Mallard



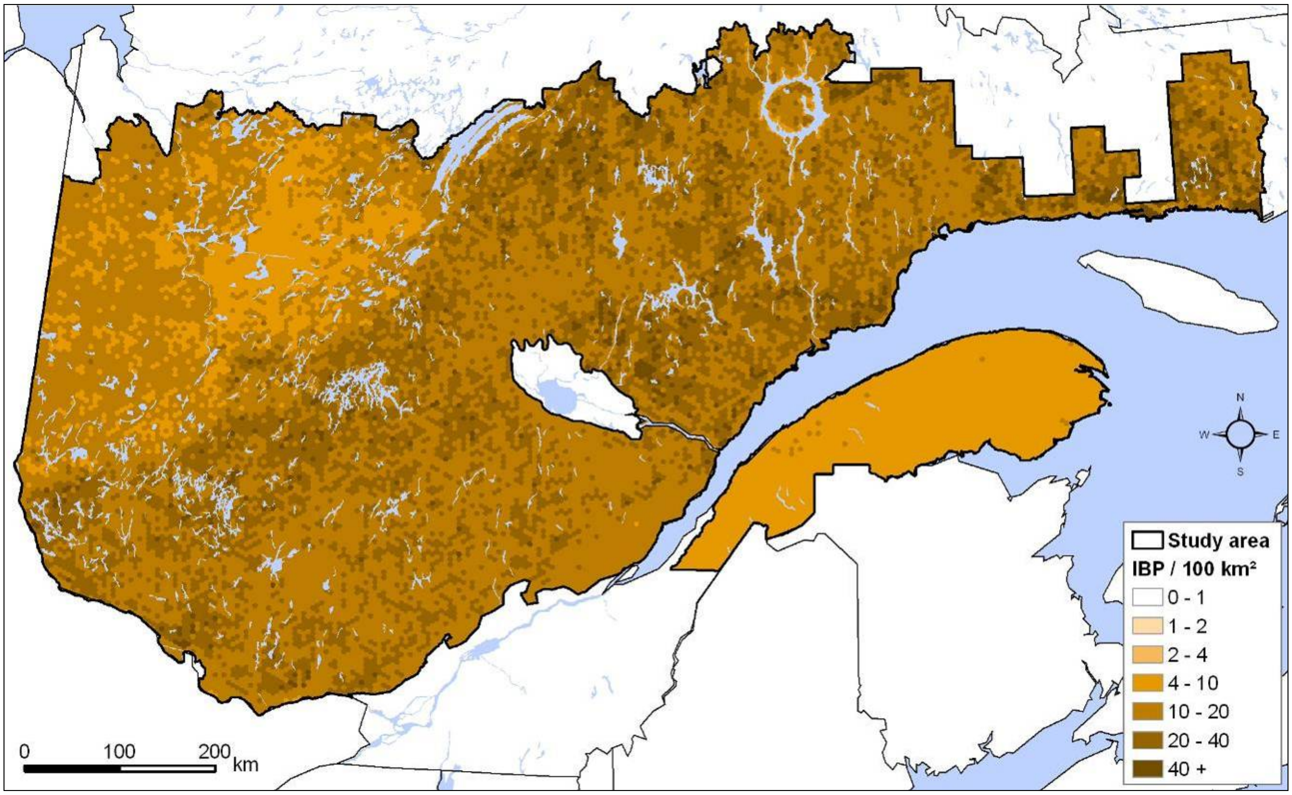
American Black Duck



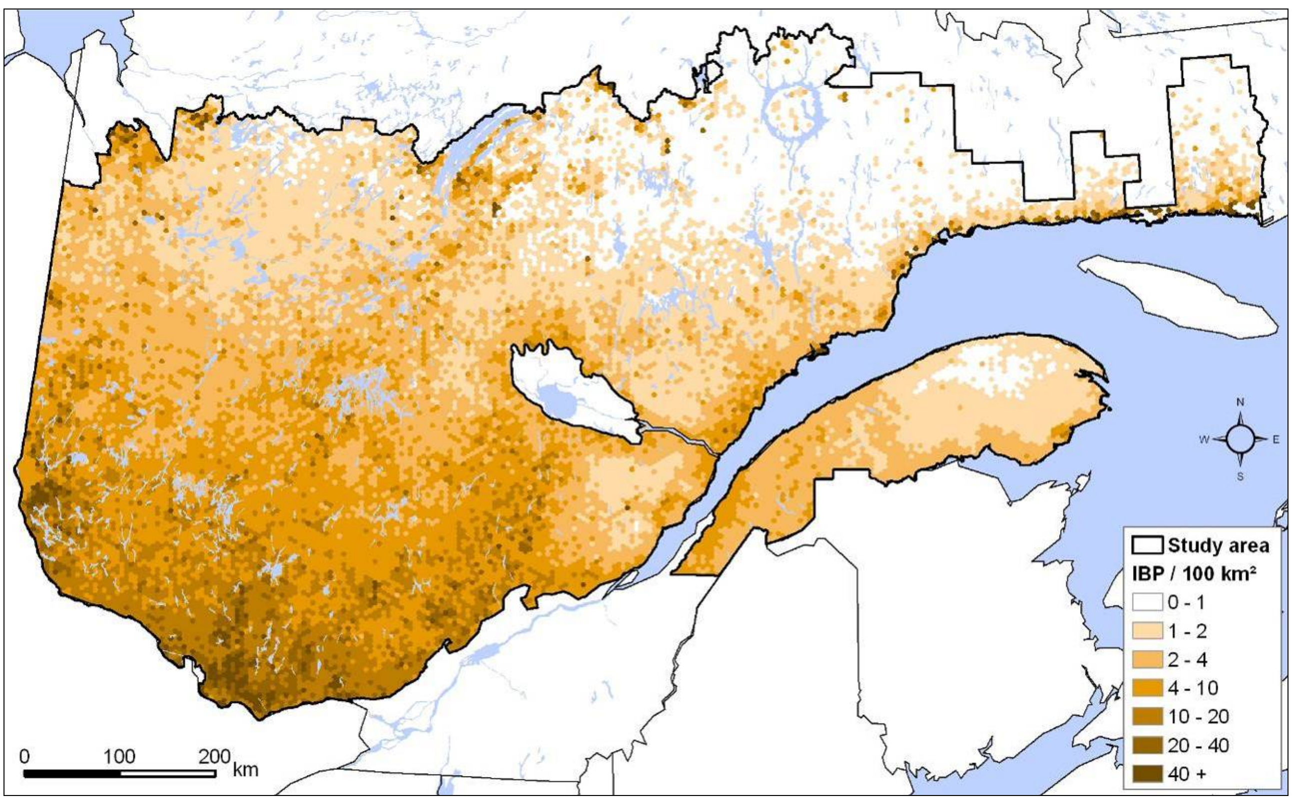
Ring-necked Duck



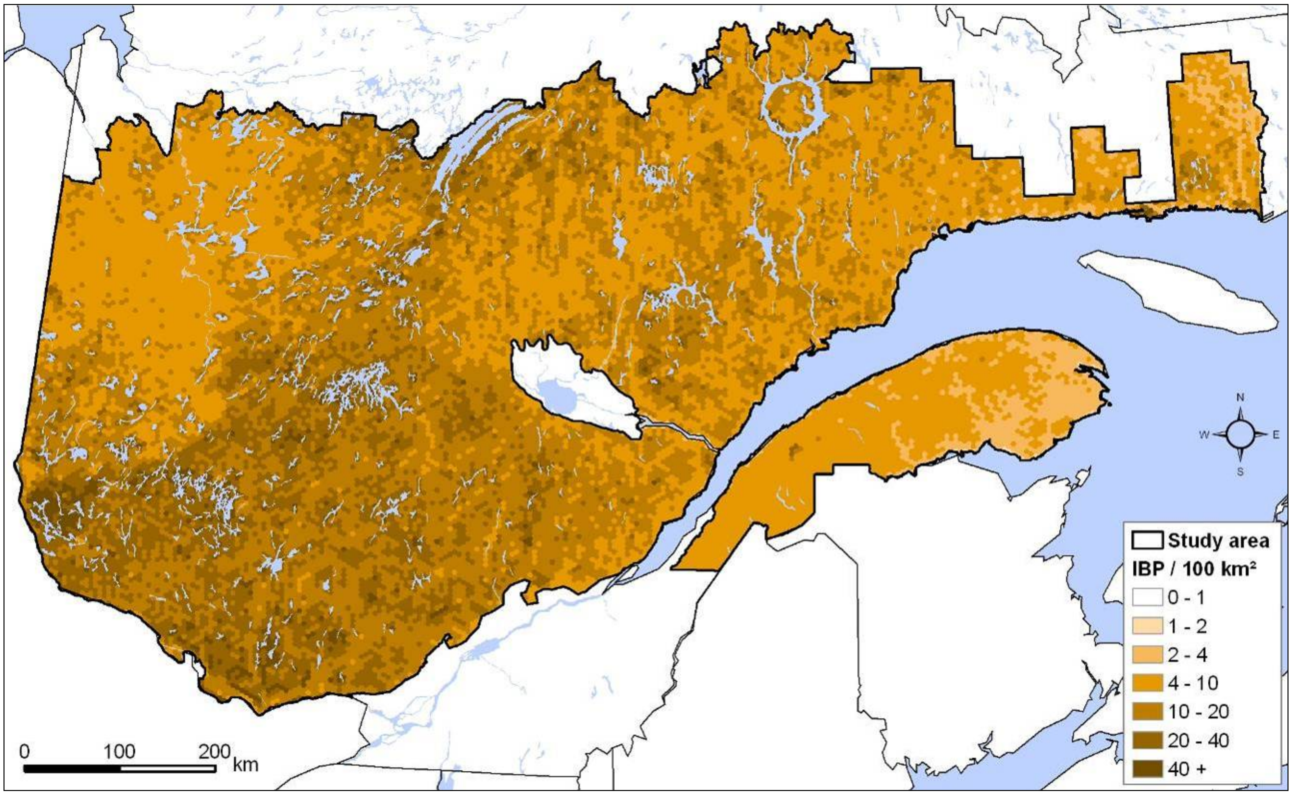
Common Goldeneye



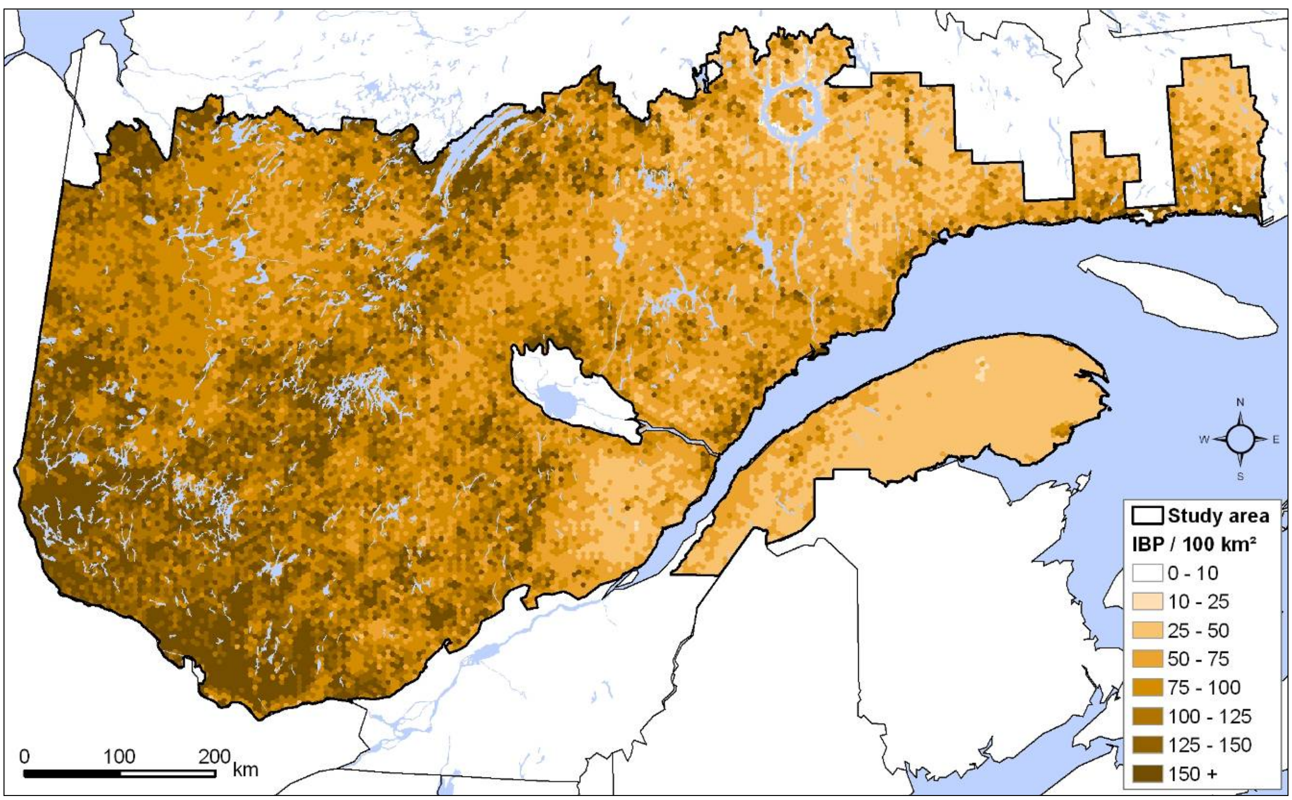
Hooded Merganser



Common Merganser



Total waterfowl



Discussion

Deepwater and wetland habitat mapping

Mapping wetland at scale finer than 1:50,000 and in large, remote areas is an extremely challenging task (Fournier et al., 2007). Since the attempts to inventory wetlands with a methodology that is uniform across Canada have not been successful (WetKit, 2004), relying on existing forestry maps appear as a more-than-acceptable compromise for a first approximation. Thus, the deepwater and wetland habitats that we produced for our study area (5.3% of Canada) will likely be a significantly contribution to the Canadian Wetland Inventory implemented in 2002 (Brian Kazmerik, CWI, pers. comm.). The classification system that we were able to derive from the forestry maps did not completely corresponded to the classes of the Canadian Wetland Classification System (Warner and Rubec, 1997) or the U.S. National Wetland Inventory System (Cowardin et al., 1979), but still allowed to extract habitat features significant to waterfowl. It is very likely that this deepwater and wetland habitats map will be used to study habitat relationships of many other wetland-related wildlife species. In fact, the numerical forestry maps provided the opportunity to produce the first thematic wetland map of Quebec forest-dominated landscapes, which may reveal extremely useful to land-use planners and resource managers.

Predictive models and maps

Our statistical analysis resulted in models with generally high predictive power, as shown by scatter plots of observed vs. fitted IBP densities of best AICc models for each species (Appendix D). Predictive maps presented patterns of species distribution and abundance that are refined relatively to the maps previously produced by Lemelin et al. (2004), who spatially extrapolated IBP numbers without habitat consideration. The modelling scale that we used (25-km²) is greater than known home-range sizes of waterfowl species in forest habitats, which is generally comprised between 1 and 3 km² (Ringelman et al., 1982; Kirby et al., 1985). Our models should therefore be considered as landscape-scale habitat associations. The could further be used to calculate waterfowl numbers included in defined areas approximately the size of or greater than 25 km². Future applications include estimation of population exposed to threats and development of decision-support tools for wetland conservation programs.

