Title: Early avian functional assemblages after fire, clearcutting, and post-fire salvage logging in North American forests

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ABSTRACT

Increased demand for timber, the reduction in the available timber resources, more frequent and severe forest fires under a changing climate have increased the use of salvage logging in North American forests despite concerns regarding impacts on biodiversity and long-term forest productivity. We aimed to complement previous approaches that used bird species richness or individual abundance in salvage-logged habitats to assess the sustainability of this practice. We looked for commonalities in the taxonomic, functional and phylogenetic components of bird assemblages among these three post-disturbance habitats across a broad geographic range. We compiled six North American datasets selected from primary and grey literature that documented species composition of avian assemblages in habitats after recent fire, post-fire salvage logging and traditional logging. Our results revealed contrasting patterns of bird trait assemblage among burned, post-fire salvage and traditionally logged habitats. In salvage-logged habitats, taxonomic diversity, functional diversity, functional and phylogenetic redundancy were significantly lower than in both burned and traditionally logged habitats. The frequency of insectivores was significantly lower after salvage logging than after both fire and traditional logging. These findings suggest that cumulative disturbances have a negative effect on early assembly of bird communities. The outcomes of this study encourage further assessments, at landscape level, of salvage logging intensity, burn size and fire severity on bird functional structure to better plan for their conservation.

Keywords: Phylogenetic redundancy, Forest disturbance, Functional redundancy, Taxonomic diversity, Timber supply

INTRODUCTION

Post-fire salvage logging is becoming more prevalent worldwide (Lindenmayer et al. 2008; Müller et al. 2019). It may become even more so if forecasted increases in the frequency and severity of natural disturbances under climate change scenarios hold true (Price et al. 2013) and burned forests become more accessible with the expansion of road networks and infrastructure. Minimizing the ecological effects of salvage logging while maintaining its economic benefits is challenging (Lindenmayer and Noss 2006; McIver and Starr 2000). A potentially significant factor associated with salvage logging is the cumulative effect of following natural (e.g. fire) disturbance with anthropogenic (e.g. clear cutting) disturbances (Lindenmayer et al. 2017) on ecosystem composition (i.e. biotic and abiotic components) and function (i.e. collective biotic activity of plants, animals, and microbes and their effects on the physical and chemical conditions of their habitat (Naeem 1998). After fire, forests are dominated by high snag densities in addition to patches of living trees of varying sizes according to fire severity (Lindenmayer et al. 2008; Nappi et al. 2004). By removing snags, post fire salvage logging modifies habitat structure (Lewis and Hartley 2006; Lindenmayer and Noss 2006) and reduces resource availability for species feeding and/or nesting in dead wood. After traditional logging, the majority of merchantable trees are removed and the harvested stands are dominated by shrubs, herbs, regenerating trees and some canopy trees within block residual retention (Swanson et al. 2011).

Several biodiversity indicators (e.g. species occurrence, species richness) have previously been used to assess the ecological impact of major forest disturbances (Lindenmayer and Noss 2006). The immediate stand-scale effect of salvage logging on biodiversity has received a lot of attention in the literature (Cahall and Hayes 2009; De Bello et al. 2007; Lindenmayer and Noss 2006; Nappi et al. 2004), with birds being one of the species groups having seen the most attention. Bird communities play many roles in ecosystem function (Mikusiński et al. 2018), including regulating predator populations, controlling populations of their prey (Van Bael et al. 2003) and enhancing plant reproduction via pollination or seed dispersal (Anderson et al. 2011). Some birds act as keystone species (Drever and Martin 2010; Hutto and Gallo 2006; Koivula and Schmiegelow 2007; Nappi et al. 2010). For example, woodpeckers generate habitat (i.e. excavation of cavities in trees) for secondary cavity users that can facilitate post-fire regeneration through seed dispersal, seed germination and regulation of insect populations, which in turn affect vegetative growth (Gregory et al. 2005; Vandewalle et al. 2010; Venier and Pearce 2004). Since bird populations show relatively rapid responses to environmental change, they represent sensitive indicators of habitat conditions (Gregory et al. 2005; Vandewalle et al. 2010; Venier and Pearce 2004).

Previous work on the response of birds to salvage logging has primarily focussed on cavity-nesting birds, which are thought to be particularly sensitive to post-fire logging because unlogged post-fire habitat provides cavity nesting habitat (Drever and Martin 2010; Hutto and Gallo 2006; Koivula and Schmiegelow 2007; Nappi et al. 2010). Aside from work on cavity nesters, most bird studies have focused on taxonomic diversity (i.e. species richness or abundance) (Cahall and Hayes 2009; Morissette et al. 2002). Examining the impact of salvage logging on taxonomic diversity has the advantages of being sensitive to short-term dynamics and easily interpretable (Saint-Germain and Greene 2009). Unfortunately, the response of taxonomic diversity to a disturbance can rarely be generalized to other regions. It may not provide insight into the interaction between birds and their environment (Klingbeil and Willig 2016a; Lindenmayer and Noss 2006; Vandewalle et al. 2010) and other regions (Hobson and Schieck 1999). Examining the response of trait-based functional groups (as opposed to individual species) could complement single-parameter approaches (e.g. species richness) by providing possible mechanistic insights not revealed through analyses of taxonomic diversity (Lindenmayer et al. 2014; Mouillot et al. 2013; Tarbill et al. 2015; Vandewalle et al. 2010). Functional traits are presumed to either have an effect on ecosystem function (e.g. seed dispersal, structural transformation, pest regulation) or characterize a response to environmental change (e.g. resource availability and disturbance) (Lavorel and Garnier 2002; Luck et al. 2012). For instance, foraging and nesting traits are related to resource use (e.g. insects, seeds) and changes in ecosystem structure (e.g. modification of soil and tree structure) and thereby provide habitat to other organisms. After a forest fire, it is well established that the activity of cavity excavating birds have cascading effects on forest succession (Tarbill et al. 2015). Less is known about whether other functional groups and interactions occur in early post-disturbance forests that may have ecological implications.

Bird communities can be described using many competing and/or complementary indices such as taxonomic diversity, functional diversity considering trait distance (FD, i.e. range in the number of ecological functions represented in a community) or functional diversity considering phylogenetic distance (PFD) or functional redundancy (FR, i.e. the number of species playing the same functional role) or phylogenetic redundancy (PFR). Although, high FD is often linked to greater resilience (Elmqvist et al. 2003; Ricotta et al. 2016), it has been predicted that conserving high FR should buffer communities following disturbance via species compensation (i.e. remaining species playing similar ecological roles as those lost from disturbance) (Concepción et al. 2016; Laliberté et al. 2010; Ricotta et al. 2016). Functional diversity and redundancy have a more direct relationship with community resilience to environmental change than taxonomic diversity (Mayfield et al. 2010; Petchey et al. 2007; Ricotta et al. 2016) and functional and taxonomic diversity may differentially respond to disturbance (Laliberte et al. 2010). Ultimately, examining the response of both taxonomic and functional diversity may provide more robust measures of the potential implications of disturbance on bird communities' resilience to disturbances than taxonomic diversity alone (Klingbeil and Willig 2016b; Lavorel and Garnier 2002; Ricotta et al. 2016).

In this study, we use a set of taxonomic diversity, functional diversity, functional and phylogenetic redundancy indices to test two hypotheses regarding the impact of disturbance on forest bird communities. We hypothesized that: 1) assemblages based upon the ecological traits of birds would differ among burned, traditionally logged and salvage-logged habitats due to the strong link between bird composition and habitat structure (Schieck and Song 2006); 2) salvage logging after fire should reduce taxonomic diversity, functional diversity, functional and phylogenetic redundancy of bird communities because of the cumulative effects of both disturbances (Lindenmayer and Noss 2006). To assess these predictions, we used legacy datasets of bird species composition and abundance in burned non-salvage, post-fire salvage and traditional logged North American forests, derived from peer-reviewed and grey literature.

METHODS

Literature search

Our literature survey included a search between September and November 2014 in ISI Web of Science and Google Scholar using the combination of different key words related to avian community in North America boreal forests and species composition changes after fire, post-fire salvage logging and traditional logging. We used the following search terms; ("boreal forest" OR "conifer forest" AND "salvage logging" OR "salvage cutting" OR "salvage harvesting" OR "commercial logging" OR "commercial cutting" OR "conventional harvesting" OR "traditional harvesting" OR harvesting OR logging OR fire OR wildfire AND bird* OR "species abundance"

OR "functional diversity"). We also obtained relevant papers, theses and reports listed in the references of primary and grey literature from the aforementioned literature search. We only selected studies that explicitly considered changes in bird community within 5 years after disturbances (fire, post-fire salvage logging, and traditional logging) in Canadian forests. Studies targeting specific bird groups (such as cavity nesters, woodpeckers) or a limited number of species from the final data compilation were excluded to avoid biased comparisons.

Data compilation

We compiled six North American datasets selected from primary (peer-reviewed) and grey literature that documented species composition of avian assemblages in coniferous, deciduous and mixed wood forests after recent (≤5 years) fire, post-fire salvage logging and traditional logging (Fig. 1; Table S1). We obtained raw data from three studies and extracted data from three published studies that provided a complete list of species and abundances. When a study had missing information that was important to consider in the study such as species abundance or occurrence, we contacted the authors for additional information. We excluded any study for which the species abundance or occurrence data were unavailable within the study. For these latter studies, we extracted the mean frequency of occurrence or species abundance for each site where point count sampling had been applied. We pooled data from stand types within the same treatment nested within individual study and treated these as our study sites. For the three studies in which we had access to the raw data, we calculated mean frequency of occurrence or abundance of species per treatment within each stand from raw data (Azeria et al. 2011; Song and Hannah unpublished; Van Wilgenburg and Hobson 2008), to make them comparable to estimates extracted from the four published studies. To ensure comparability between datasets surveyed using different methods (see Table S1), we calculated the relative contribution of each species to its community (pi). The data table Y = [yij] presents sites in rows and species occurrence or abundance in columns. Each species mean frequency of occurrence or abundance (xi) was divided by the row sums yi+ following Legendre and Gallagher (Legendre and Gallagher 2001): pi = xi/yi+. We had 17 sites in total distributed between the three treatments: fire (with no salvage logging or less than 33% area salvage-logged; n=6), salvage logging (i.e., more than 33% area salvage-logged after fire; n=7) and traditional logging (i.e., clear-cut forest; n=4).

