Landscape Productivity and the Ecology of Brood Division in Golden-winged Warblers in the Western Great Lakes Region

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Chapter 1

Management Implications of Brood Division in Golden-winged Warblers

Overview: Brood division in the post-fledging period is a widespread avian behavior that is not well understood. Brood division has been reported in Golden-winged Warblers (Vermivora chrysoptera), but it is not known how widespread this behavior is, whether males and females exhibit different strategies related to parental care and habitat use, or how brood division might influence management strategies. I radio-marked fledglings and monitored divided broods of Golden-winged Warblers from fledging until independence from adult care at three sites--two in northern Minnesota, USA and one in southeastern Manitoba, Canada--from 2010-2012 to assess differences in strategies between male and female parents and to consider possible management implications. Male- and female-reared subbroods exhibited significantly different space use during the dependent post-fledging period despite similar fledgling survival, cover type use, and microhabitat use. By independence, female-reared subbroods traveled over twice as far from the nest (418 \pm 61 m) as male-reared subbroods (192 \pm 36 m). Because parental strategies differ between sexes with regard to movement patterns, I suggest incorporating the differences in space use between sexes in future management plans for Goldenwinged Warblers and other species that employ brood division. Specifically, management actions might be most effective when they are applied at spatial scales large enough to incorporate the habitat requirements of both sexes throughout the entire reproductive season.

Introduction

Brood division is a widespread avian behavior that is characterized by adults provisioning and caring for a subset of their brood over all or a substantive portion of the post-fledgling period (i.e., after young leave the nest but before they reach independence from adult care), forming two stable 'subbroods' (Harper 1985, Leedman and Magrath 2003, Chapter 2). Will (1986) reported that Golden-winged Warblers (*Vermivora chrysoptera*) exhibited brood division but the extent to which brood division in Goldenwinged Warblers occurs and how brood division influences productivity and habitat use has not been well documented. I observed division in 98.5% of broods in northern Minnesota, USA and southern Manitoba, Canada, with equal parental care between maleand female-reared subbroods, suggesting that brood division is nearly obligate in Goldenwinged Warblers (Chapter 2).

Most studies of brood division in birds have focused on differences or similarities in adult care and the potential evolutionary benefits of employing this behavior (McLaughlin and Montgomerie 1985, Lessels 1998, Leedman and Magrath 2003, Draganoiu et al. 2005). In Golden-winged Warblers, parental care is similar between male and female parents (Chapter 2), suggesting that both sexes are similarly capable of rearing subbroods to independence. Furthermore, brood division in Golden-winged Warblers (Chapter 2) appears to most closely fit the evolutionary strategy proposed by Lessels (1998), in which brood division decreases the likelihood of survival for any individual parent when compared with brood abandonment, but increases survival of the other parent of a brood and for fledglings in both subbroods.

An aspect of brood division that has potential conservation implications but has received little attention is how subbroods partition space--only four studies of three species have reported spatial patterns of division in broods (McLaughlin and Montgomerie 1985, Weatherhead and McRae 1990, Evans Ogden and Stutchbury 1997, Rush and Stuchbury 2008). Weatherhead and McRae (1990) observed that divided American Robin (Turdus migratorius) broods traveled similar distances from the nest independent of parental sex. In contrast, female Hooded Warblers (Setophaga citrina; Evans Ogden and Stutchbury 1997, Rush and Stuchbury 2008) and Lapland Longspurs (*Calcarius lapponicus*; McLaughlin and Montgomerie 1985) traveled farther from the nest with their subbroods compared to males. How Golden-winged Warbler subbroods partition space is not known, but if female- and male-reared subbroods exhibit different spatial use patterns, conservation strategies may need to account for these differences to maximize their impact. For example, Boal et al. (2003) reported different space use patterns in breeding Northern Goshawks (Accipiter gentilis) in northern Minnesota, USA. They found that habitat use and home range around the nest site varied by parental sex, creating a need to incorporate both scales of use in conservation plans. In extreme cases, failure to recognize brood division may lead to flawed management and conservation plans for a species and failure to maximize the desired impact of management.

I studied brood division in three populations of Golden-winged Warblers in the western Great Lakes region of central North America. I monitored fledgling movements via radio telemetry throughout the dependent post-fledging period (i.e., the post-fledging period prior to independence) to assess sex-based differences and trends in movement, vegetation use, and fledgling survival in male- and female-reared subbroods. Based on my observations, I suggest what implications those differences may have on developing effective management plans.

Methods

Study Species:--Golden-winged Warblers are neo-tropical migratory songbirds that breed in northeastern and north-central North America and winter in southern Central America and northern South America (Confer et al. 2011). Golden-winged Warbler populations outside of the core population in the western Great Lakes region are declining rapidly, resulting in Golden-winged Warblers being listed as Endangered, Threatened, or of high management concern in 10 states and Canada (Buehler et al. 2007). Golden-winged Warblers are single-brooded (i.e., a single pair fledges no more than one clutch each year), with bi-parental care of both nestlings and fledglings (Confer et al. 2011). Primary nesting habitat consists of shrubby, early-successional uplands and shrubby wetlands (Confer et al. 2011), with use of mid-successional and mature forests with dense undergrowth adjacent to patches of shrubby wetlands or early-successional uplands (Streby et al. 2014a). Golden-winged Warbler post-fledging habitat use differs from that used for nesting, with birds selecting mature forest and midsuccessional forest over other cover types, but also using early-successional forests and wetlands (H. Streby unpublished data). Brood division in the 25-day post-fledging period of parental care in Golden-winged Warblers appears to be nearly obligate, with rare observations of both parents provisioning the same fledglings (Will 1986; Chapter 2). Subbroods often form

crèches with ≥1 conspecific subbrood and fledglings of other species (Will 1986, Streby et al. unpublished data). Similar to other altricial songbirds (Ricklefs 1968, Anders et al. 1998, King 2006, Streby and Andersen 2013a), Golden-winged Warbler fledgling survival is lowest in the first few days after fledging, with 75% of fledgling mortality occurring in the first 3 days (H. Streby unpublished data).

Study Sites:--From 2010-2012, I studied Golden-winged Warblers at Tamarac National Wildlife Refuge (NWR) in Becker County, Minnesota (47.049° N, 95.583° W). In 2011 and 2012 I expanded my study to include sites at Rice Lake NWR in Aitkin County, Minnesota (46.529° N, 93.338° W) and Sandilands Provincial Forest (PF) in southeastern Manitoba (49.637° N, 96.247° W). At each study site I focused my work in four to eight 2.5 - 25 ha shrubby uplands and wetlands and the surrounding mature forest in a predominantly forested landscape. For more detailed description of the landscape, see Chapter 3.

*Field Methods:--*I searched for Golden-winged Warbler nests using nest-searching methods described by Martin and Guepel (1993). I found additional nests by passively mist netting adult female Golden-winged Warblers, after their arrival from spring migration but before most started nesting, and attaching a radio transmitter (~ 4.1% of mean adult mass) using a figure-eight harness described by Rappole and Tipton (1991) and subsequently monitoring those radio-marked females (Streby et al. 2014a). Radio transmitters used in this study had no measureable impact on female productivity (Streby et al. 2013). I recorded nest locations using handheld Global Positioning System (GPS) units (GPSMAP 76 or eTrex Venture HC, Garmin Ltd., Schaffhausen, Switzerland), and I averaged locations using 100 points to achieve <5 m accuracy. I monitored nests on 4day intervals until near the estimated fledge date. When nestlings were 7 days old (rarely 6, 8, or 9; counting hatch day as day 1), I banded all nestlings in the nest with standard U.S. Geological Survey legbands, measured their mass using a digital scale (AWS-100, American Weigh Scales Inc., Norcross, GA) to the nearest 0.01 g, and attached a radio transmitter (~ 4.6% of mean nestling mass) to 1 - 5 randomly selected nestlings using the same harness design I used for adult Golden-winged Warblers. In addition, I used mist nets to capture, band, and attach radio transmitters to some non-radio-marked fledglings detected during field activities based on fledgling vocalization or adult behavior. I estimated the age of captured fledglings based on observed development of fledglings banded in the nest and subsequently monitored throughout the post-fledging period.

I recorded daily fledgling locations using ground-based radio telemetry. I followed the fledgling monitoring methodology described in Streby and Andersen (2013b) and avoided locating fledglings in inclement weather to minimize the likelihood that my activities would cause fledglings to move to locations where their survival might be compromised due to exposure to excessive cold or moisture. To ensure that observers were not interfering with fledgling location, I used triangulation to estimate fledgling location prior to obtaining visual confirmation of a fledgling's status. For each fledgling, I recorded locations using handheld GPS units as described above for nest locations, forest strata (i.e., ground, shrub, understory, or canopy) and cover type (grassland, upland shrubland, midsuccessional aspen [*Populus* spp.], mature forest, early-successional coniferous, mature coniferous, firebreak or power-line right of way, shrubby wetland,

grassy wetland, forested wetland, open-canopy mature forest or oak [*Quercus* spp.] savanna, road, open water, and human development). I converted cover type into percent non-shrubland forest (e.g., mature forest, forested wetland, and midsuccessional forest) to differentiate areas traditionally considered to be secondary Golden-winged Warbler habitat, as described by Confer et al. (2011). At each fledgling location, I estimated lateral vegetation density by recording the amount of vegetation obscuring a 2-m profile board (MacArthur and Macarthur 1961, Streby et al. 2013a). I used ImageJ (National Institutes of Health) to derive percent canopy cover from digital photographs taken vertically from 2 m above the ground at fledgling locations. For each canopy photograph, I split color channels to differentiate between sky and vegetation, converted vegetation and sky to binary pixels, and measured the percentage of pixels occupied by vegetation. I used ArcGIS 10.0 Geographic Information System (GIS) software (Environmental Systems Research Institute, Redlands, CA) to calculate daily distance from nest for all fledglings for which I knew the location of the nest from which they fledged.

I identified sex of the parent attending individual fledglings by observing adult and fledgling interactions and I excluded from my analyses 50 broods for which fledglings were depredated before parental care was observed and two broods for which I did not observe brood division (i.e., fledglings were provisioned by both parents during multiple observations). I recorded observations over the 25-day period that Goldenwinged Warbler fledglings are dependent upon adults (Will 1986).

*Post-fledging Periods:--*My initial observations indicated that whereas space use was similar between male- and female-reared subbroods shortly after fledging, space use

appeared to differ between male- and female-reared subbroods by the time fledglings became independent of adults. This suggested a shift in parental movement strategies during the post-fledging period. I identified a period of higher-than-expected directionality on days 9 and 10 that indicated a change in female space use in relation to the nest site (Chapter 2). To ensure that I compared differences in male and female parental behavior both before and after a change in parental strategies occurred, I divided the post-fledging period into two periods--an early post-fledging period from day 1 - 8, and a late post-fledging period from day 9 - 25.

*Statistical Analyses:--*I tested for differences between male- and female-reared subbroods in distance from nest and vegetation characteristics at daily fledgling locations including percent canopy cover, lateral vegetation density, non-shrubland forest use, and strata occupied by fledglings in broods for which I tracked both subbroods via radio telemetry. I used this subsample of data to avoid potential bias from non-independence of locations for subbroods that I tracked without knowing the location of the subbrood under the care of the other parent. After testing for differences between paired subbroods, I used my entire sample of subbroods to describe patterns over time for each variable as a function of parental sex. For subbroods in which I monitored >1 fledgling, I used the mean value for all fledglings (usually two) in that subbrood for each variable in analyses.

Because daily distance from a nest is likely temporally autocorrelated (i.e., the distance from the nest one day is likely to be more similar to the distance from the nest the subsequent day than the distance from any randomly selected day), I used a sign test (Dixon and Mood 1946) to assess differences between paired subbroods in daily distance

from nest. I used a Pillai-M. S. Bartlett trace multivariate analysis of covariance (MANCOVA) to test for differences between male- and female-reared subbroods in vegetation characteristics at fledgling locations using linear models in R (ver. 2.14.1, R Foundation for Statitical Computing, Vienna, Austria) with parental sex and fledgling age as independent variables and percent canopy cover, lateral vegetation density, non-shrubland forest use, and strata occupied by fledgling as dependent variables. I considered all statistical tests to be significant at the $\alpha = 0.05$ level and present means \pm SE.

I could not compare survival between male- and female-reared subbroods during the early post-fledging period because in most instances, I were unable to identify the sex of the parental caregiver for fledglings that died during that period. In addition, my data indicated that space use was nearly identical for fledglings in male- and female-reared subbroods in the early post-fledgling period, suggesting that predation pressures were likely similar. For the late post-fledging period, I used logistic regression in program MARK (ver. 5.1, Colorado State University, Ft. Collins, CO) to estimate daily fledgling survival and 95% confidence intervals using the known fate module (White and Burnham 1999) for a single fledgling per subbrood. In subbroods with multiple marked fledglings that had different capture histories (2% of all subbroods), I randomly selected a fledgling in that subbrood to include in survival analyses. Fledgling survival during the late postfledging period was unrelated to fledgling age (H. Streby, unpublished data); therefore I did not include fledgling age in my survival model. I compared 95% confidence intervals for male- and female-reared subbroods to test for differences in fledgling survival.

Results

I monitored 66 Golden-winged Warbler fledglings from 60 subbroods at Tamarac NWR, 30 fledglings from 28 subbroods at Rice Lake NWR, and 27 fledglings from 24 subbroods at Sandilands PF. In broods for which I monitored both subbroods, both maleand female-reared subbroods moved similar distances from the nest in the early postfledging period (sign test, n = 18, P = 0.82; Fig. 1). On day 8 after fledging, femalereared subbroods averaged 133 ± 29 m away from the nest and male-reared subbroods averaged 126 ± 17 m away from the nest. In contrast, female-reared subbroods moved farther from the nest than male-reared subbroods during the late post-fledging period (sign test, n = 15, P = 0.04). In the last 10 days of the post-fledging period, female-reared subbroods (n = 32) were 418 ± 61 m away from the nest, whereas male-reared subbroods (n = 38) were 192 ± 36 m away from the nest.