Although it is generally difficult to interpret predictors importance after model fitting, we noted some insights revealed by the statistical analysis. When interpreting the results of the AICc model ranking, we considered models with $\Delta_i < 2$ as very plausible, and models with $\Delta_i > 7$ as improbable (Burnham and Anderson, 2002).

Canada Goose. Geographic coordinates are better predictors than ecoregions (cumulative AICc weight of models 1 to 6 is 1.00). On the predictive map, the stricking pattern shows monotically increasing abundance of Canada Goose northwards. This could be explained by a small influence of local habitat variables on abundance pattern relatively to geographic coordinates, which are likely to result from habitat selection processes related to climate or biogeography.

American Green-winged Teal. For this species, predictive power was slightly higher for geographic coordinates than for ecoregions (subsets cumulative AICc weights of 0.8 and 0.2, respectively). The 6.15 Δ_i difference between models 3 and 4 indicates that the Green-winged Teal did not equally used the shorelines of lakes and ponds. As to the 8.91 Δ_i difference between models 3 and 5, it reveals that the subtraction of small island and forest shoreline types greatly enhanced model parsimony.

Mallard. Mallard abundance is most adequately modelled by geographic coordinates thant by ecoregions. A noticeable Δ_i difference of 7.47 between models 3 (1^{st}) and 4 (7^{th}) revealed that areal aquatic habitats (lake near-shore zone, pond, and river) are not do not contribute to model parsimony once shoreline types are considered.

American Black Duck. In Quebec forest-dominated landscapes, American Black Duck is the dominant waterfowl species. The only plausible model (no. 6) included geographic coordinates. The pattern of Δ_i rankings within both subsets ($\Delta_6 < \Delta_4 < \Delta_3 < \Delta_5$ and $\Delta_{12} < \Delta_{10} < \Delta_9 < \Delta_{11}$) clearly shows that differentiating between lake and pond shorelines was more important than differentiating between shoreline types (open wetland, flooded swamp, and shrub swamp).

Ring-necked Duck. This species abundance seemed mostly driven by local habitat characteristics, as the first three pairs of models ranked close one to another (models 4 and 10, models 2 and 8, and models 6 and 12). The first two models are both highly plausible ($w_4 = 0.53$ and $w_{10} = 0.41$), and included all shoreline types of water bodies, as well as total lake shoreline length and total pond shoreline length.