Bird trait selection

We selected seven species traits which are potentially sensitive to forest disturbances (Luck et al. 2013; Vandewalle et al. 2010). The selected traits are mainly related foraging and nesting behaviours, resource acquisition (foraging guild), mobility (body mass), reproduction (clutch size, nesting behaviour) and ecosystem engineering or structural transformation (nest location and guild). More details on potential response to environment and effect on ecosystem function of selected traits are reported in Table 1. We derived trait data from species accounts in the Birds of North America (Poole 2005) and phylogeny data in BirdTree.org (Jetz et al. 2014).

Data analysis

To assess community trait variation among disturbances, the relationship between bird species traits and disturbance type (traditional logging, fire, salvage logging, undisturbed) was tested using RLQ analysis (Dray et al. 2014). RLQ analysis is a three-matrix ordination method that relates species abundance and traits to environmental factors. The three matrices are: (1) L (community data) with species as columns and sampling units as rows; (2) Q (traits data) with traits as columns and species as rows; and (3) R (environmental data) with treatments (disturbance) as columns and sampling unit as rows. Prior to the analysis of trait data, we standardized body mass and clutch size (using Z-score scaling) to reduce the high variation in magnitude of species body mass and clutch size. We use the *rlq* function implemented in the "ade4" package version 1.7-15 (Bougeard and Dray 2018; Dray and Dufour 2007) of R the statistical and programming environment version 3.6.3 (R Core Team 2020) to perform RLQ analysis. We tested the significance of the relationship between treatments (R) and species functional traits (Q) using a "model 6" (Dray et al. 2014) Monte Carlo permutation test with 9999 permutations. Monte Carlo permutation tests were performed using the function *randtest* implemented in the "ade4" package version 1.7-15. Permutation "model 6" combines permutation "model 2" (i.e. permute entire rows of matrix L to test the null hypothesis that the distribution of species with fixed traits is not influenced by the environmental conditions) and "model 4" (i.e. permute entire columns of matrix L to test that the species composition of the sampling units is not influenced by the species traits) (Dray et al. 2014).

We used a set of complementary indices to describe the bird communities. (1) Taxonomic diversity (SD) is a measure of diversity that considers species relative abundance. 2) Functional diversity (FD) is the range in the number of ecological functions represented in a community considering trait distance (i.e. trait divergence between species) and 3) PFD when considering phylogenetic distance. 4) Functional redundancy (FR) is the number of species with similar functional roles considering trait distance and 5) phylogenetic redundancy (PFR) when considering phylogenetic distance. We used *rao.diversity* function implemented in "SYNCSA" package version 1.3.4 (Debastiani and Pillar 2012) to compute the indices. We calculated community taxonomic diversity within each treatment using the Gini-Simpson index (Simpson 1949). The rationale behind the use of Gini-Simpson index (SD) is its direct relationship with the functional diversity (FD) and functional redundancy (FR) indices (i.e. FR= SD-FD) (De Bello et al. 2007). We calculated FD and PFD using Rao's quadratic entropy index (Rao 1982). Functional diversity (FD) and FR were computed separately for each of the seven selected traits and for the overall trait assemblages by treatment, while SD, PFD and PFR were computed overall trait and phylogenetic assemblage. The values of the metrics (SD, FD, PFD, FR and PFR) range between 0 (no diversity) and 1 (infinite diversity).

The statistical analyses of the diversity and redundancy indices followed a protocol for data exploration described by Zuur et al. (2010), and protocols for conducting and presenting regression-type analyses (Stasinopoulos et al. 2017; Zuur and Ieno 2016; Zuur et al. 2010). We investigated what theoretical distribution came closest to the marginal distribution of the dependent variable (i.e. SD, FD, PFD, FR and PFR). We used the *fitDist* function of gamlss package version 5.1-4 (Rigby and Stasinopoulos 2005) in order to find the best fit (based on the Akaike's Information Criterion (AIC) of the different fitting attempts) among a list of distributions adapted to positive real number (ranged between 0 and 1) data available in the gamlss.dist package version 5.1-4 (Stasinopoulos and Rigby 2019). The simplex distribution had the best fit based on AIC for SD, FD and PFD, while beta distribution has the best fit for FR and PFD (Table S2).

Since the data were from different locations and stand types, we therefore applied mixed effect models with the combination of Location (4 levels) and Stand_type (3 levels) being treated as a random effect. To model the community diversity indices as function of disturbance, we used a Generalized Additive Model for Location, Scale and Shape (GAMLSS) with the best-fit family distribution (Table S2) mentioned above for each response variable. GAMLSS family distributions have up to four parameters (μ, σ, ν, τ). The terms location, scale, and shape refer to these parameters and are connected, but necessarily equal, to the four moments of a distribution, namely the mean (μ), the variance (σ), the skewness (ν), and the kurtosis (τ). GAMLSS is a modern distribution-based approach to regression analysis that expands traditional approaches to accommodate distribution parameters that are modeled as additive functions of predictor variables (Barber 2018). We included disturbance type as a fixed effect factor in our models. Model assumptions were verified by plotting residuals against fitted values to assess homoscedasticity; making QQ plots and computing filliben correlation coefficients to verify normality and using worm plots to visualize model fit to the data (Stasinopoulos et al. 2017). We performed likelihood-ratio tests to assess significance of the fixed and random factors.

We investigated the functional rarity within communities between disturbance types. Rare species perform different functions in ecosystems, some being redundant with those of many other rare and common species, while others are unique (Violle et al. 2017). We computed the functional rarity (Uniqueness) and taxonomic scarcity (Scarcity) indices. Uniqueness (UI) measures how functionally rare a species is, with values ranging from 0 indicating that the focal species shares the exact same traits as other species in the pool and conversely to 1 indicating the species shares no traits as others in the pool. Scarcity (SI) measures how abundant a species is in comparison to other species within a community with values ranging from 0 indicating that the focal species is abundant to 1 indicating the opposite. We used the “funrar” package version 1.2.1 (Grenié et al. 2017) to compute the functional uniqueness and the taxonomic scarcity indices.

All graphics were produced using the “ggplot2” package version 3.3.0 (Wickham 2016).

RESULTS

Bird traits response to disturbances

The first axis of the RLQ analysis captured 78% of the total association between traits and disturbance classes (i.e. co-inertia), accounting for most of their relation. The Monte Carlo permutation “model2” test was significant (*P*=0.048) indicating that trait assemblages were significantly associated to disturbances. In addition, the Monte Carlo permutation “model 4” was not significant (*P*=0.172) indicating that species composition of the sampling units was not significantly influenced by species characteristics. The summary statistics showed that the axis 1 describes 40% of the covariance between disturbances and traits. The RLQ axis 1 split the bird trait assemblage along a gradient from naturally disturbed (positive side of axis 1) to anthropogenically disturbed forest types (negative side of axis 1, Figure 2), with logged forests falling between non-salvaged and salvaged habitats. For example, there were cavity nesters on the positive side vs non-cavity nesters on the negative side of axis 1; tree nesters vs shrub and ground nesters; omnivores and insectivores vs herbivores; bark foragers, foliage gleaners and aerial foragers vs ground foragers. Axis 2 of the RLQ analysis captured 22% of the association between traits and disturbances and described 20% of covariance between them. The second axis corresponded to a gradient of trait assemblage between traditionally logged and both non-salvaged and salvaged forests. Carnivores, aerial and ground nesters were associated with traditionally logged landscapes (i.e. fell on negative side of the axis 2), while herbivores and shrub nesters more associated with salvage logged landscape (i.e. falling on negative side of axis 2).

Bark foragers that are mainly omnivores or insectivores and tree cavity nesters were the most frequent in burned and non-salvage habitat assemblages. Species associated with salvage-logged habitats were predominantly ground foragers that are herbivores and shrub nesters. The analysis also associated suggested body mass was positively correlated with salvage logging. Species using open habitats, ground nesters and carnivores characterized harvested habitats.

Birds' community metric response to forest disturbances

Bird taxonomic diversity (SD) differed substantially among disturbances (Table 2A). The validation of the model describing taxonomic diversity indicates no violation of assumptions (i.e. independence and absence of residual patterns, Figure S1), and the worm plots indicates an appropriate model fit (i.e. 95% of the worm plot lying within the dashed confidence bands). The taxonomic diversity in burned habitats was significantly lower compared to traditionally logged habitats (0.89 *vs* 0.93), while it was significantly higher (0.89 *vs* 0.77) in burned habitats compared to salvage-logged habitats (Figure 3.A, Table S3A). The effect of disturbance on taxonomic diversity was largely masked by high variation among measurements (Table S3A; Figure 3B). The highest coefficient of variation (σ) was observed in salvage-logged habitats (2.84) while there were similar in burned and traditionally logged habitats (0.92 and 0.93 respectively).

Global functional diversity (FD, univariate index) considering trait distance, did not statistically differ among disturbance types (Table 2B; Figure 3C; Table S3B). However, the coefficient of variation was significantly higher in salvage-logged habitats compared to the other disturbances (Table 2B, Figure 3D). Analysis of individual traits showed that foraging strategy FD was significantly lower in salvage-logged habitats than in both burned or traditionally logged (0.51 *vs* 0.53) habitats (Table 3A). Additionally, nesting guild FD in burned habitats was significantly higher than in salvage-logged habitats (0.31 *vs* 0.24), while the latter was significantly higher than in traditionally logged ones (0.24 *vs* 0.19). Functional diversity, considering phylogenetic distance, was significantly higher in burned habitats than in both harvested (0.01 *vs* 0.00) and salvage-logged (0.01 *vs* 0.00) habitats (Table 2C; Figure 3E, Table S3C) and the coefficient of variation followed the same pattern (Figure 3F). Model validations suggested good fit (Figure S2 & S3).

Global functional redundancy (FR, Univariate index) in burned habitats was significantly lower than in traditionally logged habitats (0.37 *vs* 0.33), while it was significantly higher in harvested habitats (0.40) than in burned ones (Table 2D; Figure 3G, Table S3D). The coefficient of variation exhibited converse pattern (Figure 3H.). The phylogenetic redundancy of the bird community followed the same pattern of the global functional redundancy (Table 2E; Figure 3I & J, Table S3E). Analysis of individual traits showed that functional redundancy in salvage-logged habitats was significantly lower than in burned habitats (e.g. foraging guild, habitat affinity, nest location and body mass) and in traditionally logged habitats (clutch size; Table 3B). Only foraging strategy and nest guild FR did not exhibit significant differences among disturbances. Model validation suggested the data were well fit by the models (Figure S4 & S5).