Male- and female-reared subbroods used areas with similar vegetation characteristics (canopy cover, shrubland use, lateral vegetation density, and forest strata) in both the early post-fledging period (n = 18, $F_{4, 221} = 0.95$, P = 0.43) and the late postfledging period (n = 12, $F_{4, 262} = 1.92$, P = 0.11). Percentage of canopy cover in locations used by subbroods increased from fledging until independence (Fig. 2A). I observed low variability in lateral vegetation density at fledgling locations across the post-fledging period (Fig. 2B). Both male- and female-reared subbroods used non-shrubland forest extensively, with use of this cover type increasing later in the post-fledging period (Fig. 2C). I observed fledglings occupying higher vegetation strata throughout the postfledging period, with the frequency of fledglings perching on the ground declining early in the post-fledging period and understory and canopy use increasing late in the postfledging period (Figs. 2D and 2E). Fledglings in both male- and female-reared subbroods had similar daily survival for the period from 9 days after fledging until independence (male $\bar{x} = 0.9887$, n = 54, 95% CI = 0.9946—0.9766; female $\bar{x} = 0.9873$, n = 46, 95% CI = 0.9939—0.9736).

Discussion

Habitat use of most birds during the post-fledging period is not well studied, and even less is known about sex-related differences in habitat use when adults divide broods. I observed a significant difference in space use between male- and female-reared subbroods of Golden-winged Warblers during the post-fledging period in the western Great Lakes region, and this difference has implications for management. Female-reared subbroods traveled farther from the nest than male-reared subbroods, beginning at about 9 days post-fledging. Male- and female-reared subbroods moved similar distances from their nests in the early post-fledging period, but by the time juveniles reached independence (25 days post-fledge), female-reared subbroods in my study had moved over twice as far from the nest as male-reared subbroods. Similar sex-related spatial separation of subbroods also has been observed in Lapland Longspurs (McLaughlin and Montgomerie 1985) and Hooded Warblers (Evans Ogden and Stutchbury 1997), suggesting that this behavior may be present in other species that exhibit brood division in the post-fledging period.

However, despite differences in space use between male- and female-reared subbroods, I observed no differences in the vegetation characteristics of locations used by subbroods related to parental sex. Male- and female-reared subbroods exhibited similar patterns over time in forest strata occupied by fledglings, canopy cover and lateral vegetation density at subbrood locations, and non-shrubland forest use. Importantly, I observed both male- and female-reared broods using what have traditionally been considered secondary Golden-winged Warbler vegetation associations (i.e., mature and mid-successional forest and forested wetlands) extensively in the post-fledging period. The similarity in characteristics of locations used by both male- and female-reared subbroods indicates that management plans designed to increase Golden-winged Warbler productivity (i.e., rearing young to independence) need not consider two sets of habitat requirements during brood rearing, but rather need to provide the same habitat characteristics at two spatial scales. Furthermore, in species that exhibit space use patterns similar to Golden-winged Warblers, I expect that in most cases management considerations focused on the larger-scale needs of females and their fledglings will incorporate the needs of males and their fledglings by default.

Habitat characteristics at locations used by broods during the post-fledging period likely influence survival (Streby and Andersen 2013a). Although I did not directly test for differences in survival between male- and female-reared subbroods in the early postfledging period, my observations that habitat characteristics at brood locations were similar during this period suggest that survival was likely also similar in male- and female-reared subbroods. Because I observed similar movement patterns and vegetation structure at locations used by both male- and female-reared subbroods in the early postfledging period, I expected that both subbroods would be subjected to similar predation pressures during that period. Identification of parental care in my population could require multiple observations over several days. If the fledglings cared for by either parent were subjected to higher predation rates than fledglings cared for by the other parent during the early post-fledging period, I would expect fewer fledglings observed under the care of that parental sex during the late post-fledging period. Instead, I observed equal division of broods between males and females in this population (Chapter 2), supporting the assumption predation pressures and rates were similar throughout the early post-fledging period for both male- and female-reared subbroods.

My observations of female Golden-winged Warblers rearing subbroods farther from the nest than males may influence mate choice and breeding habitat use. Although the mechanism of mate choice by female songbirds remains unclear, there is evidence that mate choice in some species is influenced more by territory quality than by male physical characteristics (Sirkiä and Laaksonen 2009, Temeles and Cress 2010, Hasegawa et al 2012). I suggest that female Golden-winged Warblers likely use multiple criteria for choosing a breeding territory and male, including potential nest success and potential fledgling survival, both of which influence nest-site choice in Golden-winged Warblers (Streby et al. 2014a). Under such circumstances, it is possible that many unoccupied areas that appear structurally suitable as breeding territories are unoccupied because they are not surrounded by adequate post-fledging habitat at a scale used by females to rear their subbroods. In addition, I speculate that female-based post-fledging habitat requirements might play a role in males remaining unpaired on seemingly suitable song territories. Female breeding territory and mate choice has obvious management implications, especially after incorporating considerations for post-fledging habitat selection. Managing landscapes at the territory scale defined based on singing males may be inadequate or counterproductive if females choose breeding territories based in part on the surrounding landscape.

To maximize the impact of management on Golden-winged Warbler populations, it is likely necessary to incorporate considerations for brood division and the different spatial scales used by male- and female-reared subbroods during the post-fledging period. I suggest that management and conservation plans for Golden-winged Warblers incorporate habitat requirements at scales used by both male- and female-reared subbroods. Because female Golden-winged Warblers travel with their subbroods over twice as far from the nest than males, management implemented to ensure post-fledging habitat is available 418 m from potential nest locations is likely to be more effective than management that provides access to post-fledging habitat only within 192 m. Ignoring differential space use by male and female Golden-winged Warblers during the postfledging period may result in negative consequences for half the potential production of young to independence. However, because habitat requirements for female-reared subbroods in the early post-fledging period are similar to habitat requirements of malereared subbroods over the entire post-fledging period, managing at the scale that females use space will likely provide adequate habitat for both subbroods.

Whereas my observations are confined to the Golden-winged Warbler, other birds have been reported to exhibit sex-related differences in habitat use that also influence management considerations. For example, male and female Northern Goshawks have different home-range sizes (Austin 1993) and their home ranges may not entirely overlap (Boal et al. 2003). These sex-related differences in space use influence the scale at which management activities are directed (Boal et al. 2003). I suggest that variation in male and female habitat use be investigated in other species of concern before management plans are implemented at scales that may be inappropriate for maximizing post-fledging survival and production of young to independence.

Figure 1. Trends in daily distance from nest in male-reared sub-broods (M) and female-reared sub-broods (F) in three populations of Golden-winged Warblers in the western Great Lakes region 2010-2012 (data presented as mean \pm SE).



Figure 2. Trends by days after fledging of (A) canopy cover (%), (B) lateral vegetation cover (%), and (C) non-shrubland forest use (%) in male-reared subbroods (M) and female-reared subbroods (F); and vertical strata use in (D) male-reared subbroods and (E) female-reared subbroods in three populations of Golden-winged Warblers in the western Great Lakes region 2010-2012 (data presented as mean \pm SE; SE omitted from D and E for clarity).











Chapter 2

Ecology of Brood Division in Golden-winged Warblers

Overview: Post-fledging brood division is a poorly understood, yet widespread avian behavior. Brood division has been observed in Golden-winged Warblers (Vermivora chrysoptera), although the differences in parental care between adult males and females, the fitness benefits of this behavior, and the mechanisms explaining differences in space use between male- and female-reared subbroods are unknown. From 2010 to 2012, I monitored radio-marked Golden-winged Warbler fledglings from fledging (i.e., leaving the nest) until independence from adult care at three sites in the western Great Lakes region of North America. I assessed differences in parental care between male and female parents and considered the possible evolutionary implications of my observations. I observed no significant difference in provisioning, parental attendance, and fledgling begging between males and females. However, female-reared subbroods exhibited a period of consistent directional movement on days 8 - 10 after fledging, resulting in females raising their subbroods farther from the nest than males. Spatial division in Golden-winged Warblers may be related to extensive crèching (i.e., association with nonrelated broods to improve foraging efficiency and predation defense) in the post-fledging period.

Introduction

Brood division is a widespread, yet poorly documented or described avian behavior. Brood division is characterized by separation of parental care in the post-fledging period so that each adult provisions and cares for a stable subset of the brood, forming two 'subfamilies' (Harper 1985, Leedman and Magrath 2003; hereafter I use the term 'subbrood' to describe these units of division to avoid confusion with the taxonomic term and to more accurately describe the object of division [i.e., the brood]). There is considerable variation in how brood division is manifested, with some species demonstrating obligate brood division, whereas others do not (Table 1). Similarly, timing of brood division varies among species, with most species dividing broods immediately after fledging (Nolan 1978, Smith and Merkt 1980, McLaughlin and Montgomerie 1985, Byle 1990, Anthonisen et al. 1997, Evans Ogden and Stutchbury 1997) but others dividing broods up to several weeks after fledging (Leedman and Magrath 2003).

In some multi-brooded species, divided broods recombine under the care of the male when the female begins incubation in a subsequent clutch of eggs (Weatherhead and McRae 1990, Evans Ogden and Stutchbury 1997). However, in other multi-brooded species, brood division tends to occur only in breeding attempts late in the season (Mills et al 1980, Edwards 1985, Harper 1985, Zaias and Breitwisch 1989). Brood division can also be related to fledgling sex with some species exhibiting a tendency to care for fledglings of the same or opposite sex from the parent (Byle 1990, Harper 1985, Vega et al. 2007) whereas other species exhibit no sex-related pattern in brood division (Price and

Gibbs 1987, Evans Ogden and Stutchbury 1997, Wheelwright et al 2003, Tarwater and Brawn 2008, Watson et al. 2012).

Leedman and Magrath (2003) summarized potential evolutionary factors influencing brood division and formulated eight hypotheses to explain brood division in birds related to predation, provisioning, sibling competition, preferential or specialized care by adults, tradeoffs between adult and fledgling survival, fledgling choice, and social specialization (Table 2). One or more of these factors may influence evolution of brood division, and because the natural history of species that exhibit brood division differs considerably, it is unlikely that any single hypothesis describes the evolutionary factors shaping this behavior for all species.

Golden-winged Warblers (*Vermivora chrysoptera*) are migratory songbirds that breed in northeastern and north-central North America and winter in southern Central America and northern South America (Confer et al. 2011). Both parents of this singlebrooded species (i.e., a single pair will not renest after successfully fledging a brood in any given year) care for nestlings and fledglings until independence ~25 days after fledging (Will 1986). Brood division has been documented in this species (Will 1986), but the extent and characteristics of brood division are not known. Similar to Lapland Longspurs (*Calcarius lapponicus*; McLaughlin and Montgomerie 1985) and Hooded Warblers (*Setophaga citrina*; Evans Ogden and Stutchbury 1997, Rush and Stuchbury 2008), adult female Golden-winged Warblers travel significantly farther from the nest with their subbroods after fledging than adult males (Chapter 1). Despite considerably different space use between male- and female-reared subbroods, both parents use areas with similar habitat characteristics throughout the post-fledging period (Chapter 1). At three study sites in the western Great Lakes region of North America, Golden-winged Warbler fledgling survival from day 8 after fledging until independence was similar between both male- and female-reared subbroods (Chapter 1). After fledging, Goldenwinged Warblers often form crèches (i.e., loose flocks comprised of multiple broods) in the post-fledging period with fledglings of both other species and other non-related conspecific subbroods (Will 1986, H. Streby unpublished data). The benefits of crèching are not fully understood, although some of the benefits may be similar to the benefits derived from flocking; for example, with multiple parents attending a crèche, the amount of time each individual spends defending against predation can be reduced, increasing time available for foraging or other behaviors (Moynihan 1962).

To describe behavior related to brood division and to understand the ecological benefits of brood division, I used radio telemetry to study brood division in three populations of Golden-winged Warblers to assess (1) sex-based differences and trends in parental care, fledgling survival, and movement patterns in male- and female-reared subbroods and (2) the applicability of current hypotheses explaining brood division to this species.

Methods

*Study Sites:--*From 2011-2012, I studied Golden-winged Warblers at Tamarac National Wildlife Refuge (NWR) in Becker County, Minnesota, USA (47.049° N, 95.583° W), Rice Lake NWR in Aitkin County, Minnesota, USA (46.529° N, 93.338° W) and Sandilands Provincial Forest (PF) in southeastern Manitoba, Canada (49.637° N, 96.247° W). I also performed a small pilot study in 2010 at Tamarac NWR. All three study sites were located in the northern hardwood transition zone between boreal forest in the north and east and tall-grass prairie in the south and west. Each site contained a mosaic of early successional shrubland (e.g., regenerating clearcuts), mid-successional forest with a dense, shrubby understory, older-successional forest, and shrubby wetlands. For more detailed description of the landscape, see Chapter 3. At each site, I focused my work in and around 4 - 8, 2.5 - 25 ha shrubby upland or wetland patches and the surrounding predominantly forested landscape.

*Field Methods:--*I used two methods for searching for Golden-winged Warbler nests: (1) systematic nest-searching for nests and using adult behavioral queues (Martin and Guepel 1993) to locate nests and (2) radio-telemetry of adult female Golden-winged Warblers passively captured in mist-nets and marked with radio transmitters early in the breeding season (Streby et al. 2014a). I attached radio transmitters with a figure-eight elastic harness modified from that described by Rappole and Tipton (1991). Radio transmitters were ~ 4.1% of mean adult mass at time of attachment and had no measurable impact on productivity (Streby et al. 2013a). I recorded locations for nests using handheld Global Positioning System (GPS) units (Garmin GPSMAP 76 or eTrex Venture HC) and achieved <5 m accuracy by averaging 100 points.