Common Goldeneye. Models of the ecoregion subset accounted for 74% of chances of being the more likely. However, the first two models (no. 7 and no. 1) had similar local habitat variables, highlighting the importance of lake near-shore zones, ponds, and open wetland shoreline types.

Hooded Merganser. Models containing geographic coordinates ranked 1^{st} to 6^{th}, leaving no evidence for ecoregions to be meaningful predictors. The two highly plausible models discriminated between lake and pond shoreline types but excluded areal water body variables.

Common Merganser. Ecoregions are better predictors than geographic coordinates. Models that did not separate near-shore and offshore waters of lakes ranked higher than models that did so. Separating ponds from lakes in waterbodies does not seem justified in the predictive models.

Total waterfowl. Four models were plausible best predicting model, and all included geographic coordinates. As shown by only difference between model 5 ($w = 0.56$) and model 3 ($w = 0.20$), grouping lake and pond total shoreline length added parsimony to the best model. The two models that included offshore zones of lakes (1 and 7) were importantly less plausible than the comparable ones that did not (for example, models 2 and 8).

Implications

Our study brings new evidence that breeding waterfowl hotspots in Quebec forest-dominated lanscapes concentrate on a 150-km wide strip along the Ottawa river, in the southwestern part of the province. Other waterfowl concentrations could be located around lakes Mistassini and Albanel, in the region stretching from Gouin reservoir to Cabonga reservoir, and in the Rouyn-Noranda surroundings. Smaller high-density locations may be located at the southern part of the James Bay lowlands, at the northern part of Lac-Saint-Jean lowlands, and on the low-elevated lands next to St. Lawrence river north shore, east of the Saguenay river. From a waterfowl production perspective, these regions and locations may therefore be judicious areas where to concentrate investments for habitat conservation, restoration, and enhancement. However, from a waterfowl community management perspective, it is interesting to note that the two endangered waterfowl species found in Quebec breed in areas of low total waterfowl density. In these areas, habitat capacity to support waterfowl is likely to be fragile, and would also deserve some attention.

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Appendices

Appendix A Method for calculating indicated breeding pairs (IBP) from the Black Duck Joint Venture – Canadian Wildlife Service helicopter survey in Quebec.

Sighting combination[1]				**Number of IBP**				
M	F	U	T	Dabbler (except American Black Duck)	American Black Duck	Diver (except Ring-necked Duck)	Ring-necked Duck	Canada Goose
1	0	0	1	1	1	1	1	1
0	1	0	1	0	1	0	0	1
0	0	1	1	0	1	0	0	1
2	0	0	2	2	1,5	2	2	1
1	1	0	2	1	1,5	1	1	1
1	0	1	2	1	1,5	1	1	1
0	2	0	2	0	1,5	0	0	1
0	1	1	2	0	1,5	0	0	1
0	0	2	2	0	1,5	0	0	1
3	0	0	3	3	3	3	3	1
2	1	0	3	2	3	2	2	1
2	0	1	3	2	3	2	2	1
1	2	0	3	1	3	1	1	1
1	1	1	3	1	3	1	1	1
1	0	2	3	1	3	1	1	1
0	3	0	3	0	3	0	0	1
0	2	1	3	0	3	0	0	1
0	1	2	3	0	3	0	0	1
0	0	3	3	0	3	0	0	1
4	0	0	4	4	4	4	4	0
3	1	0	4	0	4	3	3	0
3	0	1	4	3	4	3	3	0
2	2	0	4	2	4	2	2	0
2	1	1	4	2	4	2	2	0
2	0	2	4	2	4	2	2	0
1	3	0	4	1	4	1	1	0
1	2	1	4	1	4	1	1	0
1	1	2	4	1	4	1	1	0
1	0	3	4	1	4	1	1	0
0	4	0	4	0	4	0	0	0
0	3	1	4	0	4	0	0	0
0	2	2	4	0	4	0	0	0
0	1	3	4	0	4	0	0	0
0	0	4	4	0	4	0	0	0
1	x[2]	x[2]	>4	0	0	0	1	0
2	x[2]	x[2]	>4	0	0	0	2	0
3	x[2]	x[2]	>4	0	0	0	3	0
4	x[2]	x[2]	>4	0	0	0	4	0
Other combination				0	0	0	0	0

[1] M: male; F: female; U: unknown sex; T: total.
[2] Any combination as long as M + F + I > 4.

Appendix B   Codes used in the program lines

CODE	DEFINITION	UNIT/VALUES
QUADRAT	Quadrat no.	-
AREA	Quadrat area	ha
ECOR	Ecoregion code	A, C, D, E, F, G
X	X coordinate (NAD83 Quebec Lambert)	km
Y	Y coordinate (NAD83 Quebec Lambert)	km
Z	Quadrat mean elevation	m
LAOZ050	Lake 050-m offshore zone	ha
LANZ050	Lake 050-m near-shore zone	ha
LAKE	Lake (waterbody > 8 ha)	ha
POND	Pond (waterbody ≤ 8 ha)	ha
RIVR	River	ha
LAKExISLA	Lake/island shoreline	km
LAKExOPWE	Lake/open wetland shoreline	km
LAKExSWFL	Lake/flooded swamp shoreline	km
LAKExSWSH	Lake/shrub swamp shoreline	km
LAKExFRST	Lake/forest shoreline	km
LAKEx	Lake shoreline	km
PONDxISLA	Pond/island shoreline	km
PONDxOPWE	Pond/open wetland shoreline	km
PONDxSWFL	Pond/flooded swamp shoreline	km
PONDxSWSH	Pond/shrub swamp shoreline	km
PONDxFRST	Pond/forest shoreline	km
PONDx	Pond shoreline	km
RIVRx	River shoreline	km
WATExISLA	Waterbody/Island shoreline	km
WATExOPWE	Waterbody/Open wetland shoreline	km
WATExSWFL	Waterbody/Flooded swamp shoreline	km
WATExSWSH	Waterbody/Shrub swamp shoreline	km
WATExFRST	Waterbody/forest shoreline	km
WATEx	Waterbody shoreline	km
STRMxOPWE	Permanent stream/open wetland shoreline	km
STRMxSWFL	Stream/flooded swamp shoreline	km
STRMxSWSH	Stream/shrub swamp shoreline	km
STRMxFRST	Stream/forest shoreline	km
STRMx	Stream shoreline	km
CAGO	Canada Goose	Annual mean IBP counts
ABDU	American Black Duck	Annual mean IBP counts
MALL	Mallard	Annual mean IBP counts
HOME	Hooded Merganser	Annual mean IBP counts
RNDU	Ring-necked Duck	Annual mean IBP counts
COGO	Common Goldeneye	Annual mean IBP counts
COME	Common Merganser	Annual mean IBP counts
AGWT	American Green-winged Teal	Annual mean IBP counts
WTFL	Total waterfowl	Annual mean IBP counts

Appendix C   Variables used in candidate models (1: included; 2: not included)

SPECIES	MODEL.NO	ECOR	X	Y	Z	LAOZ050	LANZ050	LAKE	POND	RIVR	LAKExISLA	LAKExOPWE	LAKExSWFL	LAKExSWSH	LAKExFRST	LAKEx	PONDxISLA	PONDxOPWE	PONDxSWFL	PONDxSWSH	PONDxFRST	PONDx	RIVRx	WATExISLA	WATExOPWE	WATExSWFL	WATExSWSH	WATExFRST	WATEx	STRMxOPWE	STRMxSWFL	STRMxSWSH	STRMxFRST	STRMx	NO.VARS
CAGO	0	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	1	0	0	1	1	1	1	1	1	0	27
CAGO	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	1	1	1	1	0	21
CAGO	2	0	1	1	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	9
CAGO	3	0	1	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	10
CAGO	4	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	8
CAGO	5	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	0	9
CAGO	6	0	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	0	12
CAGO	7	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0	1	1	1	1	0	23
CAGO	8	1	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	11
CAGO	9	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	1	0	12
CAGO	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	1	0	10
CAGO	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	1	1	0	11
CAGO	12	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	1	0	1	1	0	14
ABDU	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	34
ABDU	1	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	16
ABDU	2	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	20
ABDU	3	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	14
ABDU	4	0	1	1	1	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	15
ABDU	5	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	11
ABDU	6	0	1	1	1	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	11
ABDU	7	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	1	1	1	0	18
ABDU	8	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	22
ABDU	9	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	16
ABDU	10	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	17
ABDU	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	13
ABDU	12	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	1	1	1	0	13
MALL	0	1	1	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	0	28
MALL	1	0	1	1	1	0	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	19
MALL	2	0	1	1	1	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	16
MALL	3	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	1	0	12
MALL	4	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	1	0	15
MALL	5	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	9
MALL	6	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0		0	0	0	0	0	0	0	1	1	1	1	0	13
MALL	7	1	0	0	0	0	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	21
MALL	8	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	18
MALL	9	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	1	0	14
MALL	10	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	1	1	1	1	1	0	17
MALL	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	11
MALL	12	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	1	0	15