The functional uniqueness analysis revealed that insectivores with higher uniqueness values (i.e. high functional distance from other species) in salvage-logged habitats were *Cardellina pusilla*, *Catharus ustulatus*, *Certhia americana*, *Empidonax flaviventris*, *Empidonax minimus*, *Empidonax traillii*, *Mniotilta varia*, *Poecile atricapillus*, *Troglodytes aedon* and *Troglodytes hiemalis* (Table 4; Table A1). The taxonomic scarcity analysis show that at least 12 insectivores (*Chaetura vauxi*, *Contopus cooperi*, *Ixoreus naevius*, *Pheucticus melanocephalus*, *Poecile gambeli*, *Setophaga townsendi*, *Sialia currucoides*, *Sialia mexicana*, *Sphyrapicus nuchalis*, *Sphyrapicus thyroideus*, *Sturnus vulgaris* and *Vireo gilvus*) were abundant (SI<0.01) in non-salvage habitats, while in salvage-logged habitats these species were scarce (SI>0.80) or not represented. Two species (*Bucephala albeola* and *Setophaga fusca*) were scarce (SI>0.90) in non-salvage habitats, but they were absent in salvage-logged habitats.

DISCUSSION

Consistent with our first hypothesis, our study revealed contrasting patterns of bird community composition among burned and non-salvage, post-fire salvage and traditionally logged habitats. The RLQ results showed that species displaying specific ecological traits are differentially associated with natural and anthropogenic disturbances, with traditional logging exhibiting intermediate effects between fire and salvage logging on bird species differing in their nest location and habitat affinities. This contrast is mainly due to the differences in the remaining configuration of habitat (e.g. canopy cover, snag density) left by each disturbance (Thorn et al. 2016). Forest fire generates "keystone structures" (i.e. distinct spatial structures providing resources, shelter or goods and services that are crucial for other species (Tews et al. 2004)) for cavity nester and insectivores. These structures are characterised by stand structural complexity, habitats connectivity and landscape heterogeneity (Burton et al. 2016; Lindenmayer et al. 2006). However, salvage-logging after fire reduces these keystone structures quantity and/or quality (Lindenmayer et al. 2008) favoring ground and shrub nesters.

A meta-analysis comparing changes in boreal forest bird assembly after fire and harvesting reported that post-fire communities still differed from post-harvest ones 30 years after disturbance (Schieck and Song 2006). Convergence between communities started to be observed around 60 years after disturbance (Schieck and Hobson 2000). To our knowledge, no studies have yet examined convergence between fire and salvage-logged stands. The reduction of keystone structures in salvaged habitats and the attendant impacts on insectivores (i.e. loss of perches, potential nest sites and resource upon which insects forage) could exacerbate the widespread declines that North American insectivores are experiencing (Kelly et al. 2013; Nebel et al. 2010; Sauer et al. 2017) if salvage logging becomes more widely used. While the long-term consequences of declining insectivore populations on forest ecosystem health are unclear, it may reduce the extent of natural pest control (e.g. some bark beetles or long horn beetles) (Dolbeer 2008; Naylor and Ehrlich 1997).

Our results also showed that salvage-logged habitats had the lowest taxonomic diversity, global functional diversity, functional and phylogenetic redundancy among all the disturbances considered. This is consistent with our expectations that salvage logging would reduce avian taxonomic diversity, functional diversity, functional and phylogenetic redundancy after fire. Thorn et al. (2017) found that bird taxonomic diversity was significantly lower in salvage-logged habitat than in non-salvage habitats. Our results also revealed a decrease in bird functional diversity after salvage logging. For instance, individual traits such as foraging strategy and nest guild had lower functional diversity in salvage-logged habitats than in burned and non-salvaged habitats. This is consistent with previous studies (Cahall and Hayes 2009; Hutto et al. 2015; Nappi and Drapeau 2011) that reported negative effect of salvage logging on cavity nesters, bark and aerial foragers due of the reduction of the keystone structures.

We observed that functional and phylogenetic redundancy of bird communities was lowest in salvage-logged habitats, suggesting that many species in these habitats are functionally and phylogenetically unique compared to both burned and harvested habitats. In fact, post fire habitats have high structural complexity (i.e. spatial heterogeneity) that results in greater representation of species displaying ecological traits such as insectivory and cavity nesting (Hutto et al. 2015; Morissette et al. 2002; Nappi et al. 2010). In contrast, traditionally (green) harvested habitats displayed patterns of community composition that were intermediate between fire and salvage logging with respect to the ecological traits of the constituent species.

The under scarcity of insectivores and cavity nesters species (e.g. *Bucephala albeola*, *Certhia americana*, *Chaetura vauxi, Contopus cooperi*, *Empidonax flaviventris*, *Empidonax minimus*, *Ixoreus naevius*, *Pheucticus melanocephalus*, *Pica hudsonia*, *Poecile atricapillus*, *Poecile gambeli*, *Poecile rufescens*, *Setophaga fusca*, *Setophaga townsendi*, *Sialia mexicana*, *Sphyrapicus nuchalis*, *Sphyrapicus thyroideus*, *Sphyrapicus vulgaris*, *Troglodytes aedon* and *Troglodytes hiemalis*) in salvage-logged habitats compared to post fire ones, suggests a loss of some functional roles after salvage-logging. Salvage logging disrupts the specific functional roles of some bird species and their associated partners post-fire (e.g. marked reduction of insect population control or marked reduction in seed dispersal). The disruption of these specific functional roles of some birds depends on both fire severity and salvage logging intensity, since salvage logging targets the least burned forests (Koivula and Spence 2006). The least burned habitats can function as refugia for species associated with unburned habitats. If most of the burned forests are salvage-logged, it could have a negative impact on the conservation of some bird species.

Limiting or reducing logging intensity to keep a suitable residual structure of fire legacy connected to green forest might help to mitigate salvage logging impact. As some ecological traits are positively associated with increased fire severity, the retention of the most severely burned stands which have reduced timber value may preserve components of the bird community and help maintain ecological functions performed by birds on the landscape (Koivula and Schmiegelow 2007; Smucker et al. 2005). However, the most severely burned stands are also the least colonized by saproxylic insects, which are the food for woodpeckers (Saint-Germain et al. 2004; Saint-Germain et al. 2007). These stands could be useful for at least one idiosyncratic longhorned beetle (*Gnathacmeops pratensis*) but they would not provide diverse and abundant food for bark foragers. Some authors suggested keeping the periphery of burned stands to make sure ecotones are maintained (Boucher et al. 2016; Nappi and Drapeau 2011). Maintaining ecotones along the burn periphery could facilitate species colonizing burned stands from adjacent green forest as it would reduce dispersal distances for birds and insects, many of which use both habitats. Since any single disturbance will disadvantage species not possessing traits adapted to the ecological conditions created by that disturbance, the precautionary approach would be to vary the level of retention between salvage logged stands (Bunnell and Houde 2010) and to maximize the connectivity between residual stands (Boucher et al. 2016; Nappi and Drapeau 2011).

Although we recommend limiting post fire salvage logging to conserve the functional roles played by birds, data on how trait assemblage patterns vary with fire size and severity are lacking and needed. Fire severity and size are known to have a strong effect on bird communities as well as the insects on which they feed (Boucher et al. 2016; Luck et al. 2012; Stephens et al. 2015). Understanding the relationship between bird community dynamics and fire size and severity would lead to the identification of high conservation value forests for burn-associated birds and would improve retention strategies for salvage logging operations. In conclusion, we show that in North American forests, ecological trait composition of bird communities varies between post disturbance habitats. Importantly, salvage logging significantly reduces bird taxonomic diversity, functional diversity, and both functional and phylogenetic redundancy after fire. Although we believe that we can broadly generalize our findings to other North American forests, studies are needed to test the generality of this finding in other regions in the world and to determine the variation around this estimate.

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Table 1. Description of the selected traits

Functional Trait	Class	Example of responses and effects on ecosystem function
Foraging strategy	Ground forager Bark forager Foliage gleaner Aerial forager	Resource use (e.g. reduced primary diet) and competitiveness (e.g. enhenced pollinisation by insects)
Foraging guild	Herbivorous Insectivorous Omnivorous Carnivorous	Resource use, seed dispersal (e.g. reduced seed germination and seedling survival) and predation (e.g. pest regulation)
Habitat affinity	Open canopy Forest	Resource use (e.g. reduced habitat specialists), reproductive effort (e.g. reduce reproduction sites), ecosystem engineering (e.g. tree cavities excavation providing habitat features for seed dispersers, insectivores and small predators)
Nest location	Ground Shrub Tree	Reproductive effort (e.g. reduced response capacity due to low reproductive sites), ecosystem engineering (e.g. modification of soil, trees and canopy structures, creating substantial nutrient concentration)
Nest guild	Non-cavity-nester Cavity-nester	Reproductive effort (e.g. loss of large cavity bearing tree reduce cavity nesting bird), ecosystem engineering (e.g. modification of large trees and canopy structures, provision of nesting habitats for other organisms)
Clutch size (Mean)	Quantitative	Reproductive effort (e.g. reduced response capacity due to low reproductive rates) and trophic interactions (e.g. prey availability and

		predation pressure)
Body mass (Average)	Quantitative	Resource use (e.g. reduced response capacity due to low turnover rates), mobility (e.g. habitat fragmentation)

Trait description and examples of potential responses to disturbance and effects on ecosystem function according to literature (Luck et al., 2012; Concepción et al., 2016a; Williams and Purves, 2011) are provided.