When nestlings were 7 days old (rarely 6, 8, or 9; counting hatch day as day 1), I measured nestling mass to the nearest 0.01 g using a digital scale, banded all nestlings with standard U.S. Geological Survey aluminum legbands, and attached a radio

transmitter (~4.6% of mean nestling mass) to 1 - 5 randomly selected nestlings using the same attachment method described for adults. In addition, I used mist nets to capture, band, and attach radio transmitters to 26 non-radio-marked fledglings encountered during field activities (21% of all fledglings monitored). I estimated the age of these captured fledglings based on my observed development of fledglings of a known age (i.e., those monitored from fledging).

I located fledglings daily and monitored them using the ground-based telemetry methods described by Streby and Andersen (2013a). I recorded daily fledgling locations after visually identifying the radio-marked bird using handheld GPS units and achieved <5 m accuracy by averaging 100 points. I derived daily azimuth (i.e., the direction a fledgling traveled between successive days), minimum daily distance (i.e., the minimum distance between fledgling points on successive days), and distance between fledglings (both those within the same subbrood and those in different subbroods) using ARC 10.0 Geographic Information System (GIS) software. In addition to recording fledgling location, in 2012 I also recorded parental and fledgling behavior for a 5-minute period following location of the fledglings via radio telemetry. Using these 5-minute observation periods, I recorded induced begging rate (i.e., % of observations that included begging during interaction with the adult), unattended begging rate (i.e., % of observations that included begging with no adult present), adult attendance rate (i.e., % of observations in which the parent was present), and provisioning rate (i.e., % of observations in which the fledgling was fed by an adult). In all years, I used throat and auricular plumage coloration to identify fledgling sex beginning at 14 days after fledging, when the preformative molt initiates (Pyle 1997).

*Post-fledging Periods:--*I observed significant differences in space use between male- and female- reared subbroods of Golden-winged Warblers in my three study populations (Chapter 1). Early in the post-fledging period, male- and female-reared subbroods were observed similar distances away from the nest; however, by the end of the post-fledging period, female-reared subbroods traveled over twice as far from the nest as male-reared subbroods, indicating a potential shift in parental behaviors at some point in the post-fledging period. To assess differences between sexes in the context of temporally variable parental strategies (i.e., parental strategies may change over time), I used directional data to identify when female-reared subbroods began to exhibit different movement patterns than male-reared subbroods. I then divided the post-fledging period into two periods based on when this sex-based difference in brood movements occurred to compare aspects of brood division related to parental sex.

Statistical Analyses:--I used a Rayleigh test for circular uniformity (Durand and Greenwood 1958) to assess average azimuth (i.e., the mean direction traveled by a subbrood from fledging until independence) for both male- and female-reared subbroods by testing recorded daily average azimuths throughout the post-fledging period against a general alternative. To identify directionality of movements, I calculated daily change of azimuth (i.e., the difference in azimuth from one day to the next) from day 2 - 25 for each subbrood, resulting in a distribution of values between 0° and 180° , with random selection of directional movement producing an average daily change of azimuth of 90° ,
movement in similar directions to the previous day producing an average daily change of azimuth $<90^{\circ}$, and movement in dissimilar directions to the previous day producing an average daily change of azimuth $>90^{\circ}$.

To avoid potential bias in my statistical tests due to non-independence of locations for broods in which I monitored only one subbrood, I used only broods for which I monitored both subbroods in initial comparisons. As described above, I did not radio mark all fledglings from each brood due to logistical constraints. In addition, fledgling mortality was highest during the first few days after fledging from the nest (H. Streby unpublished data), as is common among songbirds (Berkeley et al. 2007, Vitz and Rodewald 2011, Streby and Andersen 2013b). These logistical constraints and early mortality events resulted in us monitoring one subbrood for 95 broods and both subbroods for 17 broods. After testing for differences between paired subbroods (i.e., both subbroods from a single brood), I described patterns over time using data from all subbroods. In my statistical analyses, I used the mean value for all marked fledglings for any response variable for subbroods for which I monitored >1 fledgling.

To assess whether the number of fledglings in subbroods varied by sex of the parent, I used a χ^2 test to compare the number of male- and female-reared fledglings. To avoid potential sex-specific capture bias, I used only fledglings marked as nestlings in this analysis. I tested for a preferential selection of juvenile fledgling sexes by adult Golden-winged Warblers of both sexes using a χ^2 test. To assess whether adult selection of fledglings for their subbrood was correlated with nestling mass, I used a paired Student's *t*-test to compare mean nestling mass at time of banding for paired subbroods.

I assessed differences in minimum daily distance moved between male- and female-reared subbroods using an analysis of covariance (ANCOVA) on a linear model built in R (R Development Core Team 2011) with parental sex and fledgling age as independent variables and minimum daily distance moved as the dependent variable. I used a Pillai-M. S. Bartlett trace multivariate analysis of covariance (MANCOVA) to assess differences in parental behavior between male- and female-reared subbroods using a linear model with parental sex and fledgling age as independent variables and parental presence, provisioning rate, total begging rate, and unattended begging rate as dependent variables.

Assessing Brood Division Hypotheses:--I assessed support for brood division hypotheses in Golden-winged Warblers by comparing my observations with those expected for each hypothesis from Leedman and Magrath (2003; Table 3). A prediction proposed by Leedman and Magrath (2003) is that if brood division is an anti-predation behavior that spatial brood division would be most evident during the highest mortality period (i.e., for Golden-winged Warblers, the first three days after fledging [H. Streby unpublished data]). To assess whether there was a difference in distance between subbroodmates and distance between broodmates within different subbroods, I used a subsample of three broods for which I identified parental sex for >2 individuals (i.e., I observed >1 individual in one subbrood and > 0 individuals in the other). I used an ANCOVA to assess these differences using a linear model with subbrood association (i.e., whether distances measured were between fledglings in the same subbrood or between fledglings in different subbroods) and fledgling age as independent variables and distance between fledglings as the dependent variable.

Results

I monitored 66 Golden-winged Warbler fledglings from 60 subbroods at Tamarac NWR, 30 fledglings from 28 subbroods at Rice Lake NWR, and 27 fledglings from 24 subbroods at Sandilands PF. From a total of 123 radio-marked fledglings, I monitored 109 fledglings from 78 nests that were divided evenly between males (n = 59) and females (n = 50; $\chi^2 = 0.26$, df = 1, P = 0.39). For fledglings observed ≥ 14 days after fledgling, I identified the sex of 27 fledglings (46.5%) in female-reared subbroods and of 32 fledglings (49.2%) in male-reared subbroods. I did not identify the sexes of 64 other fledglings due to inadequate observation. Females were equally likely to care for female offspring (n = 15) as they were for male offspring (n = 12) ($\chi^2 = 0.61$, df = 1, P = 0.56). Similarly, males equally cared for female (n = 18) and male (n = 14) offspring ($\chi^2 = 0.41$, df = 1, P = 0.48). In broods marked in the nest for which I monitored both subbroods (n = 16), nestling mass was similar between male- ($\bar{x} = 7.33 \pm 0.14$) and female-reared ($\bar{x} = 7.15 \pm 0.19$) fledglings (n = 16; t = -0.66, P = 0.26).

I observed two periods of directional movement, or less change in direction between subsequent days than what was expected at random. On day 3 and 4, both maleand female-reared subbroods were more likely to travel in a direction similar to what they had traveled on the previous day (Fig. 1B). On days 8 - 10 only female-reared subbroods moved in similar directions to the previous day. I used this directional movement to define the early post-fledging period as days 1 - 8 after fledging and the late postfledging period as days 9 - 25 after fledging. During the late post-fledging period, fledglings were more likely to change direction >90° from the previous day, suggesting maintenance of an area of use.

Fledglings in both male- and female-reared subbroods moved similar minimum daily distances in both the early post-fledging period ($F_{2, 241} = 0.03$, P = 0.87) and late post-fledging period ($F_{2, 325} = 1.38$, P = 0.71). Neither male- (n = 25, Z = 0.218, P = 0.31) nor female-reared subbroods (n = 25, Z = 0.243, P = 0.23) moved in a consistent direction over the entire post-fledging period. In five broods for which I tracked both subbroods after day 8, I observed subbroods < 15 m apart for a brief period ($\bar{x} = 1.6 \pm 0.4$ days) in the late post-fledging period ($\bar{x} = 16 \pm 2.28$ days after fledging) before separating again. These subbroods traveled an average of 135 m (± 13 m) from the previous day's location when they reunited with the other subbrood.

I monitored six subbroods (three male-reared and three female-reared) with > 1 radio-marked fledgling for > 20 days. With the exception of two (1.5%) extreme observations (314 m and 158 m; consecutive days within the same subbrood), subbroodmates were never >86 m apart in 136 observations. In five of six subbroods, I observed that subbroodmates remained 33 m (\pm 5.3) apart until day 16 \pm 1.5, when they were < 10 m apart for the remainder of the post-fledging period, often in the same shrub or tree.

Adult and fledgling behaviors (i.e., provisioning rate, adult attendance rate, and attended and unattended fledgling begging rates) were similar between paired male- and

female-reared subbroods during the early post-fledging period ($F_{4, 189} = 1.29$, P = 0.27) and late post-fledging period ($F_{4, 222} = 0.53$, P = 0.72). In the larger sample of both paired and unpaired subbroods, I observed no temporal trend in provisioning rates throughout the post-fledging period (Fig. 2A), although parental attendance for both male- and female-reared subbroods declined steadily throughout the post-fledging period (Fig. 2B). Similarly, I found no difference between male- and female-reared subbroods in unattended begging rates (Fig. 2C) or total begging rates (Fig. 2D). In 1,233 observation periods of fledgling behavior during the post-fledging dependent period, I did not observe any agonistic actions of fledglings directed at broodmates, parents, or other non-related fledglings (including Golden-winged Warblers and other species) within a crèche.

Assessing Brood Division Hypotheses:--For Golden-winged Warblers, I found support or partial support for the sibling competition and adult conflict hypotheses of the benefits of brood division and I rejected or indirectly rejected the preferential care, specialized care, and fledgling choice hypotheses (Table 3). I found mixed support (i.e., support for some predictions but not for others) for the predation and provisioning hypotheses for brood division. I were unable to assess the social specialization hypothesis.

For three broods for which I tracked >1 fledgling in one subbrood and >0 fledgling in the other subbrood, I observed no difference in distances between subbroodmates and broodmates in different subbroods in the period of highest mortality (i.e., 1 - 3 days after fledging; $F_{1, 23} = 0.55$, P = 0.47). During that period each fledgling was ≥ 12 m from any other broodmate, with an average distance of 40 m (± 3.4 m)

between siblings regardless of subbrood. Mean minimum distance between locations on subsequent days during days 1 - 3 was $22 \text{ m} (\pm 1.3 \text{ m})$ and change in daily azimuth was < 90° (Fig. 1B), indicating that movements in this period were directional and not random. In 26 broods for which I monitored >1 fledgling (either in different subbroods or the same subbroods), minimum distance between broodmates in the first three days after fledging was 9 m, with a mean distance of 31 m (\pm 3.9 m).

Discussion

Brood division was the dominant strategy in the three populations of Goldenwinged Warblers I studied in the western Great Lakes region. Will (1986) studied Golden-winged Warblers in Michigan, USA, where brood division was the dominant strategy during the fledgling period, suggesting that this behavior is widespread in Golden-winged Warblers. I found no significant difference between the number of fledglings in subbroods cared for by females versus subbroods cared for by males, suggesting that both parents in Golden-winged Warblers provide similar amounts of care to fledglings.

Golden-winged Warblers in my study did not divide broods based on fledgling sex, also similar to observations reported by Will (1986). McLaughlin and Montgomerie (1985) hypothesized that adults care for fledglings of the same sex to teach them sexspecific behaviors necessary for breeding—that does not appear to be the mechanism operating in Golden-winged Warblers during the 25-day dependent post-fledging period. My results are also not consistent with those of Wheelwright et al. (2003), who found that male Savannah Sparrows (*Passerculus sandwichensis*) cared for smaller nestlings, as I observed no relationship between nestling mass and whether fledgling sex was associated with the sex of the parental care giver. However, differences in nestling mass can be confounded by digestive contents in Golden-winged Warblers (Streby et al. 2014b). Therefore, nestling mass was likely a non-informative measure of relative condition or development in my study. If adults are selecting to care for higher quality fledglings, they are not using a visual or behavioral cue correlated with nestling mass late in the nesting period.

During days 3 and 4 post-fledging, both male- and female-reared Golden-winged Warbler subbroods exhibited directionality in movements between successive days. These movements were consistent with the timing of early movements towards areas associated with high fledgling survival (H. Streby unpublished data), a pattern also observed in fledgling Ovenbirds (*Seiurus aurocapilla*; Streby and Andersen 2013b). My results also suggested these directed movements in the first few days post-fledging are attributable to movement away from other broodmates from both subbroods to create spatial separation, perhaps in an attempt by adults to reduce the potential for catastrophic predation events (i.e., loss of the entire subbrood). Because I did not observe broodmates < 8 m apart in the first three days after fledging, I speculate that adults dispersed broodmates to reduce the potential for multi-fledgling predation events.

Although subbrood separation has been documented in at least two other species--Lapland Longspurs (McLaughlin and Montgomerie 1985) and Hooded Warblers (Evans Ogden and Stutchbury 1997, Rush and Stuchbury 2008)--the mechanism for separation in these species was not documented. In Golden-winged Warblers, female-reared subbroods, unlike male-reared subbroods, exhibited a period of directional movement 8 – 10 days post-fledging. Because there was no difference between male- and female-reared broods in minimum daily distance traveled (Fig. 1A), spatial brood division in the populations of Golden-winged Warblers I studied occurred as a result of this directional movement by female-reared subbroods (Fig. 1B). Following day 10 post-fledging, female- and male-reared subbroods again demonstrated no multi-day directionality (Fig. 1B). The non-directional movement of subbroods throughout the remainder of the postfledging period was characterized by movements > 90° different in direction between successive days (Fig. 1B), which resulted in subbroods remaining in the same general area, likely associated with suitable brood-rearing habitat (e.g., Streby and Andersen 2013b).