SPECIES	MODEL.NO	ECOR	X	Y	Z	LAOZ050	LANZ050	LAKE	POND	RIVR	LAKExISLA	LAKExOPWE	LAKExSWFL	LAKExSWSH	LAKExFRST	LAKEx	PONDxISLA	PONDxOPWE	PONDxSWFL	PONDxSWSH	PONDxFRST	PONDx	RIVRx	WATExISLA	WATExOPWE	WATExSWFL	WATExSWSH	WATExFRST	WATEx	STRMxOPWE	STRMxSWFL	STRMxSWSH	STRMxFRST	STRMx	NO.VARS
HOME	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	1	1	1	0	1	1	1	1	1	0	31
HOME	1	0	1	1	1	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	13
HOME	2	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0	8
HOME	3	0	1	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	0	21
HOME	4	0	1	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	12
HOME	5	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	13
HOME	6	0	1	1	1	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	10
HOME	7	1	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	15
HOME	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	0	0	10
HOME	9	1	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	0	23
HOME	10	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	1	1	0	14
HOME	11	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	1	1	15
HOME	12	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	12
RNDU	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	0	32
RNDU	1	0	1	1	1	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	14
RNDU	2	0	1	1	1	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11
RNDU	3	0	1	1	1	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	16
RNDU	4	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	1	1	0	0	0	0	0	0	11
RNDU	5	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	6
RNDU	6	0	1	1	1	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	12
RNDU	7	1	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	1	0	0	16
RNDU	8	1	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	13
RNDU	9	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	0	0	18
RNDU	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	1	1	1	0	0	0	0	0	0	13
RNDU	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	8
RNDU	12	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	14
COGO	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	0	0	0	0	0	0	29
COGO	1	0	1	1	1	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	8
COGO	2	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	6
COGO	3	0	1	1	1	0	1	0	1	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	10
COGO	4	0	1	1	1	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	13
COGO	5	0	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	10
COGO	6	0	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	9
COGO	7	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	10
COGO	8	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	8
COGO	9	1	0	0	0	0	1	0	1	1	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	12
COGO	10	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	15
COGO	11	1	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	12
COGO	12	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	11

SPECIES	MODEL.NO	ECOR	X	Y	Z	LAOZ050	LANZ050	LAKE	POND	RIVR	LAKExISLA	LAKExOPWE	LAKExSWFL	LAKExSWSH	LAKExFRST	LAKEx	PONDxISLA	PONDxOPWE	PONDxSWFL	PONDxSWSH	PONDxFRST	PONDx	RIVRx	WATExISLA	WATExOPWE	WATExSWFL	WATExSWSH	WATExFRST	WATEx	STRMxOPWE	STRMxSWFL	STRMxSWSH	STRMxFRST	STRMx	NO.VARS
COME	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	32
COME	1	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	10
COME	2	0	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	9
COME	3	0	1	1	1	0	1	0	1	1	1	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	12
COME	4	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	12
COME	5	0	1	1	1	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	16
COME	6	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	11
COME	7	1	0	0	0	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	12
COME	8	1	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	11
COME	9	1	0	0	0	0	1	0	1	1	1	0	1	0	0	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	14
COME	10	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	14
COME	11	1	0	0	0	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	18
COME	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	13
AGWT	0	1	1	1	1	0	1	0	1	0	1	1	1	1	1	0	1	1	1	1	1	0	0	1	1	1	1	1	0	1	1	1	1	0	32
AGWT	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	9
AGWT	2	0	1	1	1	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	13
AGWT	3	0	1	1	1	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	12
AGWT	4	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	9
AGWT	5	0	1	1	1	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	17
AGWT	6	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	0	12
AGWT	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	1	11
AGWT	8	1	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	1	1	1	0	15
AGWT	9	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	14
AGWT	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	1	1	0	0	11
AGWT	11	1	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	19
AGWT	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	1	0	14
WTFL	0	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	0	31
WTFL	1	0	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	20
WTFL	2	0	1	1	1	0	1	0	1	0	0	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	17
WTFL	3	0	1	1	1	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	14
WTFL	4	0	1	1	1	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	9
WTFL	5	0	1	1	1	0	1	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	12
WTFL	6	0	1	1	1	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	12
WTFL	7	1	0	0	0	1	1	0	1	1	0	1	1	1	0	1	0	1	1	1	0	1	1	0	0	0	0	0	0	1	1	1	1	0	22
WTFL	8	1	0	0	0	0	1	0	1	0	0	1	1	1	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	1	1	1	1	0	19
WTFL	9	1	0	0	0	0	1	0	1	0	0	1	1	0	0	1	0	1	1	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	16
WTFL	10	1	0	0	0	0	1	0	1	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	11
WTFL	11	1	0	0	0	0	1	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	14
WTFL	12	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	1	0	0	14

Appendix D Statistical modelling outputs

Canada Goose

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
CAGO.04	10	354.7	0.00	0.44	0.44
CAGO.02	11	356.1	1.33	0.23	0.67
CAGO.05	11	356.2	1.47	0.21	0.88
CAGO.06	14	359.1	4.36	0.05	0.93
CAGO.03	12	359.6	4.84	0.04	0.97
CAGO.01	23	360.2	5.45	0.03	1.00
CAGO.07	25	374.7	20.00	0.00	1.00
CAGO.00	34	376.9	22.14	0.00	1.00
CAGO.11	13	379.9	25.13	0.00	1.00
CAGO.10	12	382.2	27.45	0.00	1.00
CAGO.12	16	382.6	27.83	0.00	1.00
CAGO.09	14	386.8	32.05	0.00	1.00
CAGO.08	13	391.3	36.59	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -6.626e+00         NA         NA        NA
X           -1.723e-03  3.505e-04 -4.916e+00 8.832e-07
Y            8.216e-03         NA         NA        NA
Z            1.556e-03  8.937e-04  1.741e+00 8.170e-02
WATExOPWE   -7.890e-03  2.901e-02 -2.719e-01 7.857e-01
WATExFRST    1.603e-02  8.245e-03  1.944e+00 5.186e-02
STRMxOPWE    2.466e-02  1.736e-02  1.420e+00 1.555e-01
STRMxSWSH   -2.468e-03  3.249e-02 -7.597e-02 9.394e-01
STRMxFRST    2.747e-03  1.881e-02  1.461e-01 8.839e-01

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 1.522e-01         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.665e+02         10        132       -Inf  3.531e+02  3.547e+02
```

AICc 2nd model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -5.833e+00  1.025e+00 -5.693e+00 1.251e-08
X           -2.460e-03  4.547e-04 -5.411e+00 6.281e-08
Y            8.601e-03  1.092e-03  7.875e+00 3.331e-15
```

```
Z             5.580e-04  8.705e-04  6.410e-01 5.215e-01
LANZ050      -1.484e-03  1.452e-02 -1.022e-01 9.186e-01
POND          2.812e-02  1.732e-02  1.623e+00 1.046e-01
RIVR         -1.415e-03  2.887e-03 -4.902e-01 6.240e-01
LAKEx         9.040e-03  7.441e-02  1.215e-01 9.033e-01
PONDx        -4.843e-02  4.524e-02 -1.071e+00 2.843e-01
STRMx        -7.959e-06  1.124e-07 -7.083e+01 0.000e+00

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 1.245e-01         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance         AIC        AICc
-1.660e+02         11        131       -Inf   3.54e+02  3.561e+02
```

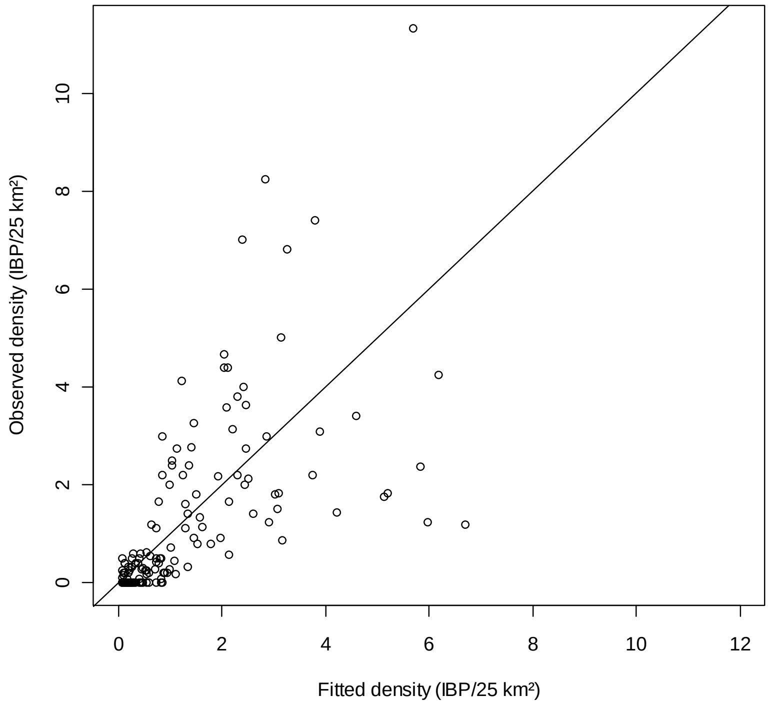
AICc 3rd model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -6.425e+00  1.526e-01 -4.210e+01 0.000e+00
X           -1.749e-03  3.591e-04 -4.869e+00 1.119e-06
Y            8.080e-03         NA         NA        NA
Z            1.308e-03  8.882e-04  1.473e+00 1.408e-01
WATExOPWE    3.501e-02  5.000e-02  7.001e-01 4.839e-01
WATExFRST    4.997e-02  3.568e-02  1.400e+00 1.614e-01
WATEx       -3.201e-02  3.189e-02 -1.004e+00 3.154e-01
STRMxOPWE    2.259e-02  1.718e-02  1.315e+00 1.885e-01
STRMxSWSH    1.795e-03  3.235e-02  5.550e-02 9.557e-01
STRMxFRST    2.502e-03  1.893e-02  1.322e-01 8.948e-01