Table 2. Likelihood ration tests (LRT) for the predictors of Gini-Simpson index (A), Rao quadratic entropy considering trait distance (B), Rao quadratic entropy considering phylogenetic distance (C), Functional redundancy (D), and Phylogenetic redundancy (E)

	df	AIC	LRT	p-value
A. Gini-Simpson index (SIMPLEX, μ and σ)				
μ				
Starting model		-62.31		
Disturbance	5.46	-49.02	24.21	<0.001
Random factor	3.47	-046.56	20.67	<0.001
σ				
Starting model		-62.31		
Disturbance	2.70	-56.73	10.98	0.009
B. Rao quadratic entropy with trait distance (SIMPLEX, μ and σ)				
μ				
Starting model		-57.88		
Disturbance	1.94	-60.39	1.38	0.488
Random factor	3.57	-46.61	18.41	<0.001
σ				
Starting model		-57.88		
Disturbance	2.50	-52.47	10.41	0.009
C. Rao quadratic entropy with phylogenetic distance (BE, μ and σ)				
μ				
Starting model		-154.15		
Disturbance	1	-148.46	7.96	0.006
Random factor	<0.01	-153.67	0.48	<0.001
σ				
Starting model		-154.15		
Disturbance	-1.19	-149.96	1.81	<0.001
D. Function redundancy (BE, μ and σ)				
μ				
Starting model		-66.51		
Disturbance	5.08	-57.96	18.72	0.002
Random factor	3.08	-63.50	9.18	0.029
σ				
Starting model		-66.51		
Disturbance	5.08	-57.95	18.72	0.002
E. Phylogenetic Redundancy (BE, μ and σ)				
μ				
Starting model		-60.76		
Disturbance	5.26	-48.45	22.64	<0.001

Random factor	3.26	-48.31	18.98	<0.001
σ				
Starting model		-60.76		
Disturbance	2.37	-55.44	10.07	0.010

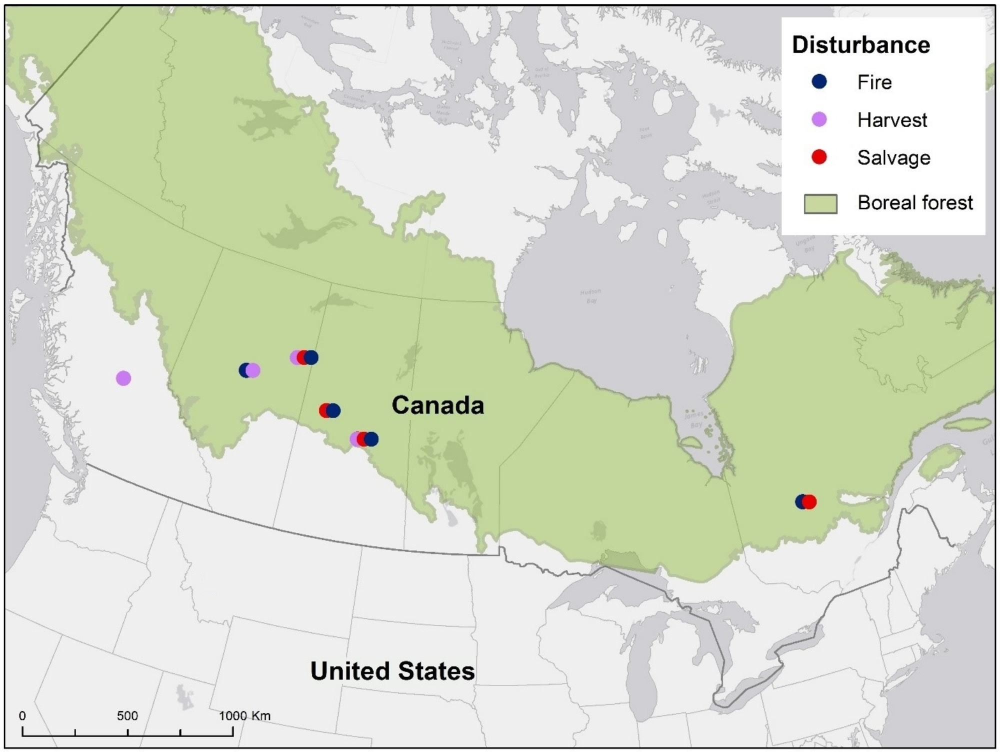
Table 3. Predicted values (Mean ± SE) across post-disturbed habitats of individual traits analysis for μ component of: (A) the (SIMPLEX, μ and σ) model for FD; (B) the (BE, μ and σ) model for FR . Bolded values indicate traits where a significant difference was detected between disturbance types (see Results).

	Fire (n=7)	Traditional logging (n=4)	Salvage logging (n=6)
A. Functional diversity measured as Rao' s quadratic entropy index (FD)			
Foraging strategy	**0.61±0.06^{a}**	**0.59±0.06^{a}**	**0.54±0.11^{b}**
Foraging guild	0.48±0.06^{a}	0.50±0.06^{a}	0.48±0.11^{a}
Habitat affinity	0.54±0.06^{a}	0.55±0.06^{a}	0.54±0.11^{a}
Nest Location	0.56±0.06^{a}	0.55±0.06^{a}	0.56±0.11^{a}
Nest guild	**0.31±0.06^{a}**	**0.19±0.06^{c}**	**0.24±0.11^{b}**
Body Mass	0.06±0.06^{a}	0.07±0.06^{a}	0.09±0.11^{a}
Clutch size	0.20±0.06^{a}	0.20±0.06^{a}	0.16±0.11^{a}
B. Functional redundancy index (FR)			
Foraging strategy	0.31±0.09^{a}	0.36±0.10^{a}	0.34±0.07^{a}
Foraging guild	**0.42±0.12^{a}**	**0.44±0.05^{ab}**	**0.36±0.08^{b}**
Habitat affinity	**0.52±0.12^{a}**	**0.50±0.11^{ab}**	**0.40±0.13^{b}**
Nest Location	**0.36±0.08^{a}**	**0.38±0.11^{ab}**	**0.30±0.14^{b}**
Nest guild	0.66±0.16^{a}	0.75±0.22^{a}	0.66±0.10^{a}
Body Mass	**0.84±0.09^{b}**	**0.86±0.10^{a}**	**0.74±0.07^{c}**
Clutch size	**0.70±0.05^{ab}**	**0.73±0.04^{a}**	**0.65±0.13^{b}**

Table 4. Summary of abundant or scarce species with high functional uniqueness. All species scarcity and functional uniqueness indices are reported in Table A1.

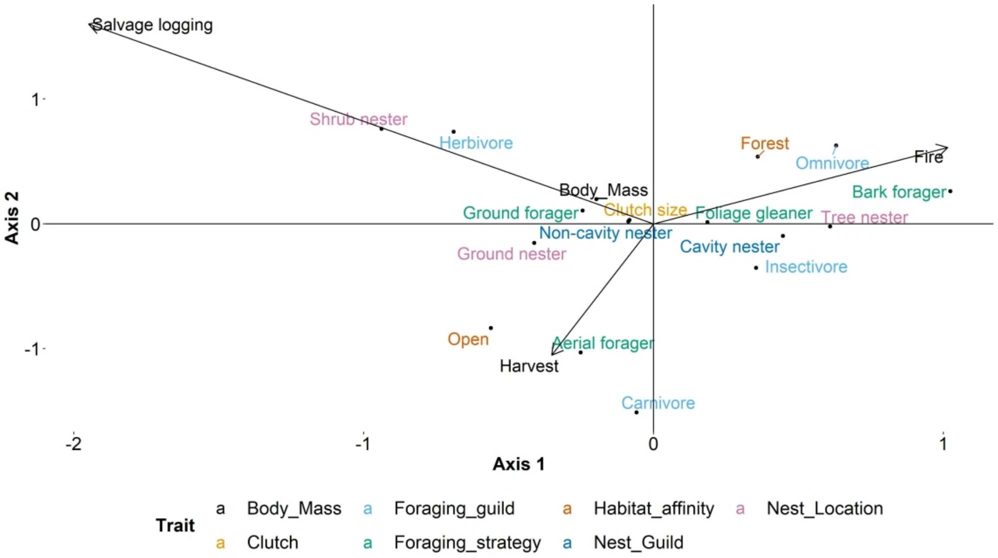
	Species scarcity index			Functional uniqueness index		
Species	Harvest	Fire	Salvage logging	Harvest	Fire	Salvage logging
Bucephala albeola	0.974	0.948	NA	0.017	0.017	NA
Cardellina pusilla	0.000	0.485	0.655	0.145	0.145	0.146
Catharus ustulatus	0.079	0.220	0.521	0.021	0.021	0.145
Certhia americana	0.760	0.281	0.572	0.146	0.144	0.146
Chaetura vauxi	NA	0.000	NA	NA	0.018	NA
Contopus cooperi	0.000	0.012	NA	0.005	0.005	NA
Empidonax flaviventris	0.818	0.535	0.764	0.146	0.146	0.146
Empidonax minimus	0.241	0.394	0.497	0.143	0.018	0.143
Empidonax traillii	NA	0.007	0.985	NA	0.002	0.145
Ixoreus naevius	0.195	0.000	NA	0.017	0.017	NA
Mniotilta varia	0.810	0.641	0.897	0.144	0.144	0.144
Pheucticus melanocephalus	NA	0.005	NA	NA	0.011	NA
Poecile atricapillus	0.374	0.279	0.812	0.144	0.001	0.144
Poecile gambeli	NA	0.000	NA	NA	0.001	NA
Setophaga fusca	0.889	0.974	NA	0.003	0.003	NA
Setophaga townsendi	NA	0.000	NA	NA	0.003	NA
Sialia currucoides	0.000	0.003	0.856	0.006	0.004	0.007
Sialia mexicana	NA	0.002	NA	NA	0.004	NA
Sphyrapicus nuchalis	NA	0.000	NA	NA	0.002	NA

Sphyrapicus thyroideus	NA	0.000	NA	NA	0.001	NA
Sturnus vulgaris	NA	0.000	NA	NA	0.010	NA
Troglodytes aedon	0.736	0.155	0.080	0.146	0.146	0.146
Troglodytes hiemalis	0.334	0.246	0.580	0.146	0.146	0.146
Vireo gilvus	0.494	0.000	0.985	0.145	0.145	0.030