I observed fledglings within the same subbrood reducing the distance between each other after day 16, when subbroodmates often occupied the same shrub or tree. The benefits of close association of fledglings within a subbrood and subbroods joining crèches may be similar to benefits related to survival and provisioning derived from flocking behavior (Moynihan 1962). Fledgling daily survival in the late post-fledging period was high (male $\bar{x} = 0.9887$, female $\bar{x} = 0.9873$), and close association among fledglings within a subbrood after day 16 may contribute toward fledglings learning to forage for themselves, with siblings able to exploit foraging locations discovered by broodmates or adults. Fledglings may also learn from successful foraging behaviors observed in both broodmates and adults. Interestingly, I often observed individual

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fledglings in crèches with unrelated conspecific and interspecific fledglings during the early post-fledging period when siblings were spatially separated. I speculate that this early crèching behavior could be a strategy to incur the benefits of flocking without the risk of multi-fledgling predation events because each adult has only a small number of offspring in the crèche.

In contrast to studies of other species that employed longer observation periods (e.g., Harper 1985, Middleton et al. 2007), I did not observe variation in provisioning rates over time. However, I observed no meaningful difference between male and female provisioning rates, similar to what was observed by Byle (1990). Although I did not directly assess differences in the quality of food delivered by each parent, Streby et al. (2014b) reported that the stomach contents of nearly all recovered fledgling Goldenwinged Warblers in this population were similar, suggesting that there was likely no difference between food items provided by each parent. I also did not observe a difference in the amount of begging by fledglings in male- and female-reared subbroods, further supporting observations of similar care between male and female parents. Although parental attendance of fledglings does not equate to equally effective defense of fledglings, my observations of similar attendance rates in male- and female-reared subbroods indicates that parents of each sex had similar opportunities to defend their fledglings.

Whereas I observed sex-specific distributions of space use in Golden-winged Warbler subroods, some studies of other species have reported single distributions of space use in the post-fledging period (e.g., Streby and Andersen 2013b). Although these observations may appear to contradict each other, reports of a single distribution of space use may, due to technological or logistical constraints during data collection, unwittingly incorporate the space use trends of both male- and female-reared subbroods simultaneously into that distribution. For example, without consideration of brood division in my study population, I would have reported a median distance from nest on day 21 of 174 m with a standard deviation of 345 m rather than a male distribution with a median of 105 m and a standard deviation of 222 m and a female distribution with a median of 352 m and a standard deviation of 397 m. Similarly, brood division and sexspecific movement strategies might explain why some species have been documented using "stationary" and "drifting" strategies of post-fledging movement (e.g., Anders et al. 1998, Vega Rivera et al. 2000, White and Faaborg 2008). It is possible that those strategies are a reflection of differences between male and female movement patterns that are difficult to decipher in sexually monomorphic species.

Brood division has a diverse suite of possible benefits. With the large variation in the characteristics of brood division it is doubtful that there is either a uniting benefit to or a shared origin for every species that employs this strategy. I agree with Harper (1985) that brood division is likely to increase provisioning evenness by providing each adult with only 1–3 fledglings for which to care. As reported by Middleton et al. (2007), provisioning rates seem to decouple from begging rates after fledging, suggesting that adults caring for subbroods no longer need to rely on fledgling hunger to determine which fledgling needs to be provisioned. By spatially dividing a subbrood and knowing

that their co-parent is not provisioning the fledglings under their care, individual adults can ensure that each fledgling is being adequately provisioned.

Whereas the relationship between number of fledglings and adult survival has not been explored in Golden-winged Warblers, if patterns observed in other species (e.g., Nur 1984, Edwards 1985) apply, then I would expect adult survival to decrease with increasing numbers of fledglings cared for. Brood division is likely a strategy for simultaneously ensuring high fledgling survival (i.e., increasing care for each fledgling by not forcing one parent to care for all fledglings) and high adult survival by reducing the number of fledglings cared for by each adult. By compromising on selfish strategies and not abandoning the brood to be cared for by only one parent, adults can increase their current seasonal productivity by improving fledgling survival (consistent care from one parent would ensure more even predation defense and food distribution) and increasing potential future fitness by increasing survival of their partner at the cost of reducing their own survival (Lessels 1998). Based on my observations, this tradeoff between increased future fitness (i.e., higher survival for an individual adult) and increased success of a current breeding attempt is the most likely explanation of the adaptive significance of brood division in Golden-winged Warblers.

An additional benefit of brood division to songbirds that has not been explored is protection against the post-fledging effects of brood parasitism. There is increasing evidence that brood parasites can have dramatic impacts on fledglings long into the postfledging period (Hoover and Reetz 2006, Peterson et al. 2012, Ridley and Thompson 2012). Brood division may reduce or eliminate those impacts in the subbrood without a brood parasite, so that rather than impacting an entire brood, parasitism my impact only half of a brood. However, although brood division has the potential to mitigate effects of brood parasitism, it is unlikely that brood division evolved in response to brood parasitism, as there are species that divide broods in the absence of brood parasites (e.g. Flammulated Owls [*Otus flammeolus*]; Linkhart and Reynolds 1987).

Protection from catastrophic predation events is a likely cause of the initial spatial dispersion of Golden-winged Warbler fledglings over the first few days after fledging. I observed stronger than expected directionality during that period and no instances in which these young, low-mobility broodmates were within the same shrub. H. Streby (unpublished data) reported that immediately after leaving the nest fledglings move toward areas associated with high fledgling survival, indicating that early post-fledging movements are likely driven by predation risk. However, fledged broods do not move toward high-survival areas as a cohesive group. Instead movement patterns in the first few days post-fledging are characterized by fledglings separating spatially while moving toward areas of higher fledgling survival. My observations suggest that the combination of increased fledgling dispersion and access to high-survival post-fledging habitat increases fledgling survival during this high predation period. However, this behavior does not appear to be related to brood division, as I observed broodmates similar distances from each other regardless of subbrood association.

I found no evidence that the spatial division between male- and female-reared broods of Golden-winged Warblers after day 9 was due to predation, provisioning efficiency, adult conflict, preferential care, specialized care, or sibling conflict. McLaughlin and Montomerie (1985) hypothesized that in Lapland Longspurs territory fidelity may be the reason that males stay close to the nest. This territory fidelity hypothesis predicts that female movements away from the nesting territory are simply unconstrained random movements that result in females eventually traveling farther from the nest. However, I demonstrated that the movement away from the breeding territory on days 8 - 10 is directed by females and not random wandering beyond the extent of a confined post-fledging area used by male-reared subbroods.

The evolutionary benefit of females traveling farther from the nest than males remains unclear. It is not related to ensuring post-fledging cover type availability, as both male- and female-reared Golden-winged Warbler subbroods used the same cover types and the same microhabitats in the post-fledging period despite the significant difference in distances from the nest (Chapter 1). It is also doubtful that this strategy is related to predation defense, as fledgling survival in this species was high during the late postfledging period when spatial separation between male- and female-reared subbroods was largest (Chapter 1).

One explanation for the variation in distances from the nest between males and females may be related to crèching. As crèching is a behavior used by multiple species, divided broods may seek out crèches while at the same time attempting to minimize any competition for resources between subbroods or the likelihood that a predation event targeting the crèche will result in the loss of a broodmate. Whereas individual subbroods commonly crèche with other unrelated broods of Golden-winged Warblers or other species with similar diets, I observed only short periods when two subbroods from the

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same brood associated with the same crèche. In all such cases, one subbrood left the area within a day or two after re-associating with the other subbrood. I speculate that these instances of brood reformation and subsequent division are the result of two crèches associating or combining followed by the abandonment of the crèche by one of the subbroods to minimize inter-subbrood competition or risk of catastrophic predation. More study of crèching behaviors in the post-fledging period is needed to fully explore the relationship between the movement patterns observed in brood division and use of crèches.

1	Table 1. Summary	y of species	documented	exhibiting bro	od division a	nd whether b	rood division is	obligate or not.

Species	Source	Obligate Division
Great Crested Grebe (Podiceps cristatus)	Simmons (1974)	
Black Coot (Fulica atra)	Horsfall (1984)	
Whimbrel (Numenius phaeopus)	Williamson (1946)	
Roseate Tern (Sterna dougallii)	Watson et al. (2012)	
Flammulated Owl (Otus flammeolus)	Linkhart and Reynolds (1987)	Y
Red-bellied Woodpecker (Melanerpes carolinus)	Cox (2011)	Y
White-browed Scrubwren (Sericornis frontalis)	Leedman and Magrath (2003)	Ν
Western Slaty Antshrike (Thamnophilus atrinucha)	Tarwater and Brawn (2008)	Y
European Robin (Erithacus rubecula)	Harper (1985)	Ν
Bluethroat (Luscinia svecica)	Anthonisen et al. (1997)	Y
Northern Wheatear (Oenanthe oenanthe)	Moreno (1984)	Y
Eurasian Blackbird (Turdus merula)	Edwards (1985)	
American Robin (Turdus migratorius)	Weatherhead and McRae (1990)	Ν
Northern Mockingbird (Mimus polyglottos)	Zaias and Breitwisch (1989)	
Dunnock (Prunella modularis)	Byle (1990)	
Seychelles Fody (Foudia sechellarum)	Vega et al. (2007)	
Hawfinch (Coccothraustes coccothraustes)	Tomiałojć (2012)	
Lapland Longspur (Calcarius lapponicus)	McLaughlin and Montgomerie (1985)	Y
Montserrat Oriole (Icterus oberi)	Allcorn et al. (2012)	
Ovenbird (Seiurus aurocapilla)	Hann (1937)	
Golden-winged Warbler (Vermivora chrysoptera)	Will (1986)	
Prairie Warbler (Dendroica discolor)	Nolan (1978)	
Hooded Warbler (Setophaga citrina)	Evans Ogden and Stutchbury (1997)	

Black Redstart (Phoenicurus ochruros)	Draganoiu et al. (2005)	Ν
Medium Ground Finch (Geospiza fortis)	Price and Gibbs (1987)	Ν
Cactus Finch (Geospiza scandens)	Price and Gibbs (1987)	Ν
Lark Bunting (Calamospiza melanocorys)	Adams et al. (2001)	
Savannah Sparrow (Passerculus sandwichensis)	Wheelwright et al. (2003)	
Song Sparrow (Melospiza melodia)	Smith (1978)	Y
White-throated Sparrow (Zonotrichia albicollis)	Kopachena and Falls (1991)	Y
Five-striped Sparrow (<i>Amphispiza quinquestriata</i>)	Mills et al. (1980)	
Blue Tit (Parus caeruleus)	Slagsvold et al. (1994)	
Crested Tit (Lophophanes cristatus)	Hope (1990)	

Hypothesis	Description	Source
Predation	Brood division may reduce the likelihood of a catastrophic	Smith (1978), Harper
	predation event (i.e. full brood mortality) or decrease the	(1985), McLaughlin and
	variance in predation pressures by spatially dividing broods.	Montgomerie (1985),
		Anthonisen (1997)
Provisioning	Brood division increases evenness of provisioning for	Smith (1978), Horsfall
	fledglings by assigning provisioning for any fledgling to 1	(1984), Moreno (1984),
	parent and thereby reducing the chances of overprovisioning or	Harper (1985)
	neglecting a fledgling. Brood division may also increase	
	provisioning efficiency by reducing the amount of travel time	
	needed for adults with food.	
Sibling Competition	Brood division might reduce the influence of aggressive	Harper (1985)
	siblings on the provisioning rates for the rest of the brood.	
Preferential Care	Brood division might be driven by parents preferring to care for	Harper (1985), Slagsvold
	specific young (e.g., known progeny or fledglings of a specific	(1994), Anthonisen
	sex).	(1997), Lessells (1998)
Specialized Care	Similar to preferential care, adults may be better at caring for a	Harper (1985),
	certain type of fledgling (e.g. specific sex).	Mclaughlin and
		Montgomerie (1985)
Adult Conflict	Because adult survival decreases as number of fledglings cared	Harper (1985), Slagsvold
	for increases (Nur 1984, Edwards 1985), brood division may be	et al. (1994), Anthonisen
	driven by adults attempting to reduce their own cost of care by	et al. (1997)
	caring for fewer needy birds or abandoning part of the brood.	
Fledgling Choice	Brood division may arise from fledglings choosing an adult to	Horsfall (1984), Moreno
	follow and aggressively excluding other fledglings.	(1984), Slagsvold (1997)
Social Specialization	Brood division may be a method of increasing provisioning	Leedman and Magrath
	efficiency and overall survival by exploiting the ability of	(2003)
	animals to learn trends or behaviors of others.	

Table 2. Summary of hypotheses of the evolutionary benefits of brood division.