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 1.454e-01         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance         AIC        AICc
-1.661e+02         11        131       -Inf  3.542e+02  3.562e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



American Green-winged Teal

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative *w*
AGWT.03	14	358.6	0.00	0.66	0.66
AGWT.09	16	362.7	4.16	0.08	0.74
AGWT.07	13	363.6	5.02	0.05	0.79
AGWT.10	13	363.7	5.16	0.05	0.84
AGWT.02	15	364.1	5.52	0.04	0.88
AGWT.01	11	364.3	5.77	0.04	0.92
AGWT.04	11	364.7	6.15	0.03	0.95
AGWT.06	14	364.9	6.35	0.03	0.98
AGWT.08	17	367.0	8.43	0.01	0.99
AGWT.05	19	367.5	8.91	0.01	0.99
AGWT.12	16	368.3	9.77	0.00	1.00
AGWT.11	21	373.4	14.81	0.00	1.00
AGWT.00	34	396.2	37.65	0.00	1.00

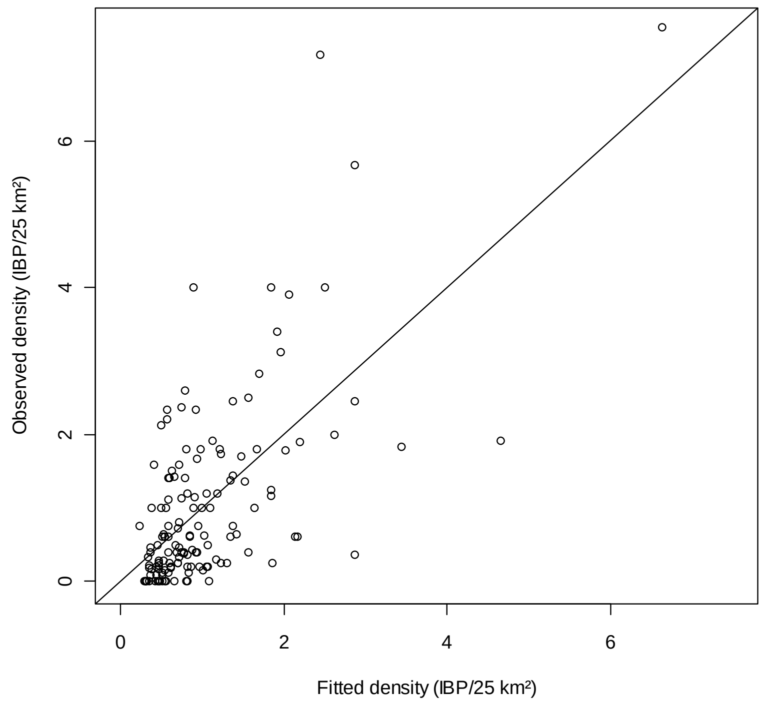
AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -1.408e+00  6.759e-01 -2.084e+00 3.719e-02
X           -1.501e-03  4.138e-04 -3.628e+00 2.852e-04
Y            1.932e-03  7.236e-04  2.669e+00 7.600e-03
Z           -1.283e-03  9.028e-04 -1.421e+00 1.554e-01
LAKExOPWE   -1.290e-02  5.805e-02 -2.222e-01 8.241e-01
LAKExSWFL    1.861e-02  2.347e-01  7.930e-02 9.368e-01
LAKExSWSH    4.230e-01  1.334e-01  3.171e+00 1.517e-03
PONDxOPWE    1.492e-02  5.029e-02  2.968e-01 7.666e-01
PONDxSWFL    2.311e-01  1.406e-01  1.643e+00 1.003e-01
PONDxSWSH    4.456e-02  1.292e-01  3.448e-01 7.302e-01
STRMxOPWE   -3.104e-03  2.088e-02 -1.487e-01 8.818e-01
STRMxSWFL   -7.127e-02  1.705e-01 -4.180e-01 6.759e-01
STRMxSWSH    2.006e-02  1.988e-02  1.009e+00 3.129e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value Pr(> z)
phi.(Intercept) 3.020e-08      2e-13 1.510e+05   0e+00

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.636e+02         14        128       -Inf  3.553e+02  3.586e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



Mallard

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
MALL.03	14	268.8	0.00	0.68	0.68
MALL.05	11	270.7	1.86	0.27	0.94
MALL.11	13	274.4	5.59	0.04	0.98
MALL.04	17	276.3	7.47	0.02	1.00
MALL.09	15	283.5	14.70	0.00	1.00
MALL.06	18	285.6	16.75	0.00	1.00
MALL.02	21	285.7	16.85	0.00	1.00
MALL.01	30	287.7	18.89	0.00	1.00
MALL.00	19	289.2	20.40	0.00	1.00
MALL.10	17	290.8	21.92	0.00	1.00
MALL.12	20	295.0	26.12	0.00	1.00
MALL.08	23	301.9	33.05	0.00	1.00
MALL.07	18	722.3	453.50	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error   z value Pr(> |z|)
(Intercept)  7.706e-01  1.876e+00  4.108e-01 6.812e-01
X           -3.280e-03  1.076e-03 -3.048e+00 2.300e-03
Y           -1.351e-03  1.295e-03 -1.043e+00 2.970e-01
Z           -3.699e-03  2.110e-03 -1.753e+00 7.955e-02
RIVRx       -1.698e-02  1.746e-02 -9.727e-01 3.307e-01
WATExOPWE   -7.016e-02  5.372e-02 -1.306e+00 1.915e-01
WATExSWFL    1.952e-01  7.634e-02  2.557e+00 1.056e-02
WATExSWSH    1.950e-01  4.652e-02  4.192e+00 2.770e-05
WATEx       -2.283e-02  1.232e-02 -1.853e+00 6.385e-02
STRMxOPWE   -2.864e-02  3.401e-02 -8.421e-01 3.997e-01
STRMxSWFL    2.822e-03  1.527e-01  1.848e-02 9.853e-01
STRMxSWSH   -3.059e-02  2.566e-02 -1.192e+00 2.332e-01
STRMxFRST    6.613e-03  3.377e-02  1.958e-01 8.448e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value   Pr(> z)
phi.(Intercept) 1.149e-01   1.76e-01 6.529e-01 2.569e-01

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.188e+02         14        128       -Inf  2.655e+02  2.688e+02
```

AICc 2nd model summary table

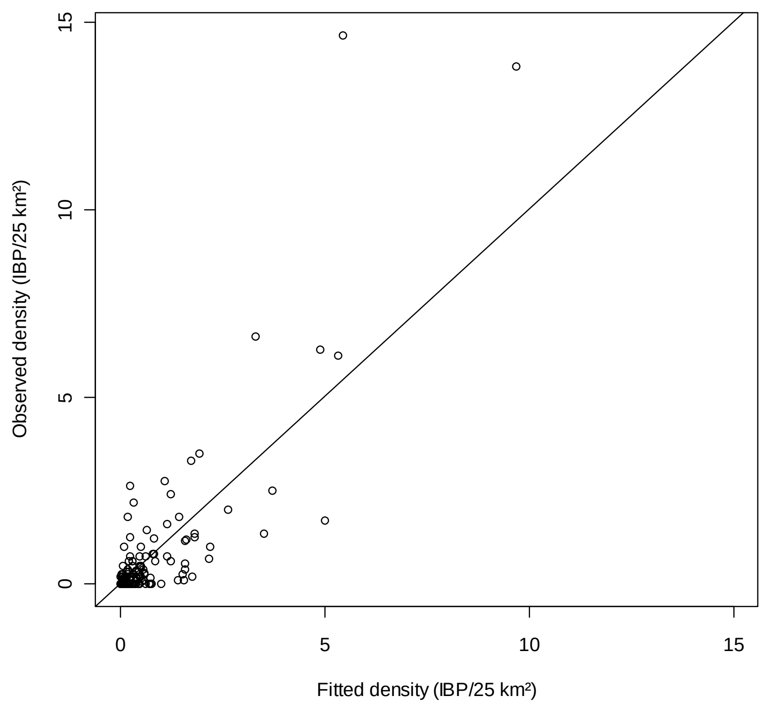
```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error   z value Pr(> |z|)
(Intercept) -2.381e-01  1.051e+00 -2.264e-01 8.209e-01
```