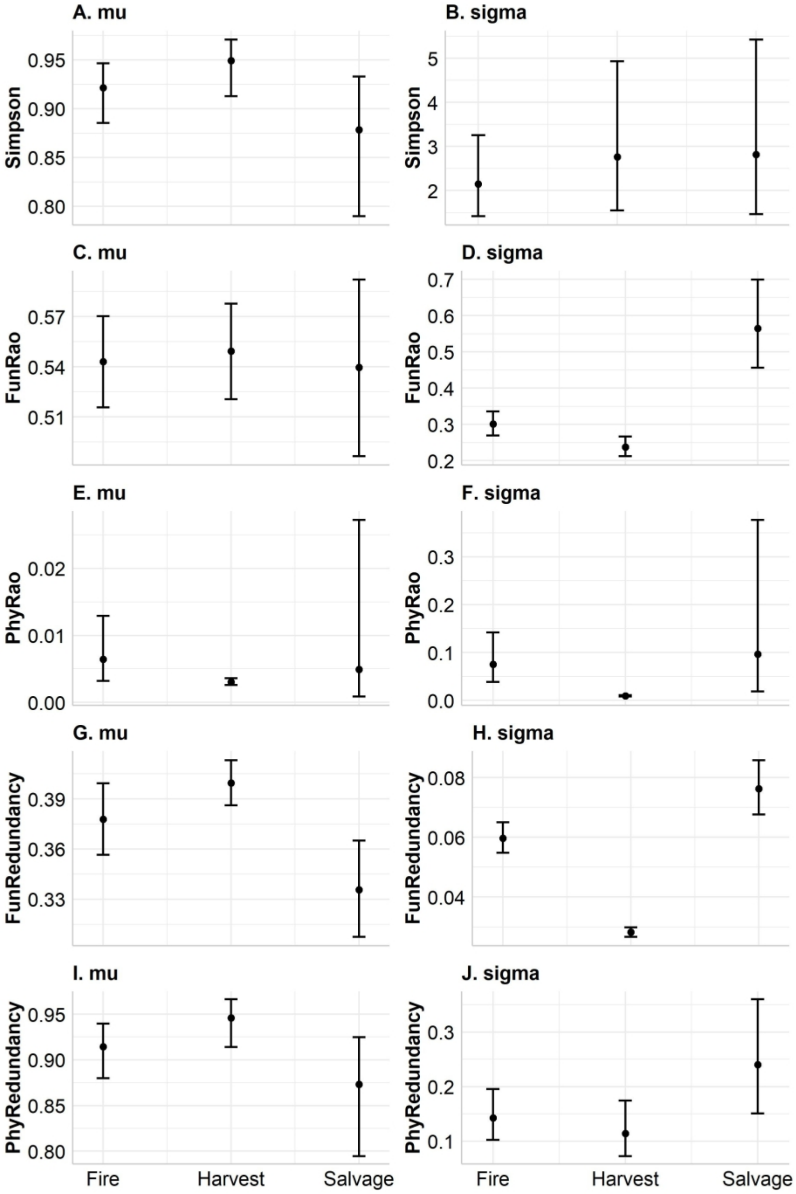
Study geographical distribution (adapted from Brandt 2009, created in ArcGIS). No permissions required from the original source/copyright holders to publish this figure.

165x125mm (220 x 220 DPI)



Relationship between traits and disturbances using RLQ analysis. Disturbance classes (Fire, Harvest, and Salvage,) are presented as vectors. Functional traits are presented as group centroids

349x199mm (300 x 300 DPI)



Predicted values and confidence intervals of additive terms of Gini-Simpson index (A. mu and B. sigma), Rao quadratic entropy considering trait distance (C. mu and D. sigma), Rao quadratic entropy considering phylogenetic distance (E. mu and F. sigma), Functional redundancy (G. mu and H. sigma) and Phylogenetic redundancy (I. mu and J. sigma) for both μ and σ components of the (SIMPLEX, μ and σ) and (BE, μ and σ) models

199x299mm (300 x 300 DPI)

Table A1. List of avia

Species	**Species_Code**	**Species_ID**
Accipiter cooperii	ACCO	COHA
Accipiter striatus	ACST	SSHA
Actitis macularius	ACMA	SPSA
Aegolius acadicus	AEAC	NSWO
Aegolius funereus	AEFU	BOOW
Agelaius phoeniceus	AGPH	RWBL
Ammospiza caudacuta	AMCAU	SALS
Ammospiza leconteii	AMLE	LCSP
Anas americana	ANAME	AMWI
Anas crecca	ANCRE	GWTE
Anas cyanoptera	ANCY	CITE
Anas discors	ANDIS	BWTE
Anas platyrhynchos	ANPLA	MALL
Anas rubripes	ANRUB	ABDU
Archilochus colubris	ARCO	RTHU
Asio otus	ASOTU	LEOW
Aythya americana	AYAME	REDH
Aythya collaris	AYCOLL	RNDU
Bombycilla cedrorum	BOCE	CEDW
Bonasa umbellus	BOUM	RUGR
Botaurus lentiginosus	BOLEN	AMBI
Branta canadensis	BRCAN	CANG
Bubo virginianus	BUVI	GHOW
Bucephala albeola	BUALB	BUFF
Bucephala clangula	BUCLA	COGO
Buteo jamaicensis	BUJA	RTHA
Buteo platypterus	BUPL	BWHA
Cardellina canadensis	CACA	CAWA
Cardellina pusilla	CAPU	WIWA
Catharus fuscescens	CAFU	VEER
Catharus guttatus	CAGU	HETH
Catharus ustulatus	CAUS	SWTH
Certhia americana	CEAM	BRCR
Chaetura vauxi	CHVA	VASW
Charadrius vociferus	CHVO	KILL
Chlidonias niger	CHNIG	BLTE
Chordeiles minor	CHMI	CONI
Cinclus mexicanus	CIME	AMDI
Circus cyaneus	CICY	NOHA
Coccothraustes vespertinus	COVE	EVGR
Colaptes auratus	COAU	NOFL
Contopus cooperi	COCO	OSFL
Contopus sordidulus	COSO	WEWP
Corvus brachyrhynchos	COBR	AMCR
Corvus corax	CORCOR	CORA
Cyanocitta cristata	CYCR	BLJA
Cyanocitta stelleri	CYST	STJA
Dendragapus obscurus	DEOB	DUGR

Dryocopus pileatus	DRPI	PIWO
Empidonax alnorum	EMAL	ALFL
Empidonax flaviventris	EMFL	YBFL
Empidonax hammondii	EMHA	HAFL
Empidonax minimus	EMMI	LEFL
Empidonax oberholseri	EMOB	DUFL
Empidonax traillii	EMTR	WIFL
Euphagus carolinus	EUCA	RUBL
Euphagus cyanocephalus	EUCY	BRBL
Falcipennis canadensis	FACA	SPGR
Falco columbarius	FACO	MERL
Falco sparverius	FASP	AMKE
Fulica americana	FUAME	AMCO
Gallinago delicata	GADE	WISN
Gavia immer	GAIM	COLO
Geothlypis philadelphia	GEPH	MOWA
Geothlypis tolmiei	GETO	MGWA
Geothlypis trichas	GETR	COYE
Grus canadensis	GRCA	SACR
Haemorhous cassinii	HACA	CAFI
Haemorhous purpureus	HAPU	PUFI
Haliaeetus leucocephalus	HALEU	BAEA
Hirundo rustica	HIRUS	BARS
Icterus galbula	ICGAL	BAOR
Ixoreus naevius	IXNA	VATH
Junco hyemalis	JUHY	DEJU
Larus argentatus	LAARG	HERG
Larus delawarensis	LADEL	RBGU
Leucophaeus pipixcan	LEPIP	FRGU
Loxia curvirostra	LOCU	RECR
Loxia leucoptera	LOLE	WWCR
Megaceryle alcyon	MEAL	BEKI
Melospiza georgiana	MEGE	SWSP
Melospiza lincolnii	MELI	LISP
Melospiza melodia	MEME	SOSP
Mergus merganser	MEMER	COME
Mniotilta varia	MNVA	BAWW
Molothrus ater	MOAT	BHCO
Myadestes townsendi	MYTO	TOSO
Myiarchus crinitus	MYCRI	GCFL
Nucifraga columbiana	NUCO	CLNU
Oporornis agilis	OPAG	CONW
Oreothlypis celata	ORCE	OCWA
Oreothlypis peregrina	ORPE	TEWA
Oreothlypis ruficapilla	ORRU	NAWA
Pandion haliaetus	PAHA	OSPR
Parkesia noveboracensis	PANO	NOWA
Passerculus sandwichensis	PASA	SAVS
Passerella iliaca	PAIL	FOSP
Passerina amoena	PAAM	LAZB
Perisoreus canadensis	PECA	CAJA
Petrochelidon pyrrhonota	PEPY	CLSW
Pheucticus ludovicianus	PHLU	RBGR

Pheucticus melanocephalus	PHME	BHGR
Pica hudsonia	PIHU	BBMA
Picoides arcticus	PIAR	BBWO
Picoides dorsalis	PIDO	ATTW
Picoides pubescens	PIPU	DOWO
Picoides villosus	PIVI	HAWO
Pinicola enucleator	PIEN	PIGR
Pipilo chlorurus	PICH	GTTO
Pipilo erythrophthalmus	PIER	EATO
Piranga ludoviciana	PILU	WETA
Podiceps grisegena	POGRI	RNGR
Podilymbus podiceps	POPOD	PBGR
Poecile atricapillus	POAT	BCCH
Poecile gambeli	POGA	MOCH
Poecile hudsonicus	POHU	BOCH
Poecile rufescens	PORU	CBCH
Pooecetes gramineus	POGR	VESP
Porzana carolina	POCAR	SORA
Quiscalus quiscula	QUQU	COGR
Regulus calendula	RECA	RCKI
Regulus satrapa	RESA	GCKI
Salpinctes obsoletus	SAOB	ROWR
Sayornis phoebe	SAPHO	EAPH
Seiurus aurocapilla	SEAU	OVEN
Selasphorus calliope	SECAL	CAHU
Selasphorus rufus	SERU	RUHU
Setophaga castanea	SECAS	BBWA
Setophaga coronata	SECO	YRWA
Setophaga fusca	SEFU	BLBW
Setophaga magnolia	SEMA	MAWA
Setophaga palmarum	SEPA	PAWA
Setophaga pensylvanica	SEPE	CSWA
Setophaga petechia	SEPET	YEWA
Setophaga ruticilla	SERUT	AMRE
Setophaga tigrina	SETI	CMWA
Setophaga townsendi	SETO	TOWA
Setophaga virens	SEVI	BTNW
Sialia currucoides	SICU	MOBL
Sialia mexicana	SIME	WEBL
Sialia sialis	SISI	EABL
Sitta canadensis	SICA	RBNU
Sitta carolinensis	SICAR	WBNU
Sphyrapicus nuchalis	SPNU	RNSA
Sphyrapicus ruber	SPRU	RBSA
Sphyrapicus thyroideus	SPTH	WISA
Sphyrapicus varius	SPVA	YBSA
Spinus pinus	SPPI	PISI
Spinus tristis	SPTR	AMGO
Spizella pallida	SPPA	CCSP
Spizella passerina	SPPAS	CHSP
Strix nebulosa	STNE	GGOW
Strix varia	STVAR	BADO
Sturnella neglecta	STNEG	WEME