Hypothesis	Predictions	Conclusion	Result
Predation	Brood division most apparent when mortality highest	Reject	Division between subbroods was no stronger than division between broodmates within the same subbrood in the period of highest mortality
	Spatial division of fledglings to reduce probability of predation of multiple fledglings in 1 event	Support	Fledglings remained separated until late in the post-fledging period when daily survival was high and multiple fledgling predation events unlikely
Provisioning	More equitable distribution of food in divided broods than in non-divided broods	N/A	Not directly assessed, as I observed near obligatory brood division
	Spatial separation between subbroods	Partial support	Spatial separation began > 8 days after fledging
	Subbroods remain separated to avoid disturbance and competition	Reject	I observed subbroods forming crèches with other Golden-winged Warbler family groups
Sibling Competition	Separation of young to ensure equal care	Partial support	Spatial separation within a subbrood occurred until approximately day 16 after fledging, when subbroods were often found in the same shrub or tree
Preferential Care	Males care for own offspring preferentially	Indirectly reject	Not directly assessed, however I observed male Golden-winged Warblers caring for Brown-headed Cowbirds
	Preferential care for	Reject	I observed no correlation between adult

Table 3. Assessment of brood division hypotheses for Golden-winged Warblers in the western Great Lakes region 2010-2012.

	fledglings of a specific sex		sex and fledgling sex
Specialized Care	Adults better at caring for fledglings of a specific sex	Reject	I observed no correlation between adult sex and fledgling sex
	Best provisioner provisions	Indirectly	Not directly assessed, however I
	neediest young	reject	observed no sex-based difference
			between male and female provisioning
			rates or begging rates in fledglings
			parented by either sex, suggesting that
			neither sex is intrinsically a better
			provisioner or more capable of caring
		G (for needler fledglings
Adult Conflict	Each parent attempts to	Support	a fladelings agreed for by males and the
	offspring cared for		number of fledglings cared for by
	resulting in even division		females
	unless 1 sex is dominant		Tomatos
Fledgling	Dominant fledglings select	Indirectly	Not directly assessed, however I
Choice	best provisioner	reject	observed similar provisioning rates
			between males and females. If the
			dominant fledgling selects the best
			provisioner, then provisioning is not a
			sex-based trait
	Dominant fledglings	Reject	I did not observe any agonistic behavior
a • 1	exclude other fledglings		between fledglings
Social	Provisioning efficiency	N/A	Not directly assessed
Specialization	would increase over time		

Figure 1. Trends in (A) minimum daily distance (m; distance between fledgling locations on subsequent days) and (B) daily change in azimuth (degrees) by day after fledging from nest in male-reared subbroods (M) and female-reared subbroods (F) in three populations of Golden-winged Warblers in the western Great Lakes region 2010-2012 (data presented as mean \pm SE).





Figure 2. Daily trends in (A) provisioning rates (% observations with adult provisioning), (B) parental attendance (% observations with adult present), (C) unattended begging rates (% observations with fledgling begging in the absence of the adult), and (D) total begging rates (% observations with fledgling begging, including begging induced by adult) all by day after fledging in male-reared subbroods (M) and female-reared subbroods (F) in three populations of Golden-winged Warblers in the western Great Lakes region 2010-2012 (data presented as mean \pm SE).









Chapter 3

Spatially Explicit Models of Full-Season Productivity and Implications for Landscape Management of Golden-winged Warblers in the Western Great Lakes Region

Overview: The relationship between landscape structure and composition and full-season productivity (i.e., young raised to independence from adult care) for most birds is poorly understood. For species of high conservation concern, insight into how productivity is related to landscape structure and composition can be used to develop more effective conservation strategies that increase recruitment. I monitored nest productivity and fledgling survival of Golden-winged Warblers (Vermivora chrysoptera), a species of high conservation concern, in managed forest landscapes at two sites in northern Minnesota, USA, and one site in southeastern Manitoba, Canada from 2010 to 2012. I used logistic exposure models to identify the influence of landscape structure and composition on nest productivity and fledgling survival. I used those models to predict spatially-explicit, fullseason productivity across my study sites to identify areas of low relative productivity that could be targeted for management. I then used my models of spatially-explicit, fullseason productivity to simulate the impact of potential management actions on my study sites with the goal of increasing total population productivity. Unlike previous studies that suggested wetland cover types provide higher-quality breeding habitat for Goldenwinged Warblers, my models predicted 14% greater productivity in upland cover types. Simulated succession of a 9-ha grassland patch to a shrubby upland suitable for nesting, increased the total number of fledglings produced by that patch and adjacent upland shrublands by 30%, despite decreasing individual productivity by 13%. Further simulated

succession of the same patch described above into deciduous forest reduced the total number of fledglings produced to independence on a landscape by 18% because of a decrease in the area available for nesting. Simulated reduction in the cumulative length of shrubby edge within a 50-m radius of any location in my landscapes from 0.6 km to 0.3 km increased full-season productivity by 5%. My models demonstrated that the effect of any single management action depended on the context of the surrounding landscape. I concluded that spatially-explicit, full-season productivity models that incorporate data from both the nesting and post-fledging periods are useful for informing breeding habitat management plans for Golden-Winged Warblers and that similar models can benefit management planning for many other species of conservation concern.

Introduction

Estimates of productivity are important for modeling population growth and identifying habitat features that affect productivity is important for informing management plans. For example, management directed at identification and elimination of habitat features that comprise ecological traps could increase population growth rate (Battin 2004). Most models of songbird population dynamics include estimates of nest success, but lack consideration of fledgling survival, which can result in estimates of population productivity that are at best incomplete and potentially misleading (Streby and Andersen 2011, Shipley et al. 2013). Because habitat characteristics can have different effects on different life stages (Streby et al. 2014a), and because many songbirds appear to have different habitat requirements for nesting than for rearing fledglings (Pagen et al. 2000, Marshall et al. 2003, Vitz and Rodewald 2007, Streby and Andersen 2011), it is important to include survival of both nests and fledglings in estimates of full-season productivity.

Although there are abundant data on the relationships between edge (Askins 1995, Benson et al. 2010), forest fragmentation (Robinson and Wilcove 1994, Faaborg et al. 1995, Bayne and Hobson 1997, Lloyd et al. 2005, Rush and Stutchbury 2008), deforestation (Askins et al. 1987), and urban encroachment (Ausprey and Rodewald 2011) and individual aspects of songbird productivity (i.e., nest success, fledgling survival, or observed population growth), there have been comparatively few efforts to assess the influence of landscape structure and composition to model productivity across multiple life stages, or to simultaneously assess both multiple landscape components and multiple life stages (e.g., Streby and Andersen 2011). In many landscapes, predation is a primary source of both nest failure (Martin 1993) and fledgling mortality (H. Streby unpublished data) and landscape composition can have substantial impact on the composition of the predator community and thus songbird productivity (Robinson 1992, Porneluzi et al. 1993, Hoover et al. 1995, Brawn and Robinson 1996, Chalfoun et al. 2002). Furthermore, predators may be using a landscape at a different spatial scale than breeding songbirds. As a consequence, some aspects of the landscape may influence productivity more than others (e.g., Stephens et al. 2005), and it is only when the entire landscape is considered that productivity can be assessed across a spatial extent relevant for management at the population level.

Golden-winged Warblers (*Vermivora chrysoptera*) are a species of conservation concern that nest in patches of upland shrubland or wetland shrubland within a matrix of mature forest (often with dense understories; Confer et al. 2011) in the Appalachian Mountains, northeastern and north-central USA, and adjacent southern Canada. Relationships between Golden-winged Warbler breeding and landscape configuration are largely unknown, although Confer et al. (2010) observed significantly greater nest success in swamp forests in a Golden-winged Warbler population in New York, USA, and suggested that populations using those cover types may act as sources for populations using upland cover types. Across much of their breeding distribution, however, declines in Golden-winged Warbler populations are largely attributed to the loss of earlysuccessional upland forest stands and hybridization with the closely related Blue-winged Warbler (*Vermivora cyanoptera*; Buehler et al. 2007, Confer et al. 2011). Efforts to mitigate or reverse population declines have concentrated on forest management and the creation or maintenance of early-successional upland forest stands (Huffman 1997, Roth and Lutz 2004, Kubel and Yahner 2008, Percy 2012) or wetland shrublands (Rossell et al. 2003, Rush and Post 2008, Confer et al. 2010). However, management strategies to date have been developed without a clear understanding of how landscape structure and composition influences full-season productivity and how to best incorporate landscape effects into management plans.

To more fully assess the relationship between landscape structure and composition and productivity, I studied three populations of Golden-winged Warblers in the western Great Lakes region of central North America and derived estimates of fullseason productivity at a landscape scale. I constructed spatially-explicit models of fullseason productivity as a function of landscape structure and composition and used these models to estimate full-season productivity across my study areas. Resulting estimates of full-season productivity combined estimates of nest success and fledgling survival, each as a function of landscape structure and composition to derive estimates of productivity across my study sites. I used these spatially-explicit estimates of full-season productivity to evaluate the efficacy of potential management actions.

Methods

Study Areas:--I studied Golden-winged Warblers at Tamarac National Wildlife Refuge (NWR) in Becker County, Minnesota, USA (47.049° N, 95.583° W) from 2010 – 2012 and at Rice Lake NWR in Aitkin County, Minnesota, USA (46.529° N, 93.338° W)

and Sandilands Provincial Forest (PF) in southeastern Manitoba, Canada (49.637° N, 96.247° W) from 2011 - 2012. All three sites were located in the northern hardwood forest transition zone, with boreal forest to the north and east, and tallgrass prairie (mostly converted to agriculture) to the south and west. Although I collected all data in portions of these national wildlife refuges and provincial forest, there were no official boundaries for each study site, and animal movements expanded my perceived study sites almost daily. Each study site covered $\sim 50 \text{ km}^2$ by the end of the study. The landscape immediately surrounding each study site (within 5 km) was primarily upland and wetland forest, and shrubland, with limited areas (<10%) of agriculture and other human development. At all sites, mature forest stands were dominated by maple (Acer spp.), oak (*Quercus* spp.), aspen (*Populus* spp.), paper birch (*Betula papyrifera*), and American basswood (*Tilia americana*), with a few mature stands of jack pine (*Pinus banksiana*) and red pine (*Pinus resinosa*). The term "mature forest" can be ambiguous in managed forests where there might not be a specific age or structure at which a stand becomes mature. I describe stands by structure rather than age here because (1) forest structure and age are not reliably correlated in my study area, (2) I assume birds respond to vegetation structure rather than age, and (3) forest structure is readily comparable for others drawing inference from my results. Upland forests on my study sites were primarily even-aged stands; I use "mature forest" here to refer to stands that had canopy >20 m. All mature forest stands on my three study sites averaged >60% canopy closure, which is defined as closed tree canopy forest by the U.S.D.A. Forest Service (Brohman and Bryant 2005). Sampled locations within mature forest stands ranged from 50% to 96% canopy cover,

and most mature stands contained a patchy and dense shrub layer (vegetation <2 m tall) and understory (vegetation between 2 m and ~15 m tall) of maple, aspen, oak, and hazel (*Corylus* spp.).

Forested areas at each study site were managed through harvest, prescribed fire, or both for timber production and wildlife management resulting in the presence of regenerating forest stands of various seral stages. Because age classes provide little useful information (e.g., a 10-year-old stand north or south of my study area has considerably different vegetation structure), I include a range of stand ages here, but describe stands primarily by vegetation composition and canopy height. I classified stands dominated by vegetation 1-3 m tall as shrub-dominated clearcuts. These stands, traditionally described as the vegetative component of Golden-winged Warbler habitat (e.g., Confer et al. 2011) ranged from 5-15 years post-harvest, and were composed of shrubs, forbs, grasses, paper birch saplings, and aspen propagules with stems <2 cm in diameter that reached 5 m tall in some areas. Shrub-dominated clearcuts ranged from 1 - 30 ha, and contained sparse individual or small patches (i.e., <0.25 ha) of trees 10 - 25 m tall. I classified stands dominated by sapling trees with canopy 5-20 m tall as sapling-dominated clearcuts. All but two stands classified as sampling-dominated clearcuts had canopies 10 -20 m tall. Sapling-dominated clearcuts ranged from 15 - 30 years post-harvest and were dense stands of aspen, birch, and sometimes green ash (*Fraxinus pennsylvanica*) averaging ~ 10 cm dbh, but ranging widely in dbh, with sparse individual trees taller than the main canopy, similar to those in the shrub-dominated clearcuts. I classified stands that were structurally similar to shrub-dominated clearcuts, but on a wetland substrate and

with wetland-associated vegetation, as wetland shrublands. Wetland shrublands were dominated by willow (*Salix* spp.) and alder (*Alnus* spp.) and also contained sedges, grasses, and hazel shrubs. The substrate of wetland shrublands ranged from dry ground to standing or moving water depending on snowmelt and recent rainfall, and in some cases the substrate was sphagnum moss (*Sphagnum papillosum*).

Other, less common cover types at each study site included forested wetlands of tamarack (*Larix laricina*) or black ash (*Fraxinus nigra*), upland and wetland grasslands, firebreaks and powerline rights-of-way (mostly grass with some shrubs), roads ranging from two-track access trails to two-lane paved roads, and small areas of human occupation (houses, outbuildings, and lawns). Each site also contained open water in the form of rivers and lakes, but I excluded open water from my analysis because I assumed it was not available for use by Golden-winged Warbler fledglings. Sandilands PF also included a few small plantations of young jack pine.

*Data Collection:--*I searched for Golden-winged Warbler nests at all three sites using radio-telemetry to monitor adult females and using standard nest-searching methods (Martin and Guepel 1993). I attached radio transmitters (~ 4.1% of mean adult mass; Blackburn Transmitters, Nacogdoches, TX) to passively mist-netted adult female Golden-winged Warblers using a figure-eight harness design modified from Rappole and Tipton (1991), as used by Streby and Andersen (2013b). I used homing on radio signals to locate marked females and find their nests during nest building, egg laying, or early incubation. Radio transmitters had no measurable effect on any aspect of productivity (Streby et al. 2013) during my study. I recorded nest locations using handheld Global Positioning System (GPS) units (GPSMAP 76 or eTrex Venture HC Global Positioning System, Garmin Ltd., Schaffhausen, Switzerland), averaging 100 points to ensure <5 m accuracy. I monitored nests on four-day intervals until nestlings fledged. When possible, I assessed the condition of nests from a distance using binoculars and approached nests from various directions on different visits to minimize nest-site disturbance. I considered nests to be successful when at least one nestling fledged and, to reduce inaccurately assigned nest fates, I considered nests to have failed if I found them empty before a possible fledge date (i.e., before nestling day seven), if they had cold eggs and were unattended for >2 observation intervals during the incubation stage, or if radio-tagged fledglings were depredated and no broodmates were detected in the vicinity of the nest (Streby and Andersen 2013c).