```
X            -3.066e-03  7.355e-04 -4.168e+00 3.072e-05
Y            -1.702e-04  9.959e-04 -1.709e-01 8.643e-01
Z            -3.620e-03  1.718e-03 -2.107e+00 3.511e-02
WATExOPWE   -9.607e-02  4.719e-02 -2.036e+00 4.177e-02
WATExSWFL    1.140e-01  6.817e-02  1.673e+00 9.437e-02
WATExSWSH    1.391e-01  3.724e-02  3.735e+00 1.878e-04
STRMxOPWE   -3.262e-02  3.274e-02 -9.966e-01 3.190e-01
STRMxSWFL    1.270e-01  1.359e-01  9.346e-01 3.500e-01
STRMxSWSH   -6.683e-03  2.246e-02 -2.975e-01 7.661e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value  Pr(> z)
phi.(Intercept) 1.902e-01  1.407e-01 1.353e+00 8.81e-02

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.233e+02         11        131       -Inf  2.687e+02  2.707e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



American Black Duck

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
ABDU.06	13	701.7	0.00	0.91	0.91
ABDU.04	17	707.1	5.44	0.06	0.97
ABDU.01	18	709.9	8.25	0.01	0.98
ABDU.12	15	711.1	9.36	0.01	0.99
ABDU.03	16	712.5	10.78	0.00	0.99
ABDU.05	13	712.5	10.78	0.00	1.00
ABDU.10	19	715.9	14.22	0.00	1.00
ABDU.02	22	716.0	14.26	0.00	1.00
ABDU.07	20	722.1	20.36	0.00	1.00
ABDU.09	18	722.3	20.63	0.00	1.00
ABDU.11	15	723.1	21.37	0.00	1.00
ABDU.08	24	728.2	26.45	0.00	1.00
ABDU.00	35	739.4	37.67	0.00	1.00

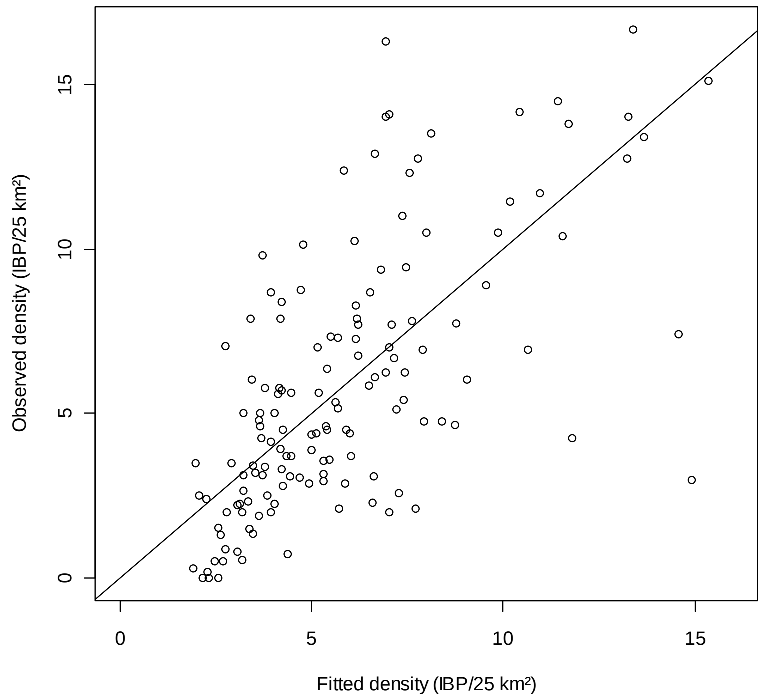
AICc 1st model summary table

```
Negative-binomial model
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept)  1.852e+00         NA         NA        NA
X           -8.378e-04  1.338e-04 -6.263e+00 3.773e-10
Y           -1.261e-03         NA         NA        NA
Z           -7.522e-04  3.985e-04 -1.888e+00 5.905e-02
LAKExOPWE    3.525e-02  3.245e-02  1.086e+00 2.773e-01
LAKEx        8.892e-03  4.096e-03  2.171e+00 2.994e-02
PONDxOPWE   -1.346e-02  3.462e-02 -3.889e-01 6.974e-01
PONDx        3.246e-02  1.069e-02  3.037e+00 2.388e-03
STRMxOPWE    2.005e-02  1.032e-02  1.942e+00 5.210e-02
STRMxSWFL    3.883e-02  4.958e-02  7.831e-01 4.336e-01
STRMxSWSH    1.145e-02  1.115e-02  1.027e+00 3.044e-01
STRMxFRST    8.852e-04  1.106e-02  8.002e-02 9.362e-01

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 7.542e-02         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-3.364e+02         13        129       -Inf  6.989e+02  7.017e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



Ring-necked Duck

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
RNDU.04	12	561.3	0.00	0.53	0.53
RNDU.10	14	561.9	0.52	0.41	0.94
RNDU.02	13	567.6	6.27	0.02	0.97
RNDU.08	15	568.3	6.91	0.02	0.98
RNDU.06	14	570.4	9.03	0.01	0.99
RNDU.12	16	570.4	9.10	0.01	1.00
RNDU.05	8	572.4	11.08	0.00	1.00
RNDU.01	16	573.7	12.39	0.00	1.00
RNDU.07	18	575.1	13.74	0.00	1.00
RNDU.09	20	575.2	13.84	0.00	1.00
RNDU.03	18	577.4	16.03	0.00	1.00
RNDU.11	10	579.9	18.52	0.00	1.00
RNDU.00	33	602.2	40.82	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept)  1.940e+00         NA         NA        NA
X            1.474e-04         NA         NA        NA
Y           -1.309e-03         NA         NA        NA
Z           -1.591e-03         NA         NA        NA
LAKEx        3.300e-02  1.072e-02  3.078e+00 2.085e-03
PONDx        4.739e-02  1.446e-02  3.278e+00 1.045e-03
WATExISLA   -9.777e-02         NA         NA        NA
WATExOPWE    7.488e-02  1.845e-02  4.058e+00 4.954e-05
WATExSWFL    1.246e-01         NA         NA        NA
WATExSWSH   -2.937e-02  3.041e-02 -9.659e-01 3.341e-01
WATExFRST   -3.192e-02  1.120e-02 -2.850e+00 4.368e-03

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 1.393e-01         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-2.675e+02         12        130       -Inf  5.589e+02  5.613e+02
```