Sturnus vulgaris	STVU	EUST
Surnia ulula	SUUL	NHOW
Tachycineta bicolor	TABI	TRES
Tringa flavipes	TRFL	LEYE
Tringa melanoleuca	TRME	GRYE
Tringa solitaria	TRSO	SOSA
Troglodytes aedon	TRAE	HOWR
Troglodytes hiemalis	TRHI	WIWR
Turdus migratorius	TUMI	AMRO
Tyrannus tyrannus	TYTY	EAKI
Vireo cassinii	VICA	CAVI
Vireo gilvus	VIGI	WAVI
Vireo olivaceus	VIOL	REVI
Vireo philadelphicus	VIPH	PHVI
Vireo solitarius	VISO	BHVI
Xanthocephalus xanthocephalus	XAXAN	YHBL
Zenaida macroura	ZEMA	MODO
Zonotrichia albicollis	ZOAL	WTSP
Zonotrichia leucophrys	ZOLE	WCSP

n species with their functional traits, and their taxonomic scarcity and function

English_Name	French_Name	Foraging strategy	Foraging guild
Cooper's Hawk	Épervier de Cooper	A	C
Sharp-shinned Hawk	Épervier brun	G	C
Spotted Sandpiper	Chevalier grivelé	G	C
Northern Saw-whet Owl	Petite Nyctale	G	C
Boreal Owl	Nyctale de Tengmalm	G	C
Red-winged Blackbird	Carouge à épaulettes	G	I
Saltmarsh Sparrow	Bruant à queue aiguë	G	I
LeConte's Sparrow	Bruant de LeConte	G	I
American Wigeon	Canard d'Amérique	G	H
Green-winged Teal	Sarcelle d'hiver	G	H
Cinnamon Teal	Sarcelle cannelle	G	H
Blue-winged Teal	Sarcelle à ailes bleues	G	H
Mallard	Canard colvert	G	H
American Black Duck	Canard noir	G	I
Ruby-throated Hummingbird	Colibri à gorge rubis	F	H
Long-eared Owl	Hibou moyen-duc	G	C
Redhead	Fuligule à tête rouge	G	H
Ring-necked Duck	Fuligule à collier	G	H
Cedar Waxwing	Jaseur d'Amérique	F	H
Ruffed Grouse	Gélinotte huppée	F	O
American Bittern	Butor d'Amérique	G	C
Canada Goose	Bernache du Canada	G	H
Great Horned Owl	Grand-duc d'Amérique	G	C
Bufflehead	Petit Garrot	G	I
Common Goldeneye	Garrot à oeil d'or	G	I
Red-tailed Hawk	Buse à queue rousse	G	C
Broad-winged Hawk	Petite Buse	G	C
Canada Warbler	Paruline du Canada	F	I
Wilson's Warbler	Paruline à calotte noire	F	I
Veery	Grive fauve	G	I
Hermit Thrush	Grive solitaire	G	I
Swainson's Thrush	Grive à dos olive	F	I
Brown Creeper	Grimpereau brun	B	I
Vaux's Swift	Martinet de Vaux	A	I
Killdeer	Pluvier kildir	G	I
Black Tern	Guifette noire	G	I
Common Nighthawk	Engoulevent d'Amérique	G	I
American Dipper	Cincle d'Amérique	G	I
Northern Harrier	Busard des marais	G	C
Evening Grosbeak	Gros-bec errant	G	H
Northern Flicker	Pic flamboyant	G	I
Olive-sided Flycatcher	Moucherolle à côtés olive	A	I
Western Wood-Pewee	Pioui de l'Ouest	A	I
American Crow	Corneille d'Amérique	G	O
Common Raven	Grand Corbeau	G	O
Blue Jay	Geai bleu	G	O
Steller's Jay	Geai de Steller	G	O
Dusky Grouse	Tétras sombre	G	H

Pileated Woodpecker	Grand Pic	B	I
Alder Flycatcher	Moucherolle des aulnes	A	I
Yellow-bellied Flycatcher	Moucherolle à ventre jaune	A	I
Hammond's Flycatcher	Moucherolle de Hammond	A	I
Least Flycatcher	Moucherolle tchébec	A	I
Dusky Flycatcher	Moucherolle sombre	A	I
Willow Flycatcher	Moucherolle des saules	A	I
Rusty Blackbird	Quiscale rouilleux	G	I
Brewer's Blackbird	Quiscale de Brewer	G	H
Spruce Grouse	Tétras du Canada	F	H
Merlin	Faucon émerillon	A	C
American Kestrel	Crécerelle d'Amérique	G	C
American Coot	Foulque d'Amérique	G	H
Wilson's Snipe	Bécassine de Wilson	G	I
Common Loon	Plongeon huard	G	C
Mourning Warbler	Paruline triste	F	I
MacGillivray's Warbler	Paruline des buissons	F	I
Common Yellowthroat	Paruline masquée	F	I
Sandhill Crane	Grue du Canada	G	O
Cassin's Finch	Roselin de Cassin	G	H
Purple Finch	Roselin pourpré	F	H
Bald Eagle	Pygargue à tête blanche	G	C
Barn Swallow	Hirondelle rustique	A	I
Baltimore Oriole	Oriole de Baltimore	F	I
Varied Thrush	Grive à collier	G	I
Dark-eyed Junco	Junco ardoisé	G	H
Herring Gull	Goéland argenté	G	O
Ring-billed Gull	Goéland à bec cerclé	G	O
Franklin's Gull	Mouette de Franklin	G	O
Red Crossbill	Bec-croisé des sapins	F	H
White-winged Crossbill	Bec-croisé bifascié	F	H
Belted Kingfisher	Martin-pêcheur d'Amérique	G	C
Swamp Sparrow	Bruant des marais	G	I
Lincoln's Sparrow	Bruant de Lincoln	G	I
Song Sparrow	Bruant chanteur	G	I
Common Merganser	Grand Harle	G	C
Black-and-white Warbler	Paruline noir et blanc	B	I
Brown-headed Cowbird	Vacher à tête brune	G	H
Townsend's Solitaire	Solitaire de Townsend	A	I
Great Crested Flycatcher	Tyran huppé	A	I
Clark's Nutcracker	Cassenoix d'Amérique	F	O
Connecticut Warbler	Paruline à gorge grise	G	I
Orange-crowned Warbler	Paruline verdâtre	F	I
Tennessee Warbler	Paruline obscure	F	I
Nashville Warbler	Paruline à joues grises	F	I
Osprey	Balbuzard pêcheur	G	C
Northern Waterthrush	Paruline des ruisseaux	G	I
Savannah Sparrow	Bruant des prés	G	I
Fox Sparrow	Bruant fauve	G	I
Lazuli Bunting	Passerin azuré	G	I
Canada Jay	Mésangeai du Canada	G	O
Cliff Swallow	Hirondelle à front blanc	A	I
Rose-breasted Grosbeak	Cardinal à poitrine rose	G	O

Black-headed Grosbeak	Cardinal à tête noire	F	I
Black-billed Magpie	Pie d'Amérique	G	I
Black-backed Woodpecker	Pic à dos noir	B	I
American Three-toed Woodpecker	Pic à dos rayé	B	I
Downy Woodpecker	Pic mineur	B	I
Hairy Woodpecker	Pic chevelu	B	I
Pine Grosbeak	Durbec des sapins	F	H
Green-tailed Towhee	Tohi à queue verte	G	H
Eastern Towhee	Tohi à flancs roux	G	O
Western Tanager	Piranga à tête rouge	F	I
Red-necked Grebe	Grèbe jougris	G	C
Pied-billed Grebe	Grèbe à bec bigarré	G	C
Black-capped Chickadee	Mésange à tête noire	F	I
Mountain Chickadee	Mésange de Gambel	F	I
Boreal Chickadee	Mésange à tête brune	F	I
Chestnut-backed Chickadee	Mésange à dos marron	F	I
Vesper Sparrow	Bruant vespéral	G	I
Sora	Marouette de Caroline	G	H
Common Grackle	Quiscale bronzé	G	O
Ruby-crowned Kinglet	Roitelet à couronne rubis	F	I
Golden-crowned Kinglet	Roitelet à couronne dorée	F	I
Rock Wren	Troglodyte des rochers	G	I
Eastern Phoebe	Moucherolle phébi	A	I
Ovenbird	Paruline couronnée	G	I
Calliope Hummingbird	Colibri calliope	F	H
Rufous Hummingbird	Colibri roux	F	H
Bay-breasted Warbler	Paruline à poitrine baie	F	I
Yellow-rumped Warbler	Paruline à croupion jaune	F	I
Blackburnian Warbler	Paruline à gorge orangée	F	I
Magnolia Warbler	Paruline à tête cendrée	F	I
Palm Warbler	Paruline à couronne rousse	G	I
Chestnut-sided Warbler	Paruline à flancs marron	F	I
Yellow Warbler	Paruline jaune	F	I
American Redstart	Paruline flamboyante	F	I
Cape May Warbler	Paruline tigrée	F	I
Townsend's Warbler	Paruline de Townsend	F	I
Black-throated Green Warbler	Paruline à gorge noire	F	I
Mountain Bluebird	Merlebleu azuré	A	I
Western Bluebird	Merlebleu de l'Ouest	A	I
Eastern Bluebird	Merlebleu de l'Est	G	I
Red-breasted Nuthatch	Sittelle à poitrine rousse	B	I
White-breasted Nuthatch	Sittelle à poitrine blanche	B	I
Red-naped Sapsucker	Pic à nuque rouge	B	I
Red-breasted Sapsucker	Pic à poitrine rouge	B	I
Williamson's Sapsucker	Pic de Williamson	B	I
Yellow-bellied Sapsucker	Pic maculé	B	I
Pine Siskin	Tarin des pins	F	H
American Goldfinch	Chardonneret jaune	F	H
Clay-colored Sparrow	Bruant des plaines	F	H
Chipping Sparrow	Bruant familier	G	H
Great Gray Owl	Chouette lapone	G	I
Barred Owl	Chouette rayée	G	C
Western Meadowlark	Sturnelle de l'Ouest	G	I