On nestling day seven (rarely six, eight, or nine; counting hatch day as day one), I banded all nestlings with a standard U.S. Geological Survey legband and attached a radio transmitter to 1 - 5 randomly selected individuals at each nest (commonly two individuals) using a figure-eight harness (radio transmitters were ~ 4.6% of mean nestling mass). Additionally, I attached transmitters to 10 fledglings from known nests captured 1 – 8 days after fledging. I tracked fledglings daily to assess survival and I right censored 19 individuals (10% of fledglings I monitored) with unknown fates because transmitters detached from fledglings. Because I focused on the impact of predation in this analysis, I also censured individuals that died due to exposure (n = 11). I focused analysis on the early post-fledging period, days 1 - 8 after fledging, because that period included most

(86%) of the fledgling mortality I observed (H. Streby unpublished data). I divided the early post-fledging period into two stages for modeling: days 1 - 3, characterized by low-mobility and high and variable daily mortality and days 4 - 8, characterized by greater mobility and relatively low mortality (H. Streby unpublished data, Chapter 2).

Landscape Attributes:--To model the impact of cover types on nest success and fledgling survival, I categorized 11 cover types using aerial photographs in Arc 10.1 Geographic Information System (GIS) software (Environmental Systems Research Institute, Redlands, CA). For Tamarac NWR and Rice Lake NWR, I used 1-m resolution digital orthophoto quadrangles (2009; Minnesota Department of Natural Resources). For Sandilands PF, I used geo-referenced 1-m resolution satellite images obtained from Google EarthTM 6.2 (2010; Google Inc., Mountain View, CA). I confirmed the cover types derived from aerial photographs and satellite images using >2,500 locations visited at my study sites. Because each additional cover type doubled the number of possible unique combinations of cover types present on a landscape, I collapsed these 11 cover types into six broad categories (Deciduous Forest, Upland Shrubland, Forested Wetland, Grassland, Wetland Shrubland, and Coniferous Forest), included an additional covariate related to edge density (described below), and used these seven categories as potential variables in my full-season productivity model (Table 1). With the exception of Coniferous Forest (which was adjacent to only one site) and Forested Wetland (which was an uncommon cover type at each site), I modeled the relationship between each cover-type category and nest success and fledgling survival using ≥ 200 exposure days for each period (Table 1).

In addition to cover-type variables, I included a covariate for edge density (i.e., length of edge within a specified area) in my models to assess how productivity was related to the density of forest-shrubland edge present. I used Arc GIS 10.1 to identify edges between Deciduous Forest, Coniferous Forest, or Forested Wetland with a canopy height >5 m and shrubland cover types (i.e., Upland Shrubland and Wetland Shrubland). I limited my measure of edge density to edges between forest and shrubland cover types because those are the edges with which Golden-winged Warblers are most commonly associated (Confer et al. 2011); I excluded less ecologically significant edges (e.g., edges between grassland and shrubland).

For each of the seven model covariates (six cover-types and edge density; hereafter, "landscape variables"), I calculated an "impact radius." The impact radius defined the scale at which each landscape variable was most strongly related to survival in each period (i.e., nests and fledglings). To calculate this value, I buffered each nest location with circles with radii in 25-m increments from 25 - 200 m and at 100 m increments from 200 - 500 m. For nest survival and fledgling survival from day 1 - 3, I used a range of 25 - 200 m for potential impact radii and for fledgling survival from day 4 - 8, I used a range of 25 - 500 m for potential impact radii, corresponding with the distance that adults moved fledglings (Chapter 2). I summed the total area (ha) for each cover type and total linear distance of edge (km) for each buffer distance around each nest location. Because the impact radius of each landscape variable could be at a scale unique to that landscape variable (e.g., Deciduous Forest might be related to nest success at a 50-m radius, whereas Wetland Shrubland might be related to nest success at a 200-m radius), I independently estimated survival using each combination of scale and polynomial function (i.e., linear, quadratic, or cubic relationships) for each variable by fitting logistic exposure models (Shaffer 2004) to survival data from all three sites and years for three different periods (nest survival, fledgling survival day 1 - 3, and fledgling survival day 4 - 8) using PROC NLMIXED (SAS Institute, Chicago, IL). For example, to determine the impact radius and polynomial function of Deciduous Forest in relation to nest success, I compared 24 different Deciduous Forest models ranging from a linear relationship with a 25-m impact radius to a cubic relationship with a 200-m impact radius.

I treated these models as exploratory and did not attempt to predict what relationships might occur between landscape structure and composition and survival. I used multiple potential polynomial functions to account for the possibility of curvilinear relationships among modeled variables (i.e., to account for the potential of diminishing returns or exponential increases in the impact of any landscape variable on survival). I included age as a covariate in models of nest survival and fledgling survival from day 1 – 3. Because of relatively constant survival after the first 3 days (H. Streby unpublished data), I did not include age as a variable when modeling fledgling survival from day 4 – 8. For models of fledgling survival in both the early and late fledgling periods, I used brood as a random effect. Previous modeling of this study population determined that there were no site or year effects on nest or fledgling depredation (Streby et al. 2014a), so I did not include those variables in my models. I centered all impact radii on the nest because fledgling survival during the first eight days outside the nest was directly related

to nest location (Streby et al. 2014a, H. Streby unpublished data). Because fledglings moved farther from the nest after the first three days (Chapter 1), I increased the range of potential impact radii to 25 - 500 m to model fledgling survival from day 4 - 8, but I still centered radii around the nest because nest location was the strongest predictor of survival during this stage in previous models (H. Streby unpublished data). I did not include survival data from day 9 to independence because survival was consistently high and largely unrelated to habitat use or nest location (H. Streby unpublished data) during this period. For each landscape variable, I ranked models of nest or fledgling survival using Akaike's Information Criterion corrected for small sample size (AICc; Burnham and Anderson 2002) and selected the best-supported combination of polynomial function (e.g., a quadratic relationship) and impact radius for use in modeling productivity on a landscape (for complete AICc rankings, see Appendix A). I defined models with age (for nest survival and fledgling survival from day 1-3) or constant survival (for fledgling) survival from day 4-8) as null models. If all combinations of polynomial function and impact radius for a variable were less supported than the null model for that survival period, I considered that variable to be non-informative and excluded it from survival models.

Modeling Survival on a Landscape:--For each survival period, I used methods similar to those used for resource selection functions (Manly et al. 2002) to estimate survival related to landscape structure and composition around any given location at my study sites. I combined the best-supported impact radius and polynomial function for each landscape variable (identified above) into composite survival models that
incorporated all landscape variables present at every location (1-m² pixel) across my study sites. I used these survival models and estimates of renesting rates and brood size to create spatially-explicit estimates of the number of fledglings that could be produced to fledgling day 8 at any given location. In contrast to resource selection functions, which estimate the probability of presence or use on a landscape, my models of full-season productivity estimated productivity for a hypothetical breeding pair at every 1-m² pixel on my study sites.

For each landscape variable, I built a "landscape variable map" that delineated the area over which that variable was related to each component of survival (nest, fledgling days 1-3, fledgling days 4-8). To do this, I used the vector cover type layer delineated using aerial or satellite imagery and isolated each cover type. I individually converted all landscape variable maps to 1 x 1-m resolution raster layers and then used a neighborhood function in Arc GIS 10.1 to calculate a value at every 1 x 1-m pixel on the map equal to the quantity (i.e., area or length, "variable quantity map") of each landscape variable within its impact radius for each survival period. For example, Deciduous Forest was related to fledgling survival from day 1 - 3 at a 25-m scale; I therefore created a variable quantity map that for each pixel contained a value equal to the number of ha of Deciduous Forest within 25 m of that pixel.

I estimated survival separately for each period because Golden-winged Warbler nest and fledgling survival are associated differently with landscape composition around a nest (Streby et al. 2014a). For each survival period, I used all seven variable quantity maps (i.e., six cover types and edge density) to create a landscape structure and composition map comprised of landscape structure and composition values representing each unique combination of variable quantity values present at every pixel. To do this, I used raster algebra to identify the landscape variables present within their respective impact radii around each pixel (i.e., those with variable quantities > 0, including edge density). This approach created 32 unique combinations of five informative landscape variable compositions (groups; Table 2; see Appendix B for full model results), ranging from simple landscapes (e.g., a pixel with only one cover type within its impact radius) to more complex landscape areas (e.g., a pixel with several cover types and edge density within their respective impact radii). Although they were considered to be informative landscape variables, Coniferous Forest and Forested Wetland were not included in the groups used for the results presented here because they were not present at the specific stands analyzed in this manuscript.

For each survival period (nest, fledgling days 1-3, fledgling days 4-8), I used PROC GENMOD in SAS (SAS Institute, Chicago, IL) and built logistic exposure survival models (Shaffer 2004) corresponding to the landscape variable composition group associated with each pixel. I assigned each of these equations to each pixel based on the landscape structure and composition surface described above. This approach allowed the effect of each landscape variable to differ depending on landscape structure and composition around each pixel. For example, quantity of Deciduous Forest might be related to nest survival differently depending upon whether Deciduous Forest is adjacent to Wetland Shrubland or Grassland. I estimated daily survival (*S*) within each period for each observed combination of landscape structure and composition ($_l$) and survival period ($_p$) as:

$$S_{lp} = exp(\alpha_{lp} + \beta_{1lp}x_{1lp} + \beta_{2lp}x_{2lp} + \beta_{3lp}x_{3lp} \dots) / (1 + exp(\alpha_{lp} + \beta_{1lp}x_{1lp} + \beta_{2lp}x_{2lp} + \beta_{3lp}x_{3lp} \dots))$$

where α is the estimated intercept and β_I is the estimated coefficient for landscape variable x_I .

To apply the logistic exposure survival equation defined above to a landscape, I created coefficient maps for each β value derived from each logistic exposure survival equation. I assigned the calculated β values for each survival period ($_p$) to each pixel based on its corresponding landscape structure and composition value ($_l$). For example, if x_l for an equation represented the amount of Wetland Shrubland within 200 m (i.e., the impact radius of Wetland Shrubland associated with nest success), the value at any given pixel on the coefficient map for x_l was equal to the β_l value calculated by the logistic exposure survival equation for the landscape structure and composition value at that pixel.

At each pixel on a landscape, I used the previously assigned values of (1) the amount of each landscape variable surrounding that pixel and (2) the β coefficients for the logistic exposure survival equation for the appropriate landscape variable to estimate nest success, fledgling survival from day 1 – 3, and fledgling survival from day 4 – 8. For example, to calculate fledgling survival from day 4 – 8 for a pixel at the center of a circle with 3/4 of the landscape made up of Deciduous Forest and 1/4 of the landscape made up

of Shrubby Wetland, with a straight Shrubby Edge separating the cover types at a right angle, the survival equation would be:

Daily Survival = $\exp(4.2177 + (0.4524 * \text{Deciduous Forest}) - (0.0010 * \text{Edge}) + (2.7450 * 10^{-7} \cdot \text{Edge}^2) + (1.6789 * \text{Shrubby Wetland}) - (0.5959 * \text{Shrubby Wetland}^2) + (0.0454 * \text{Shrubby Wetland}^3)) / (1 + \exp(4.2177 + (0.4524 * \text{Deciduous Forest}) - (0.0010 * \text{Edge})) + (2.7450 * 10^{-7} \cdot \text{Edge}^2) + (1.6789 * \text{Shrubby Wetland}) - (0.5959 * \text{Shrubby Wetland}^2) + (0.0454 * \text{Shrubby Wetland}) - (0.5959 * \text{Shrubby Wetland}^2)$

where each numerical value was the assigned β coefficient for that landscape variable. Each pixel that fell within the Deciduous Forest and Edge landscape would be assigned those β coefficients and the value for the number of ha of Deciduous Forest within 25 m, the number of ha of Shrubby Wetland within 300 m, and km of Edge within 400 m of that pixel. The hypothetical fledgling's nest described above would exist on a landscape with 0.147 ha of Deciduous Forest within 25 m, 7.068 ha of Shrubby Wetland within 300 m, and 0.8 km of Edge within 400 m, and the fledgling would have a 0.6508 probability of surviving during days 4–8 (Daily survival = 0.9177).

I calculated nest productivity (i.e., number of juveniles fledged by a breeding pair; NP) assuming two nesting attempts (i.e., one attempted renest following nest failure; H. Streby unpublished data) and a mean fledged brood of four fledglings (H. Streby unpublished data) as,

$$NP = (NS + (1 - NS) * NS) * 4$$

where NS is nest success. I calculated fledgling survival (FS) as,

$$FS = ES * LS$$
,

where ES is fledgling survival in the early period (days 1 - 3) and LS is fledgling survival in the late period (days 4 - 8). Assuming negligible mortality until independence (Chapter 2), I calculated full-season productivity (FSP), or the number of young raised 8 days post-fledging, as,

$$FSP = NP * FS.$$

After applying these equations, each pixel on the map had a value for NP, FS, and FSP, the product of NP and FS that represented the expected productivity for a pair nesting within that pixel. I then used these values to identify areas of high and low productivity on a landscape. For a detailed description of the process I used to estimate spatially-explicit productivity, see Appendix C.

There is no standard method to assess the robustness of my spatially-explicit models of full-season productivity, so I assessed whether my models predicted survival better than null models using *k*-fold cross-validation (Boyce et al. 2002, Koper and Manseau 2009). I evenly divided the sample for each survival period by randomly assigning nests or broods to eight equal folds. For each fold, I used the remaining seven folds to train a set of spatially-explicit models of survival and a null model with either age as a variable (for nests and for fledglings from day 1 - 3) or constant survival (for fledglings from day 4 - 8). I then calculated a Spearman's rank correlation between observed survival and survival predicted by both the null model and the spatially-explicit model of survival.