AICc 2nd model summary table

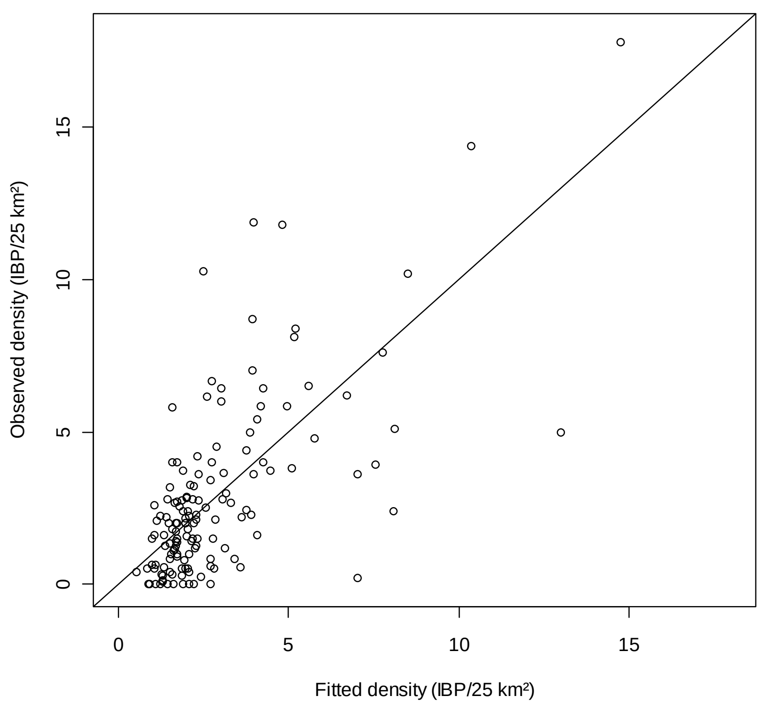
```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept)  1.006e+00  2.292e-01  4.391e+00 1.130e-05
ECORC       -6.358e-01  2.639e-01 -2.409e+00 1.600e-02
ECORD       -1.009e+00  2.790e-01 -3.616e+00 2.994e-04
```

```
ECORE       -1.703e+00  4.457e-01 -3.820e+00 1.333e-04
ECORF       -3.897e-01  2.870e-01 -1.358e+00 1.745e-01
ECORG       -9.411e-01  3.179e-01 -2.961e+00 3.071e-03
LAKEx        2.986e-02  1.188e-02  2.514e+00 1.193e-02
PONDx        5.376e-02  1.463e-02  3.676e+00 2.373e-04
WATExISLA   -1.113e-01  4.099e-02 -2.715e+00 6.634e-03
WATExOPWE    7.980e-02  2.566e-02  3.110e+00 1.870e-03
WATExSWFL    1.441e-01  4.440e-02  3.246e+00 1.171e-03
WATExSWSH   -4.725e-02  3.150e-02 -1.500e+00 1.336e-01
WATExFRST   -1.912e-02  1.185e-02 -1.613e+00 1.067e-01

Overdispersion coefficients:
                Estimate Std. Error   z value   Pr(> z)
phi.(Intercept) 9.95e-02  5.542e-02 1.795e+00 3.629e-02

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-2.653e+02         14        128       -Inf  5.586e+02  5.619e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



Common Goldeneye

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative *w*
COGO.07	12	530.9	0.00	0.59	0.59
COGO.01	10	533.6	2.61	0.16	0.76
COGO.09	14	535.4	4.45	0.06	0.82
COGO.12	13	536.1	5.16	0.04	0.87
COGO.05	12	536.1	5.19	0.04	0.91
COGO.11	14	536.8	5.87	0.03	0.94
COGO.03	12	537.1	6.13	0.03	0.97
COGO.06	11	537.5	6.57	0.02	0.99
COGO.08	10	541.5	10.59	0.00	0.99
COGO.10	17	541.7	10.72	0.00	1.00
COGO.04	15	541.7	10.77	0.00	1.00
COGO.02	8	549.0	18.07	0.00	1.00
COGO.00	30	568.0	37.08	0.00	1.00

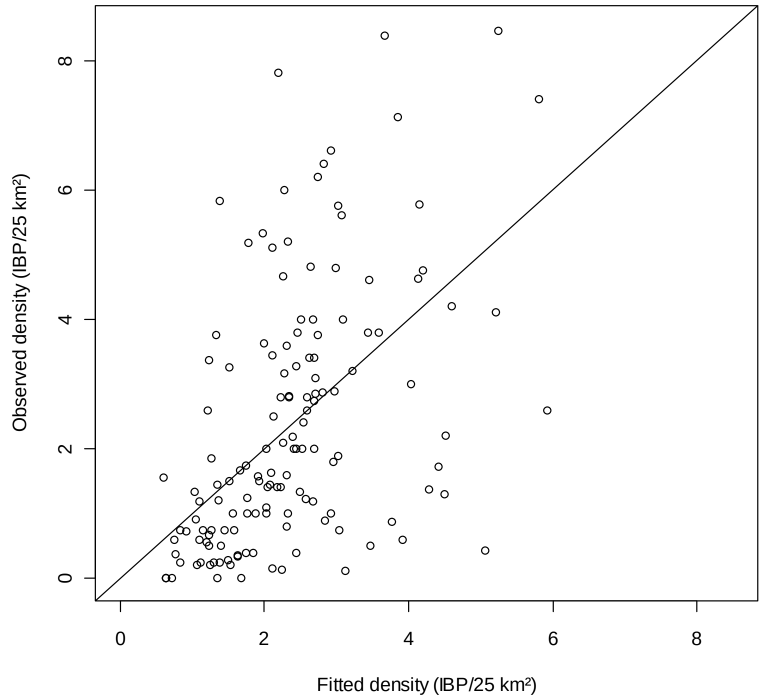
AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -4.528e-01  4.256e-01 -1.064e+00 2.874e-01
ECORC        8.776e-01  4.507e-01  1.947e+00 5.153e-02
ECORD        9.019e-01  4.467e-01  2.019e+00 4.350e-02
ECORE        7.322e-01  5.218e-01  1.403e+00 1.606e-01
ECORF        6.957e-01  4.750e-01  1.465e+00 1.430e-01
ECORG        3.657e-01  4.958e-01  7.375e-01 4.608e-01
LANZ050      1.993e-03  1.790e-03  1.114e+00 2.655e-01
POND         2.312e-02  5.902e-03  3.917e+00 8.963e-05
LAKExOPWE    1.028e-01  4.925e-02  2.088e+00 3.677e-02
PONDxOPWE   -3.303e-02  4.074e-02 -8.107e-01 4.175e-01
WATEx       -8.562e-03  9.126e-03 -9.382e-01 3.481e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value   Pr(> z)
phi.(Intercept) 1.053e-01  6.229e-02 1.691e+00 4.546e-02

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance         AIC        AICc
-2.523e+02         12        130       -Inf   5.285e+02   5.309e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



Hooded Merganser

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
HOME.06	12	299.0	0.00	0.60	0.60
HOME.05	15	300.8	1.80	0.25	0.85
HOME.02	10	303.3	4.32	0.07	0.92
HOME.01	15	303.6	4.65	0.06	0.98
HOME.04	14	305.8	6.84	0.02	1.00
HOME.03	23	317.3	18.31	0.00	1.00
HOME.08	12	318.5	19.49	0.00	1.00
HOME.11	17	320.0	20.98	0.00	1.00
HOME.12	14	322.6	23.62	0.00	1.00
HOME.10	16	324.6	25.67	0.00	1.00
HOME.07	17	326.8	27.85	0.00	1.00
HOME.09	25	338.9	39.89	0.00	1.00
HOME.00	33	339.8	40.85	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept)  2.149e+00  6.205e-01  3.464e+00 5.319e-04
X           -5.895e-04  4.575e-04 -1.288e+00 1.976e-01
Y           -4.536e-03  8.023e-04 -5.654e+00 1.564e-08
Z           -1.847e-03  9.000e-04 -2.053e+00 4.011e-02
LAKExOPWE    2.419e-02  6.317e-02  3.830e-01 7.017e-01
LAKExSWFL   -1.471e-01  1.858e-01 -7.919e-01 4.284e-01
PONDxOPWE    1.873e-01  4.967e-02  3.772e+00 1.620e-04
PONDxSWFL    1.800e-01  1.038e-01  1.734e+00 8.287e-02
STRMxOPWE    3.813e-03  2.809e-02  1.358e-01 8.920e-01
STRMxSWFL    2.754e-03  1.005e-01  2.740e-02 9.781e-01
STRMxSWSH   -1.277e-02  2.701e-02 -4.729e-01 6.363e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value Pr(> z)
phi.(Intercept) 4.043e-09      2e-13 2.022e+04   0e+00

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.363e+02         12        130       -Inf  2.966e+02   2.99e+02
```

AICc 2nd model summary table

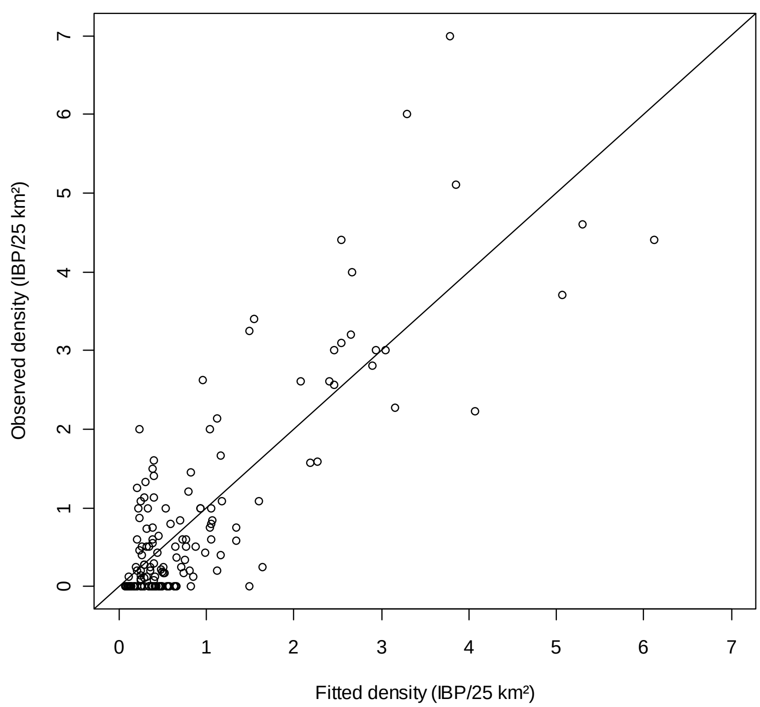
```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error z value Pr(> |z|)
(Intercept)  1.931e+00         NA      NA        NA
X           -1.313e-03         NA      NA        NA
Y           -4.284e-03         NA      NA        NA
```

```
Z             -2.022e-03         NA      NA        NA
LAKExOPWE      4.971e-02         NA      NA        NA
LAKExSWFL     -2.184e-01         NA      NA        NA
PONDxISLA     -9.059e-01         NA      NA        NA
PONDxOPWE      2.053e-01         NA      NA        NA
PONDxSWFL      1.690e-01         NA      NA        NA
PONDxSWSH      5.790e-02         NA      NA        NA
PONDxFRST      4.036e-02         NA      NA        NA
STRMxSWFL      5.960e-02         NA      NA        NA
STRMxFRST      1.113e-02         NA      NA        NA
STRMx         -6.364e-06         NA      NA        NA

Overdispersion coefficients:
                 Estimate Std. Error z value Pr(> z)
phi.(Intercept) 1.123e-08         NA      NA      NA

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-1.335e+02         15        127       -Inf  2.970e+02  3.008e+02
```