European Starling	Étourneau sansonnet	G	I
Northern Hawk Owl	Chouette épervière	G	C
Tree Swallow	Hirondelle bicolore	A	I
Lesser Yellowlegs	Petit Chevalier	G	I
Greater Yellowlegs	Grand Chevalier	G	I
Solitary Sandpiper	Chevalier solitaire	G	I
House Wren	Troglodyte familier	F	I
Winter Wren	Troglodyte des forêts	G	I
American Robin	Merle d'Amérique	G	I
Eastern Kingbird	Tyran tritri	A	I
Cassin's Vireo	Viréo de Cassin	F	I
Warbling Vireo	Viréo mélodieux	F	I
Red-eyed Vireo	Viréo aux yeux rouges	F	I
Philadelphia Vireo	Viréo de Philadelphie	F	I
Blue-headed Vireo	Viréo à tête bleue	F	I
Yellow-headed Blackbird	Carouge à tête jaune	G	I
Mourning Dove	Tourterelle triste	G	H
White-throated Sparrow	Bruant à gorge blanche	G	H
White-crowned Sparrow	Bruant à couronne blanche	G	I

al uniqueness values in non-salvage, salvage and traditionally logged h

Habitat affinity	Nest location	Nest guild	Body Mass (g)	Clutch size (Mean)	SI_Harvest
F	T	NCN	473	4.2	0.993502429
F	T	NCN	183	4.3	0.800583824
O	G	NCN	48.1	4	0.993502429
F	T	CN	131.1	5.67	0.711144773
F	T	CN	166.8	3.25	NA
O	S	NCN	43.8	4	0.737429659
O	G	NCN	19	6	0.987041506
O	G	NCN	13.2	4.51	0.565007609
O	G	NCN	1330	10	0.980625407
O	G	NCN	500	10	0.993502429
O	G	NCN	394	10	2.29E-06
O	G	NCN	545	14	0.961573353
O	G	NCN	1114	8.72	0.924724927
O	G	NCN	1600	14	NA
O	T	NCN	3.4	2	0.987041506
F	T	CN	430	10	0.993502429
O	G	NCN	1500	8	0.987041506
O	G	NCN	900	4	0.942509787
O	T	NCN	32.7	4.5	0.239173332
F	G	NCN	500.1	10.5	0.249411643
O	G	NCN	500	5	0.974251015
O	G	NCN	9000	8	0.582116222
O	T	NCN	1706	2	0.711144773
O	T	CN	600	15	0.974251015
O	T	CN	1300	16	0.919244748
O	T	NCN	1224	2.5	0.61495463
F	T	NCN	437	2.5	0.993502429
F	G	NCN	10.2	4.5	0.801128678
O	G	NCN	7.72	5	5.89E-11
F	G	NCN	32.4	4	0.993502429
O	G	NCN	30.1	4	0.254597362
F	S	NCN	29.6	3.5	0.078597311
F	T	NCN	8.4	5.5	0.760245448
F	T	NCN	18.8	6	NA
O	G	NCN	101.5	4	0.847511413
O	G	NCN	60	3	0.924724927
O	G	NCN	66.5	2	0.980625407
O	G	NCN	53.6	4.1	NA
O	G	NCN	513	4.4	1.57E-15
F	T	NCN	62.6	3	0.553622659
O	T	CN	131.83	5.5	0.283081587
O	T	NCN	31.9	3	1.57E-15
O	T	NCN	12.2	3	0.450457099
O	T	NCN	474	5	0.945635233
O	G	NCN	1055	4.5	0.317146291
F	T	NCN	70.53	4.5	0.792065933
F	T	NCN	128	3.06	NA
F	G	NCN	839	7.1	NA

F	T	CN	270	3.5	0.544874948
O	T	NCN	10.2	4	0.156880258
F	T	CN	10.83	3.5	0.818266088
F	G	NCN	10.3	4	6.10E-11
F	T	NCN	10.3	4	0.241409306
O	S	NCN	11.06	3.6	1.57E-15
O	S	NCN	12.3	3.68	NA
F	T	NCN	64	4.5	0.493520753
O	S	NCN	58.1	4.98	NA
F	G	NCN	424	5	1.37E-06
O	T	NCN	243.6	4.2	0.496751215
O	T	CN	120	4	0.322640091
O	G	NCN	700	10	0.993502429
O	G	NCN	109	4	0.28000026
O	G	NCN	4657	2	0.69859306
F	G	NCN	12.27	3.5	0.271899799
F	S	NCN	10.4	4.12	5.50E-11
O	S	NCN	9.9	4	0.372669828
O	G	NCN	3460	2	0.891476194
F	T	NCN	27.7	4	NA
F	T	NCN	24.6	3.5	0.477687649
F	T	NCN	6300	3	0.803434358
O	T	CN	20	4	0.967917979
O	T	NCN	40	6	NA
F	T	NCN	31.7	3.2	0.19471461
F	G	NCN	20.25	4	0.098904379
O	G	NCN	1200	2	NA
O	G	NCN	700	4	0.707764624
O	G	NCN	300	4	0.900914199
F	T	NCN	26.54	3	0.490328498
F	T	NCN	24.9	4	0.207484117
O	G	NCN	151.6	6	0.929644277
O	G	NCN	17	4.5	0.520948801
O	G	NCN	18.1	4	0.194713551
O	S	NCN	23.4	4.5	0.429013888
O	T	CN	1185	11.5	NA
F	G	NCN	10.7	4.5	0.809592312
O	T	NCN	32	40	0.88409647
O	G	NCN	32.6	4	NA
O	T	CN	40	8	0.980625407
F	T	NCN	129	3.06	NA
F	G	NCN	15.32	4.5	0.591824771
F	G	NCN	9.2	4.6	0.338090391
F	G	NCN	8.9	5	0.001974553
F	G	NCN	8.6	4.5	0.484859891
O	T	NCN	1900	3	0.562297904
F	G	NCN	16.1	4	8.79E-09
O	G	NCN	20	4	NA
F	G	NCN	33.9	3.5	0.496751215
O	S	NCN	14.9	3.13	0.993502429
F	T	NCN	67.6	3	0.248892809
O	G	NCN	24.15	3.48	NA
F	T	NCN	45.1	3.5	0.355625885

F	T	NCN	48.2	3.4	NA
O	T	NCN	25	4	NA
F	T	CN	68	3.5	0.450457099
F	T	CN	52	3.87	0.45340438
F	T	CN	27.64	4.5	0.955375298
F	T	CN	65.96	3.5	0.431391912
O	T	NCN	48.1	4	0.496751215
O	S	NCN	29.4	3.65	NA
O	G	NCN	39.3	4	NA
F	T	NCN	29.8	4	0.360188598
O	G	NCN	1600	8	0.961626189
O	G	NCN	500	10	0.974251015
F	T	CN	11	6.5	0.374372156
F	T	CN	10.78	6.38	NA
F	T	NCN	9.8	6	0.767329029
F	T	CN	9.1	6.2	NA
O	G	NCN	22.95	3.6	NA
O	G	NCN	100	12	0.918713907
O	T	NCN	100.8	4.5	NA
F	T	NCN	6.4	8.5	0.046187079
F	T	NCN	6.1	8.5	0.43598151
O	G	NCN	18	5.6	NA
O	T	CN	20	6	0.961626189
F	G	NCN	21.7	4.5	0.076031225
O	T	NCN	2.85	2	1.57E-15
O	T	NCN	3.58	2	1.57E-15
F	T	NCN	11.1	5.5	0.792993341
F	T	NCN	12.2	3.5	0.011152337
F	T	NCN	10.3	4	0.889239707
F	T	NCN	8.4	4	0.325828437
O	G	NCN	10.3	4.5	0.830079778
O	S	NCN	12	4	0.686098104
O	S	NCN	9.6	4.5	0.809592312
F	T	NCN	8.7	4	0.492468396
F	T	NCN	10.2	6.5	0.850015297
F	T	NCN	8.6	5.7	NA
F	T	NCN	9	3.5	0.735676047
O	T	CN	29.6	5.53	1.57E-15
O	T	CN	27.09	4.78	NA
O	T	CN	30	4.5	NA
F	T	CN	10	5.5	0.273708198
F	T	CN	21.1	7.3	0.974251015
F	T	CN	49.2	4.8	NA
F	T	CN	57.7	4.69	8.47E-14
F	T	CN	47.6	4.38	NA
F	T	CN	50.3	4.5	0.405404256
O	T	NCN	12.91	4	0.121991039
O	S	NCN	11.97	5.5	0.873300581
O	S	NCN	12.2	4	0.318602487
O	S	NCN	12.3	4	0.014711867
F	T	NCN	1267	4.6	0.711144773
F	T	CN	1000	5	0.958342892
O	G	NCN	100	6	NA

O	T	CN	79.46	5.1	NA
F	T	CN	339.8	7	0.993502429
O	T	CN	21.1	5.5	0.393455169
O	G	NCN	85.2	4	0.967917979
O	G	NCN	176	3.7	0.450756915
O	T	NCN	48.4	4	0.840597684
O	T	CN	12	6.8	0.736008058
F	T	CN	8.6	5.5	0.333695929
O	T	NCN	75	3.5	0.331941358
O	T	NCN	41.6	3	0.980625407
F	T	NCN	14.6	3.87	1.78E-09
O	T	NCN	13.98	3.5	0.493520753
F	T	NCN	19.9	3.5	0.068594943
F	T	NCN	12.2	4	0.716403383
F	T	NCN	15.4	4	0.432768827
O	S	NCN	100	4	NA
O	T	NCN	112	2	NA
F	G	NCN	25.1	4	0.002530435
O	G	NCN	25.47	4.58	NA