Application of Spatially Explicit Models of Full-Season Productivity:-- To assess the effects of potential management actions designed to increase Golden-winged Warbler full-season productivity, I used Arc GIS 10.1 to simulate altering landscapes on my study sites. At each of my study sites, I applied spatially-explicit models of full-season productivity to existing and hypothetical landscapes and present estimates of productivity that used all landscape categories in various combinations with the exception of Forested Wetland and Coniferous Forest. The scenarios I selected were chosen to illustrate (1) differences between wetland and upland cover types, (2) the effect of grassland succession to upland shrubland and additional successional to mature forest, and (3) the effect of management of shrubby edge density on a landscape. I considered all roads, open water, grassland, or any cover types >100 m from Upland Shrubland or Wetland Shrubland to be areas unused for nesting by Golden-winged Warblers and did not include those values in my analyses. I smoothed all graphical representations of spatially-explicit productivity estimates using a 25-m mean of productivity in Arc GIS 10.1 to reduce minor, abrupt transitions between landscape structure and composition categories.

In my first assessment, I evaluated the relative full-season productivity of upland and wetland cover types while controlling for the effect of surrounding landscape structure and composition on productivity. Although Golden-winged Warblers use both upland and wetland cover types as nesting habitat, Confer et al. (2010) suggested that productivity in wetland cover types may be greater than productivity in upland cover types. For my study site at Rice Lake NWR (Fig. 1A) I evaluated the difference in fullseason productivity between landscapes dominated by wetland cover types and those dominated by upland cover types. For a wetland-dominated portion of that study site, I used Arc GIS 10.1 to simulate the conversion of the same landscape with all wetland cover types to structurally similar upland cover types. I performed this assessment not to encourage converting wetland to upland cover types on managed landscapes, but to measure the difference in estimated full-season productivity in structurally similar patches. I quantified the difference between wetland and upland cover types by calculating the mean productivity within 100 m of known nest sites for this scenario. I also used logistic exposure to model productivity in the absence of landscape data by dividing nests into those located in wetland cover types and those located in upland cover types, as a separate assessment of the difference between upland and wetland cover type productivity.

In my second assessment, I simulated management to increase productivity at Tamarac NWR, where grassland cover comprised 9 ha of my study area and could be managed for Golden-winged Warblers. I simulated modifying an open Grassland (Fig. 1B) within a forested landscape to evaluate how succession of an open area would affect Golden-winged Warbler full-season productivity. I simulated converting Grassland to Upland Shrubland and adding shrubby edges where the altered Grassland patch abutted Deciduous Forest to simulate early-successional cover. I then simulated Upland Shrubland continuing to succeed into Deciduous Forest and merged it with the adjoining Deciduous Forest patch. The landscape simulation at Tamarac NWR not only altered productivity, but also the area available for nesting. I quantified the difference between management scenarios at Tamarac NWR by multiplying the area available for nesting in each scenario by the mean productivity for that area, therefore accounting for both productivity and changes in area available for nesting. In my final assessment, I identified two areas with low productivity (i.e., estimate of <1 fledgling produced per 1x1-m pixel) associated with high edge density (i.e., >0.6 km of edge within 50 m of a pixel) at my Sandilands PF site (Fig. 1C). In these areas I simulated forest management that would result in lesser edge density, either by allowing Upland Shrubland to succeed into Deciduous Forest or by harvesting forest to create a lesser edge density (i.e., <0.3 km of edge length within 50 m of a pixel). I quantified the difference between these edge densities by calculating the mean productivity within the impact radius of altered cover types.

Results

I monitored 29 nests and 49 fledglings in Sandilands PF and 56 nests and 47 fledglings at Rice Lake NWR from 2011–2012, and 131 nests and 94 fledglings at Tamarac NWR from 2010–2012. Of 216 nests and 190 fledglings I monitored, 127 nests (59%) and 70 fledglings (37%) were depredated. I constructed a total of 96 logistic exposure models (Appendix B). For all three survival periods, the spatially-explicit models I developed (Nest, $r_s = 0.30$; Fledgling 1 - 3, $r_s = 0.19$; Fledgling 4 - 8, $r_s = 0.11$) explained more variation in survival than the null model (Nest, $r_s = 0.14$; Fledgling 1 - 3, $r_s = 0.00$; Fledgling 4 - 8, $r_s = -0.14$), indicating that my spatially-explicit models were more informative than the null models.

Simulation of Management Options:-- All three of my simulations of altering landscapes at my study areas led to biologically significant changes in full-season productivity. When I simulated converting wetland cover types to upland cover types at Rice Lake NWR, estimated mean full-season productivity (i.e., the mean estimated number of fledglings raised to fledgling age 8 from breeding attempts at a random pixel $[1 \text{ m}^2]$) increased 14% from 1.62 fledglings per pixel (SD = 0.74) to 1.84 fledglings per pixel (SD = 0.65; Figs. 2a, 2b). When I modeled productivity in wetland and upland cover types without including landscape variables, I estimated that wetland cover types would produce a mean of 1.05 fledglings per pixel and upland cover types would produce a mean of 1.59 fledglings per pixel, a 51% increase. At Tamarac NWR, when I simulated succession from Grassland to Upland Shrubland, the area available for nesting (i.e., Upland Shrubland and Deciduous Forest <100 m from Upland Shrubland) increased from 18.3 ha to 27.3 ha (Figs. 3a, 3b). However, estimated full-season productivity decreased in this simulation from 1.97 fledglings per pixel (SD = 0.51) to 1.73 fledglings per pixel (SD = 0.40), largely because of decreased fledgling and nest survival in areas that had previously been positively impacted by the presence of nearby grassland cover. Despite estimated mean productivity decreasing by 13%, the increase in available nesting area caused total landscape productivity to increase by 30%. Simulated further succession from Upland Shrubland to Deciduous Forest reduced available nesting area by 22% to 21.2 ha and resulted in estimated landscape productivity 18% lower than what I estimated in the Upland Shrubland simulation, despite increasing estimated mean full-season productivity from 1.73 fledglings per pixel to 1.86 fledglings per pixel (SD = 0.39; Fig. 3c). Finally, when I simulated reduced edge density in two small areas with high edge density (i.e., >0.6 km of edge within 50 m of a given pixel; < 1 ha of altered area) that had lower estimated full-season productivity than the surrounding landscape at

Sandilands PF, estimated mean productivity in 22.5 ha of breeding habitat increased 5% from 1.93 fledglings per pixel (SD = 0.52) to 2.03 fledglings per pixel (SD = 0.43; Figs. 4a, 4b).

Discussion

I developed spatially-explicit models of full-season productivity of Goldenwinged Warblers across landscapes at three study areas in the western Great Lakes region, where relatively little information about Golden-winged Warbler-breeding habitat relations exists, but where a significant portion of the global population breeds. With the spatially-explicit models of full-season productivity, I estimated productivity at any given location based on landscape characteristics around that location. These models of fullseason productivity allowed us to address questions about low-productivity areas, assess productivity across a landscape, and evaluate management effects on productivity prior to implementation. Perhaps the most important finding from my simulations of potential management options was that any management action can have considerably different effects on Golden-winged Warbler full-season productivity depending on the context of the surrounding landscape. Therefore, I cannot use the results of the simulations presented here to provide broad, generalizable recommendations with regard to any onesize-fits-all management option. Instead, I provide a tool that can be used to assess the influence of specific management actions on individual landscapes, each with their own intrinsic complexities. Within the western Great Lakes region and, potentially, other

regions with similar predator communities and cover types, the models provided here may be used to predict productivity and the impact of management actions.

In contrast to Confer et al. (2010), my results suggested that management of upland cover types on my study sites would increase full-season productivity more than management of wetland cover types, which were generally associated with lesser full-season productivity in my study area when compared with similar upland cover types. Lesser full-season productivity predicted by my models was supported by similar estimates calculated from nests found in wetland versus upland cover types at my sites. The difference between my findings and those of Confer et al. (2010) with regard to the value of wetlands to Golden-winged Warbler productivity may result from differences in structure and composition between wetland shrub communities in my study areas and swamp forests studied in New York. The difference may also be due in part to my assessment of full-season productivity. I included fledgling survival, a critical component of productivity that is affected by the wetland cover type differently than nest success, whereas Confer et al.'s (2010) study was limited to nest success.

At Tamarac NWR, I evaluated how succession of Grassland to Upland Shrubland cover types influenced Golden-winged Warbler productivity in a landscape that already hosted high productivity. Succession of a Grassland patch to an Upland Shrubland patch increased the area available for nesting by 9 ha (49%), and increased the total estimated productivity of the landscape by 30%, in spite of mean estimated full-season productivity decreasing by 0.24 fledglings per 1-m² pixel (12%). These results demonstrate that there may be scenarios in which increasing the area available for nesting can result in

increasing overall productivity within a landscape, even while decreasing overall nest-site quality. However, this result appears to be management scale and landscape context dependent. For example, given the mean estimated full-season productivity presented here for the Grassland (1.97 fledglings per pixel) and Upland Shrubland (1.73 fledglings per pixel) cover types, if I only increased the area available for nesting by 2 ha, total estimated productivity of the landscape would decrease by 3%. If I extended this scenario to include succession of this 2-ha patch to Deciduous Forest (1.86 fledglings produced per pixel), the Deciduous Forest scenario would produce 5% more fledglings than the Grassland cover type and 8% more fledglings than the Upland Shrubland cover type. These results demonstrate how sensitive the models are to the size and landscape context of the proposed management.

Finally, my assessment of landscape characteristics related to Golden-winged Warbler nest and fledgling survival indicated that highly complex shrubland-forest edges (e.g., Fig. 4) were associated with lesser full-season productivity of Golden-winged Warblers in the landscape contexts I studied in the western Great Lakes region. Similar to observations of nest success in Indigo Buntings (*Passerina cyanea*; Weldon and Haddad 2005), I predicted lesser full-season productivity near highly complex forest edges. However, I note that the relationship between edge and productivity can vary substantially depending on the surrounding landscape structure and composition and the amount of edge within the impact radius at any location. For many of the models I developed, the amount of edge was positively related to full-season productivity until an apparent threshold (approximately 0.5 km of shrubby edge within 50 m of any given point), after which increasing the amount of edge led to reduced full-season productivity (Appendix B). Importantly, the edges I assessed were those between shrubland and forest cover types, and not smaller-scale, micro-edges within shrublands, which may have a different relationship with productivity from the one I observed at a larger spatial scale.

Unlike resource selection functions (Manly 2002), which have been used extensively to assess factors related to species presence (e.g., Beerens et al. 2011, Refsnider et al. 2013, Slaght et al. 2013), my spatially-explicit models of full-season productivity predict both the amount and quality of breeding habitat, and how the spatial distribution of cover types across a landscape influences productivity. Because there are no established methods to validate my spatially-explicit models of full-season productivity, I assessed my models by comparing predicted and estimated values of fullseason productivity in a cross-validation framework. The results of that cross-validation indicated that my models of the relationship(s) between full-season productivity and landscape structure and composition explained more variation in both nest success and fledgling survival than models that did not incorporate landscape structure and composition. I suggest, however, that a more thorough validation of my approach is warranted, given the low Spearman's rank correlation from k-fold cross validation and the general difficulties of validating models of binary and highly stochastic (i.e., nest success or fledgling survival) phenomena.

I also note that there are limitations to my analytical approach. As currently presented, my full-season productivity models do not predict the likelihood any location will be selected as a nest site (i.e., 3rd order selection) nor as a home range (i.e., 2nd order

selection, Johnson 1980). Incorporating these probabilities into a composite model may make it possible to identify the most used and the most productive areas on a landscape. Additionally, the renesting rate and brood sizes I used in my models may not apply to populations other than those in the western Great Lakes region. Applying my models to other regions would likely also require region-specific information about both renesting rates and brood size.

My models of full-season productivity predict the potential productivity of a specific location, regardless of whether a breeding pair uses that location. For each pixel across my study sites, my nesting model produced a value that represented the probability that a successful nest could occur in that pixel during the season; that value includes the probability of a first nest succeeding, the probability that a second nest is possible at that location (i.e., did the first nest fail?), and the probability of a second nest succeeding. My model produces the same estimates of productivity regardless of movements between nesting attempts because the estimates are for any first nest and any second nest at each location, and does not require that those attempts be from the same female or breeding pair. For simplicity, the full-season productivity estimate for each location can be viewed as a modeled estimate of the number of young raised to independence by a breeding pair that nested, and potentially renested, at that specific location. Generally Golden-winged Warblers do not renest in the same location (Streby et al. 2014a), although violation of this simplifying assumption would not change my results or conclusions.

For the landscapes I studied, my models provided several insights into Goldenwinged Warbler ecology and conservation. First, modeling full-season productivity across landscapes allowed us to identify specific areas where management could be directed to have the largest, positive influence on productivity. Second, simulation of the effects of proposed management can inform decisions about how best to use resources to affect population dynamics. Third, spatially-explicit models of full-season productivity can identify areas of high productivity, which may be areas to avoid manipulating or to emulate in other landscapes. Fourth, this modeling process may alter previous management recommendations (i.e., that wetlands provide better habitat for Golden-winged Warblers than shrubby uplands). Finally, assuming comparable demographic data are collected, my approach can be used to simultaneously assess likely impacts on full-season productivity of multiple species in the same landscape (e.g., other species associated with early successional forests, such as American Woodcock [*Scolopax minor*]), to better understand how management for a single species influences other species.

Table 1. Categorization, definition, and total exposure days used for three logistic exposure models (N = nest success, E = fledgling survival days 1 - 3, L = fledgling survival days 4 - 8) of similar cover types present on landscapes used by three Golden-winged Warbler populations studied from 2010–2012 in the western Great Lakes region of North America.