AICc 1st model scatter plot: Observed vs. fitted density



Common Merganser

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
COME.08	13	471.9	0.00	0.48	0.48
COME.07	14	473.7	1.79	0.20	0.68
COME.02	11	475.1	3.18	0.10	0.78
COME.10	15	475.5	3.58	0.08	0.86
COME.12	15	475.9	3.99	0.07	0.92
COME.01	12	477.5	5.58	0.03	0.95
COME.09	16	477.7	5.83	0.03	0.98
COME.04	13	479.9	8.03	0.01	0.99
COME.06	13	480.3	8.42	0.01	0.99
COME.03	14	481.7	9.81	0.00	1.00
COME.11	20	482.2	10.27	0.00	1.00
COME.05	18	487.6	15.71	0.00	1.00
COME.00	32	506.6	34.67	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -6.974e-01  4.503e-01 -1.549e+00 1.214e-01
ECORC        9.760e-01  4.703e-01  2.075e+00 3.796e-02
ECORD        3.243e-01  4.795e-01  6.764e-01 4.988e-01
ECORE       -4.207e-01  6.269e-01 -6.710e-01 5.022e-01
ECORF        3.404e-01  5.051e-01  6.739e-01 5.004e-01
ECORG        9.996e-01  4.799e-01  2.083e+00 3.724e-02
LAKE         3.840e-04  1.995e-04  1.925e+00 5.419e-02
POND         2.887e-04  5.395e-03  5.351e-02 9.573e-01
RIVR        -2.674e-03  1.957e-03 -1.366e+00 1.718e-01
WATExISLA    5.947e-04  2.899e-02  2.052e-02 9.836e-01
WATExSWFL    7.134e-02  3.994e-02  1.786e+00 7.406e-02
WATEx        2.126e-02  5.550e-03  3.831e+00 1.274e-04

Overdispersion coefficients:
                 Estimate Std. Error   z value Pr(> z)
phi.(Intercept) 2.570e-06      2e-13 1.285e+07   0e+00

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance        AIC       AICc
-2.215e+02         13        129       -Inf   4.69e+02  4.719e+02
```

AICc 2nd model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept) -6.903e-01  4.598e-01 -1.501e+00 1.333e-01
ECORC        1.017e+00  4.787e-01  2.124e+00 3.367e-02
```

ECORD	4.008e-01	4.880e-01	8.213e-01	4.115e-01
ECORE	-4.019e-01	6.345e-01	-6.334e-01	5.265e-01
ECORF	3.988e-01	5.129e-01	7.776e-01	4.368e-01
ECORG	1.028e+00	4.881e-01	2.106e+00	3.522e-02
LAOZ050	2.536e-04	2.327e-04	1.090e+00	2.758e-01
LANZ050	2.244e-03	2.132e-03	1.053e+00	2.924e-01
POND	1.219e-03	6.045e-03	2.017e-01	8.401e-01
RIVR	-1.347e-03	2.412e-03	-5.583e-01	5.767e-01
WATExISLA	-9.518e-03	3.015e-02	-3.156e-01	7.523e-01
WATExSWFL	7.753e-02	4.027e-02	1.925e+00	5.418e-02
WATEx	1.439e-02	1.061e-02	1.356e+00	1.752e-01

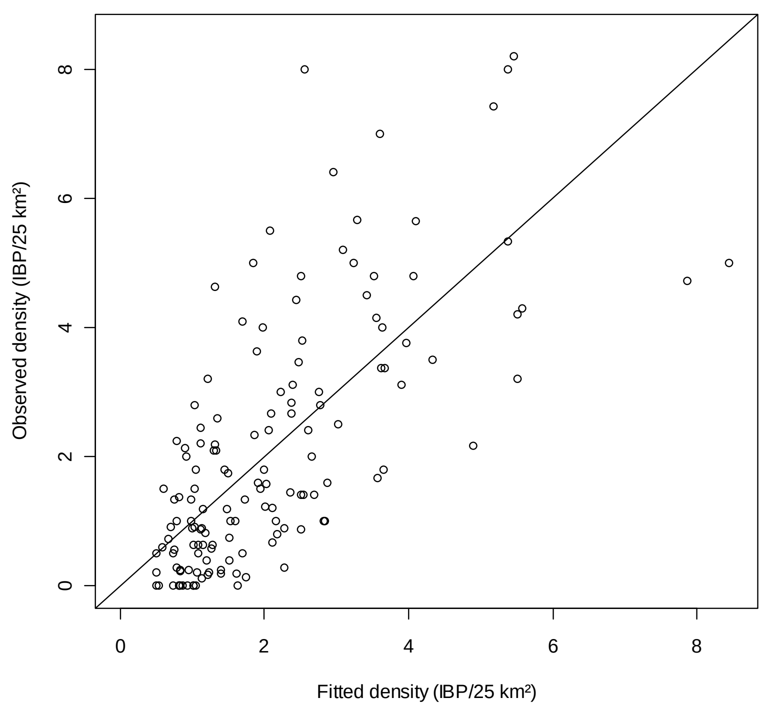
Overdispersion coefficients:

	Estimate	Std. Error	z value	Pr(> z)
phi.(Intercept)	5.205e-10	2e-13	2.603e+03	0e+00

Log-likelihood statistics

Log-lik	nbpar	df res.	Deviance	AIC	AICc
-2.212e+02	14	128	-Inf	4.704e+02	4.737e+02

AICc 1st model scatter plot: Observed vs. fitted density



Total waterfowl

AICc summary table

Model no.	df	AICc	Δ_i	w_i	Cumulative w
WTFL.05	14	986.8	0.00	0.56	0.56
WTFL.03	16	988.8	2.04	0.20	0.76
WTFL.06	14	989.8	3.04	0.12	0.88
WTFL.04	11	990.0	3.26	0.11	0.99
WTFL.02	19	995.9	9.16	0.01	1.00
WTFL.11	16	999.8	13.04	0.00	1.00
WTFL.01	22	1001.0	14.27	0.00	1.00
WTFL.12	16	1001.4	14.68	0.00	1.00
WTFL.09	18	1003.0	16.23	0.00	1.00
WTFL.10	13	1005.0	18.22	0.00	1.00
WTFL.08	21	1008.9	22.16	0.00	1.00
WTFL.00	31	1016.4	29.58	0.00	1.00
WTFL.07	24	1017.1	30.38	0.00	1.00

AICc 1st model summary table

```
Negative-binomial model
-----------------------
Fixed-effect coefficients:
              Estimate Std. Error    z value Pr(> |z|)
(Intercept)  2.450e+00  3.172e-01  7.726e+00 1.110e-14
X           -8.357e-04  1.743e-04 -4.794e+00 1.637e-06
Y           -3.231e-05  4.059e-04 -7.960e-02 9.366e-01
Z           -8.709e-04  3.605e-04 -2.416e+00 1.571e-02
LANZ050      1.521e-03  1.018e-03  1.494e+00 1.352e-01
POND         1.104e-02  3.664e-03  3.012e+00 2.594e-03
LAKExOPWE    5.467e-02  2.798e-02  1.954e+00 5.072e-02
LAKExSWFL   -1.296e-01  1.195e-01 -1.084e+00 2.782e-01
PONDxOPWE    5.291e-02  2.658e-02  1.991e+00 4.651e-02
PONDxSWFL    1.089e-01  6.283e-02  1.733e+00 8.316e-02
WATEx       -2.248e-03  4.876e-03 -4.610e-01 6.448e-01
STRMxOPWE   -5.912e-04  9.939e-03 -5.948e-02 9.526e-01
STRMxSWFL    4.395e-02  7.112e-02  6.180e-01 5.366e-01

Overdispersion coefficients:
                 Estimate Std. Error   z value   Pr(> z)
phi.(Intercept) 1.182e-01  2.564e-02 4.609e+00 2.022e-06

Log-likelihood statistics
   Log-lik      nbpar    df res.   Deviance         AIC        AICc
-4.777e+02         14        128       -Inf   9.835e+02   9.868e+02
```

AICc 1st model scatter plot: Observed vs. fitted density