abitats

SI_Fire	SI_Salvage	UI_Harvest	UI_Fire	UI_Salvage
0.564829518	NA	0.150651615	0.160069043	NA
0.201033415	0.722245394	0.022199383	0.15385626	0.148619241
0.477519836	NA	0.027871448	0.027871448	NA
NA	NA	0.021885383	NA	NA
NA	0.551665614	NA	NA	0.028028946
0.231662785	0.313663119	0.012994194	0.012994194	0.014153321
NA	0.772256657	0.007611057	NA	0.007816712
0.708312459	0.385021479	0.004435768	0.004435768	0.004894452
NA	NA	0.007954059	NA	NA
NA	NA	0.004224147	NA	NA
NA	NA	0.004224147	NA	NA
NA	NA	0.016565469	NA	NA
0.923499164	0.920653644	0.007954059	0.013049658	0.013908758
NA	0.555178626	NA	NA	0.081936597
0.973820305	NA	0.000914611	0.000914611	NA
NA	NA	0.015452182	NA	NA
NA	NA	0.007981392	NA	NA
0.923499164	NA	0.021526346	0.021526346	NA
0.340662615	0.346750945	0.008721584	0.008721584	0.020075283
0.341480145	0.677454341	0.166460501	0.166460501	0.166765723
0.923499164	NA	0.002710712	0.018796992	NA
0.368865584	0.245543193	0.031766743	0.039748134	0.043611168
NA	NA	0.005668893	NA	NA
0.94832605	NA	0.017467558	0.017467558	NA
0.857014866	0.678657781	0.017467558	0.017467558	0.084280811
0.464400877	0.764247209	0.007766329	0.009675824	0.01048888
NA	NA	0.022199383	NA	NA
0.530802563	0.905552385	0.00220533	0.00220533	0.002396117
0.48527596	0.655366619	0.145378912	0.145378912	0.145641906
NA	NA	0.002682069	NA	NA
0.119422079	0.350758362	0.009017385	0.005141677	0.005450502
0.220446303	0.520630584	0.020875177	0.020875177	0.144868683
0.281126585	0.572437739	0.145948316	0.144026203	0.146270694
1.87E-07	NA	NA	0.018186781	NA
0.899322238	0.771341483	0.00126391	0.00126391	0.001395722
0.766987656	0.96208944	0.005582994	0.005582994	0.005773176
0.521225866	0.690815564	0.005582994	0.005582994	0.005773176
0.289590038	NA	NA	0.00613513	NA
NA	NA	0.002710712	NA	NA
0.449661119	0.856765146	0.144219515	0.018214726	0.144361596
0.343241845	0.491926191	0.062581644	0.010479414	0.032741534
0.011756225	NA	0.004707041	0.004707041	NA
0.230440815	0.302386116	0.006933808	0.006933808	0.007264867
0.718840017	0.759148852	0.153528739	0.029325966	0.032188329
0.309342996	0.437292864	0.00915256	0.00915256	0.009911044
0.746908153	0.793035604	0.006391357	0.006391357	0.00646981
2.45E-09	NA	NA	0.01154438	NA
0.002036658	NA	NA	0.073872526	NA

0.326838588	0.82290299	0.024447263	0.024447263	0.02699686
0.255837043	0.273895971	0.006933808	0.006933808	0.007264867
0.535444358	0.764247209	0.145626433	0.145626433	0.145719208
7.76E-13	NA	0.142857143	0.142857143	NA
0.394120138	0.496795028	0.142857143	0.018186781	0.143048153
2.76E-40	NA	0.145796045	0.002184749	NA
0.0070329	0.984542143	NA	0.002184749	0.144543591
0.73663459	0.660972711	0.017343268	0.017343268	0.058827564
0.045129344	NA	NA	0.017076723	NA
0.941970664	0.551665614	0.166460501	0.162851762	0.166765723
NA	NA	0.154621774	NA	NA
0.36476278	0.939587579	0.150163181	0.068795827	0.073030025
0.923499164	0.96208944	0.005965436	0.013049658	0.013908758
0.370470691	0.525490052	0.00126391	0.00126391	0.001395722
0.695006304	0.617523655	0.041497865	0.041497865	0.043473266
0.23778634	0.35018121	0.007035244	0.007035244	0.00737688
1.14E-38	NA	0.020875177	0.020875177	NA
0.319693316	0.440753091	0.002425261	0.002425261	0.002482157
0.620958233	0.873687614	0.030456146	0.01877445	0.020732431
4.40E-62	NA	NA	0.018214726	NA
0.852850706	0.856765146	0.002094603	0.002094603	0.002117015
NA	NA	0.049188213	NA	NA
NA	NA	0.006588341	NA	NA
NA	0.984542143	NA	NA	0.029980266
7.76E-13	NA	0.017343268	0.017343268	NA
0.136148267	0.208303315	0.003806724	0.003806724	0.004203726
0.544727947	0.558691639	NA	0.011681697	0.011919811
0.973820305	0.96208944	0.00915256	0.00915256	0.009911044
0.923499164	NA	0.015022046	0.015022046	NA
5.79E-71	0.856765146	0.003225474	0.003225474	0.003365825
0.552833552	0.368681133	0.002094603	0.002094603	0.002117015
0.602712764	0.555178626	0.02491695	0.02491695	0.03840166
0.587241513	0.438604993	0.002991305	0.002991305	0.003107234
0.311767984	0.294224354	0.002991305	0.00176975	0.003107234
0.213986345	0.31344408	0.012994194	0.012994194	0.013987548
0.467977064	0.555178626	NA	0.068795827	0.073030025
0.641362324	0.896685657	0.143705599	0.143705599	0.143794085
0.237890675	0.653687114	0.268321737	0.165067824	0.270428539
1.15E-52	NA	NA	0.007274189	NA
NA	NA	0.014624114	NA	NA
5.62E-43	NA	NA	0.142995115	NA
0.261769344	0.711619078	0.002760141	0.002760141	0.006816262
0.486910154	0.939587579	0.00157163	0.00157163	0.001696329
0.200673681	0.409113905	0.002091527	0.002091527	0.002152825
0.52707538	0.605525218	0.00157163	0.00157163	0.001696329
0.353427385	0.612429865	0.005668893	0.009675824	0.01048888
6.46E-07	NA	0.002760141	0.002760141	NA
3.37E-60	NA	NA	0.00176975	NA
NA	NA	0.002682069	NA	NA
0.002036658	0.965706335	0.013152961	0.013152961	0.013987548
0.179656596	0.372406245	0.006391357	0.006391357	0.00646981
4.15E-06	NA	NA	0.007274189	NA
0.775474041	0.781135041	0.009055226	0.009055226	0.00980356

0.004932909	NA	NA	0.010780811	NA
0.289590038	NA	NA	0.011712438	NA
0.226695515	0.483349531	0.000540022	0.000540022	0.000596341
0.4156907	0.632107807	0.002957721	0.002957721	0.003019179
0.496480575	0.925063568	0.010615294	0.010088252	0.01172236
0.353333266	0.592421117	0.000540022	0.000540022	0.000596341
0.0070329	NA	0.008721584	0.008721584	NA
1.20E-06	NA	NA	0.016765069	NA
0.045129344	NA	NA	0.036035945	NA
0.484176739	0.830474	0.009038612	0.009038612	0.009785213
0.973820305	0.955079116	0.028140712	0.028140712	0.030291366
0.899322238	0.92561609	0.018796992	0.018796992	0.030291366
0.278846693	0.812237326	0.144195843	0.000809309	0.144335456
7.35E-45	NA	NA	0.000809309	NA
0.529179582	0.702538481	0.002588968	0.002588968	0.002662938
0.15583873	NA	NA	0.003680367	NA
6.46E-07	0.031085015	NA	0.003943065	0.005723948
0.821131444	0.668382318	0.031828949	0.042018532	0.045616499
0.544727947	0.631626521	NA	0.029325966	0.032188329
0.194237363	0.421869939	0.000851173	0.000851173	0.000939941
0.43063547	0.882824818	0.000851173	0.000851173	0.000939941
0.045129344	NA	NA	0.00514872	NA
NA	0.939587579	0.002828943	NA	0.002927939
0.218473966	0.508046685	0.00617253	0.00617253	0.006816262
0.000589796	NA	0.003128459	0.003128459	NA
6.51E-14	NA	0.000914611	0.000914611	NA
0.512496507	0.954339624	0.004088116	0.004088116	0.004318431
0.113042363	0.386872395	0.001879699	0.001879699	0.001879699
0.973820305	NA	0.002993085	0.002993085	NA
0.282332985	0.737916135	0.000622147	0.000622147	0.00068703
0.814083341	0.922457129	0.004435768	0.004435768	0.004894452
0.354156842	0.734046515	0.00341063	0.00341063	0.003766323
0.284256156	0.65822571	0.002425261	0.002425261	0.002482157
0.455843844	0.905552385	0.000622147	0.000622147	0.00068703
0.945148357	0.958214532	0.002588968	0.002588968	0.002662938
7.08E-10	NA	NA	0.003443631	NA
0.923499164	0.92561609	0.002480752	0.002480752	0.002543436
0.003340567	0.855742604	0.006114193	0.004390542	0.006740078
0.002036658	NA	NA	0.004390542	NA
0.489353985	0.534315694	NA	0.019525032	0.032741534
0.196730989	0.583695136	0.020005214	0.021784461	0.02366429
NA	NA	0.015313082	NA	NA
2.07E-17	NA	NA	0.001519841	NA
NA	NA	0.003147677	NA	NA
0.00031739	NA	NA	0.001429297	NA
0.664484009	0.628235083	0.002957721	0.001429297	0.003019179
0.34884614	0.764689783	0.018356882	0.018356882	0.020075283
0.620324691	0.793035604	0.005976531	0.005976531	0.006011721
0.126710326	0.23336388	0.005976531	0.005976531	0.006011721
0.021519339	0.010803745	0.143001873	0.016765069	0.143016967
0.970551732	0.984542143	0.053307361	0.053307361	0.058827564
NA	NA	0.02665583	NA	NA
NA	0.76297118	NA	NA	0.007810291

8.45E-09	NA	NA	0.010479414	NA
0.419868992	0.665406724	0.015452182	0.163979704	0.028028946
0.242376162	0.351670822	0.002828943	0.006114193	0.002927939
NA	0.886675142	0.003103654	NA	0.003427334
0.804867306	0.589638832	0.009622595	0.009622595	0.010508512
0.650351057	0.92561609	0.00964495	0.00964495	0.010454786
0.154851198	0.079938879	0.145527618	0.145527618	0.145688501
0.246272733	0.58003591	0.145531136	0.145531136	0.145810006
0.191026963	0.32502978	0.00964495	0.00964495	0.010454786
0.708312459	0.544410571	0.004707041	0.004707041	0.024016056
NA	NA	0.001434512	NA	NA
2.74E-33	0.984542143	0.145017464	0.145271736	0.029980266
0.237885939	0.418276509	0.006424659	0.006424659	0.006898652
0.611058781	0.826887966	0.001879699	0.001879699	0.001879699
0.28544884	0.68027066	0.001434512	0.004129727	0.004560415
0.899322238	NA	NA	0.014636229	NA
0.404390272	NA	NA	0.154123613	NA
0.043200345	0.107924505	0.003806724	0.003806724	0.004203726
5.06E-26	0.984542143	NA	0.005141677	0.005450502