Landscape Structure and	Definition	Total	Cover Type ^a
Composition Cover Type		Exposure	
Category		Days	
Coniferous Forest	Forest dominated by coniferous trees	N = 18	Coniferous forest
		E = 15	
		L = 33	
Deciduous Forest	Forest with >60% canopy closure and	N = 817	Mature forest
	dominated by deciduous trees >5 m in height	E = 364	Sapling-dominated clearcut
		L = 463	
Shrubby Edge	Edge between Shrubland and Coniferous Forest,	N = 760	N/A
	Forested Wetland, or Deciduous Forest	E = 442	
		L = 534	
Forested Wetland	Perennially wet forest dominated by trees >5 m	N = 106	Forested wetland
	in height	E = 57	
		L = 211	
Grassland	Landscape dominated by grass or sedge	N = 573	Grassy wetland
		E = 270	Upland grassland
		L = 279	
Wetland Shrubland	Perennially wet shrubland with a canopy <5 m	N = 501	Wetland shrubland
	in height	E = 211	
		L = 288	
Upland Shrubland	Perennially dry shrubland or sapling-dominated	N = 716	Firebreak/Power-line
	clearcut with a canopy <5 m in height	E = 359	Shrub-dominated clearcut
		L = 386	

^{*a*} for detailed description of Cover Types see Chapter 3

Table 2. Scale and polynomial function of top-ranked survival models for each landscape variable and survival period for three populations of Golden-winged Warblers in the western Great Lakes region. Non-informative landscape variables are indicated by "N/A".

	Nest Survival		Day 1 - 3 Fledgling Survival		Day 4 - 8 Sur	Day 4 - 8 Fledgling Survival	
Landscape Variable	Scale (m)	Polynomial Function	Scale (m)	Polynomial Function	Scale (m)	Polynomial Function	
Coniferous Forest	50	Linear	50	Quadratic	N/A	N/A	
Deciduous Forest	N/A	N/A	25	Linear	25	Linear	
Edge	50	Cubic	200	Cubic	400	Cubic	
Forested Wetland	175	Linear	125	Cubic	400	Cubic	
Grassland	200	Quadratic	200	Linear	175	Quadratic	
Wetland Shrubland	200	Linear	N/A	N/A	300	Cubic	
Upland Shrubland	N/A	N/A	N/A	N/A	N/A	N/A	

Figure 1. Aerial photographs of three Golden-winged Warbler study sites in the western Great Lakes region of North America from 2010–2012 with nest locations marked with a circle, soft shrubby edges marked by a dashed line and (A) wetland cover types delineated by hatched lines at Rice Lake National Wildlife Refuge, (B) grassland delineated by hatched lines at Tamarac National Wildlife Refuge, (C) areas with complex edges indicated by hatched lines at Sandilands Provincial Forest.







Figure 2. Estimated full-season productivity (fledglings per $1-m^2$ pixel) modeled from Golden-winged Warbler populations studied from 2010–2012 in the western Great Lakes region of North America of (A) a wetland at Rice Lake National Wildlife Refuge and (B) a hypothetical upland with identical landscape structure. Soft shrubby edges are marked by a dashed line, nests are marked with a black circle, wetland cover types are delineated by gray lines, and areas unused for nesting (grassland, roads, open water, and deciduous forest >100 m from shrubby cover types) are marked by solid black.



(A)



Figure 3. Estimated full-season productivity (fledlgings per $1-m^2$ pixel) modeled from Golden-winged Warbler populations studied from 2010–2012 in the western Great Lakes region of North America of (A) upland shrubland and deciduous forest landscape at Tamarac National Wildlife Refuge with an open grassland southeast of the site, (B) early stages of succession, with open grassland replaced by upland shrubland, and (C) later stages of succession, with open grassland replaced with Deciduous Forest. Soft shrubby edges are marked by a dashed line, nests are marked with a black circle, grassland is delineated by a gray line, and areas unused for nesting (grassland, roads, open water, and deciduous forest >100 m from shrubby cover types) are marked by solid black.



(A)





Figure 4. Estimated full-season productivity (fledglings per 1-m^2 pixel) modeled from Golden-winged Warbler populations studied from 2010–2012 in the western Great Lakes region of North America of (A) an upland shrubland at Sandilands Provincial Forest with complex edges in the northwest and south portions of the clearcut and (B) the same upland with complex edges removed or reduced. Soft shrubby edges are marked by a dashed line, nests are marked with a black circle, complex edges are circled with gray, and areas unused for nesting (grassland, roads, open water, and deciduous forest >100 m from shrubby cover types) are marked by solid black.



(A)



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Nest Landscape Variables								
Shrubby Edge								
Model	Ν	K	AIC	AICc	Delta AICc			
Shrubby Edge 50^3	2650	5	816.106	816.129	0			
Shrubby Edge 25	2650	3	818.093	818.102	1.973			
Shrubby Edge 100^3	2650	5	818.088	818.11	1.981			
Shrubby Edge 25^3	2650	5	818.369	818.392	2.263			
Shrubby Edge 50	2650	3	820.065	820.074	3.945			
Shrubby Edge 25^2	2650	4	820.072	820.087	3.958			
Shrubby Edge 75^3	2650	5	820.471	820.493	4.364			
Shrubby Edge 50^2	2650	4	820.704	820.719	4.59			
Null Model	2650	2	820.765	820.77	4.641			
	F	orest	ed Wetland					
Model	Ν	K	AIC	AICc	Delta AICc			
Forested Wetland 175	2650	3	819.868	819.877	0			
Forested Wetland 200	2650	3	819.96	819.969	0.092			
Forested Wetland 150	2650	3	820.159	820.168	0.291			
Null Model	2650	2	820.765	820.77	0.893			
		Gr	assland					
Model	Ν	K	AIC	AICc	Delta AICc			
Grassland 200^2	2650	4	820.192	820.207	0			
Grassland 200^3	2650	5	820.425	820.448	0.241			
Null Model	2650	2	820.765	820.77	0.563			
Wetland Shrubland								
Model	Ν	K	AIC	AICc	Delta AICc			
Wetland Shrubland 200	2650	3	820.334	820.343	0			
Wetland Shrubland 175	2650	3	820.493	820.503	0.16			
Wetland Shrubland 150	2650	3	820.637	820.646	0.303			
Null Model	2650	2	820.765	820.77	0.427			
Coniferous Forest								
Model	Ν	K	AIC	AICc	Delta AICc			
Coniferous Forest 50	2650	3	820.386	820.395	0			
Coniferous Forest 25	2650	3	820.386	820.395	0			
Coniferous Forest 125	2650	3	820.438	820.447	0.052			
Coniferous Forest 150	2650	3	820.586	820.595	0.2			
Coniferous Forest 200	2650	3	820.597	820.606	0.211			

Appendix A. AICc rankings of landscape variables of different scales and polynomial functions for three survival periods (nest success, day 1–3 fledgling survival, and day 4–8 fledgling survival).

Coniferous Forest 175	2650	3	820.623	820.632	0.237
Null Model	2650	2	820.765	820.77	0.375

Fledgling Day 1 to 3 Landscape Variables									
Coniferous Forest									
Model	Ν	K	AIC	AICc	Delta AICc				
Coniferous Forest 50 ²	440	5	344.419	344.556	0				
Coniferous Forest 100 ²	440	5	344.42	344.557	0.001				
Coniferous Forest 75 ²	440	5	344.42	344.557	0.001				
Coniferous Forest 125^2	440	5	344.441	344.579	0.023				
Coniferous Forest 175^2	440	6	344.895	345.089	0.533				
Coniferous Forest 150 [^] 3	440	6	344.895	345.089	0.533				
Coniferous Forest 150 ²	440	5	345.069	345.207	0.651				
Coniferous Forest 200 ³	440	6	345.365	345.559	1.003				
Coniferous Forest 175 ²	440	5	345.84	345.978	1.422				
Coniferous Forest 200 ²	440	5	346.406	346.543	1.987				
Coniferous Forest 75 ³	440	6	346.419	346.612	2.056				
Coniferous Forest 50 [^] 3	440	6	346.419	346.612	2.056				
Coniferous Forest 100 [^] 3	440	6	346.419	346.612	2.056				
Coniferous Forest 125^3	440	6	346.425	346.618	2.062				
Null Model	440	3	347.652	347.707	3.151				
	D	ecidu	ious Forest						
Model	Ν	K	AIC	AICc	Delta AICc				
Deciduous Forest 25	440	4	344.944	345.035	0				
Deciduous Forest 50	440	4	345.557	345.649	0.614				
Deciduous Forest 75	440	4	346.123	346.214	1.179				
Deciduous Forest 100	440	4	346.67	346.762	1.727				
Deciduous Forest 25^2	440	5	346.839	346.977	1.942				
Deciduous Forest 125	440	4	346.939	347.03	1.995				
Deciduous Forest 200	440	4	347.008	347.099	2.064				
Deciduous Forest 175	440	4	347.014	347.105	2.07				
Deciduous Forest 150	440	4	347.055	347.147	2.112				
Deciduous Forest 50^2	440	5	347.554	347.692	2.657				
Deciduous Forest 200 ³	440	6	345.927	346.12	1.085				
Deciduous Forest 200^2	440	5	346.125	346.263	1.228				
Null Model	440	3	347.652	347.707	2.672				
Shrubby Edge									
Model	Ν	K	AIC	AICc	Delta AICc				
Shrubby Edge 200^3	440	6	345.927	346.12	0				
Grassland									
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Model	Ν	K	AIC	AICc	Delta AICc				
Grassland 200	440	4	346.88	346.971	0				
Null Model	440	3	347.652	347.707	0.736				
	Fo	oreste	ed Wetland						
Model	Ν	K	AIC	AICc	Delta AICc				
Forested Wetland 125^3	440	6	347.099	347.292	0				
Forested Wetland 175	440	4	347.31	347.401	0.109				
Null Model	440	3	347.652	347.707	0.415				

Fledgling Day	Fledgling Day 4 to 8 Landscape Variables									
	Gras	slan	d							
Model	Ν	K	AIC	AICc	Delta AICc					
Grassland 175 ²	511	4	97.163	97.238	0					
Grassland 150 ²	511	4	98.149	98.225	0.987					
Grassland 150 [^] 3	511	5	98.909	99.023	1.785					
Grassland 175 ³	511	5	99.381	99.494	2.256					
Grassland 200^2	511	4	99.642	99.717	2.479					
Grassland 125 ³	511	5	100.431	100.545	3.307					
Grassland 25	511	3	100.572	100.617	3.379					
Grassland 125 ²	511	4	100.661	100.736	3.498					
Grassland 150	511	3	101.613	101.658	4.42					
Grassland 25^2	511	4	101.725	101.801	4.563					
Grassland 200 [^] 3	511	5	101.761	101.875	4.637					
Grassland 125	511	3	101.872	101.917	4.679					
Grassland 175	511	3	102.02	102.065	4.827					
Grassland 50	511	3	102.064	102.109	4.871					
Grassland 100	511	3	102.381	102.427	5.189					
Grassland 75	511	3	102.551	102.596	5.358					
Null Model	511	2	102.913	102.935	5.697					
W	etland	Shru	bland							
Model	Ν	K	AIC	AICc	Delta AICc					
Wetland Shrubland300^3	511	5	99.69	99.803	0					
Wetland Shrubland200^3	511	5	100.602	100.716	0.913					
Wetland Shrubland175^2	511	4	101.562	101.638	1.835					
Wetland Shrubland150^2	511	4	101.569	101.644	1.841					
Wetland Shrubland400^3	511	5	101.593	101.706	1.903					
Wetland Shrubland175^3	511	5	101.608	101.721	1.918					
Wetland Shrubland200^2	511	4	102.165	102.241	2.438					
Wetland Shrubland400^2	511	4	102.483	102.558	2.755					
	(0								

Wetland Shrubland150^3	511	5	102.465	102.579	2.776					
Null Model	511	2	102.913	102.935	3.132					
Shrubby Edge										
Model	Ν	K	AIC	AICc	Delta AICc					
Shrubby Edge 200^2	511	4	101.491	101.566	0					
Shrubby Edge 400^3	511	5	101.701	101.815	0.249					
Shrubby Edge 200^3	511	5	101.785	101.899	0.333					
Shrubby Edge 25^3	511	5	102.741	102.854	1.288					
Null Model	511	2	102.913	102.935	1.369					
	Deciduous Forest									
	Deciduo	us F	orest							
Model	Deciduo N	us F K	orest AIC	AICc	Delta AICc					
Model Deciduous Forest 25	Deciduo N 511	us Fo K 3	orest AIC 102.189	AICc 102.234	Delta AICc 0					
Model Deciduous Forest 25 Deciduous Forest 400^3	Deciduo N 511 511	us F K 3 5	orest AIC 102.189 102.709	AICc 102.234 102.822	Delta AICc 0 0.588					
Model Deciduous Forest 25 Deciduous Forest 400^3 Null Model	Deciduo N 511 511 511	us F K 3 5 2	orest AIC 102.189 102.709 102.913	AICc 102.234 102.822 102.935	Delta AICc 0 0.588 0.701					
Model Deciduous Forest 25 Deciduous Forest 400^3 Null Model	Deciduo N 511 511 511 Deciduo	us F K 3 5 2 us F	orest AIC 102.189 102.709 102.913 orest	AICc 102.234 102.822 102.935	Delta AICc 0 0.588 0.701					
Model Deciduous Forest 25 Deciduous Forest 400^3 Null Model Model	Deciduo N 511 511 511 Deciduo N	us F K 3 5 2 us F K	orest AIC 102.189 102.709 102.913 orest AIC	AICc 102.234 102.822 102.935 AICc	Delta AICc 0 0.588 0.701 Delta AICc					
ModelDeciduous Forest 25Deciduous Forest 400^3Null ModelModelForested Wetland 400^3	Deciduo N 511 511 511 Deciduo N 511	us F K 3 5 2 us F K 5	orest AIC 102.189 102.709 102.913 orest AIC 102.33	AICc 102.234 102.822 102.935 AICc 102.443	Delta AICc 0 0.588 0.701 Delta AICc 0					

Appendix B. Parameter values for landscape variables for logistic exposure survival equations of landscapes composed of seven variables (Chapter 3, Table 2) for three survival periods (nest success, day 1–3 fledgling survival, and day 4–8 fledgling survival). Note: values not calculated by SAS are marked with "N/A"

			Nest Survival Models			
			Null Model			
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1765	0.2804	3.627	4.726	221.92	<.0001
Age	-0.0773	0.0166	-0.1098	-0.0447	21.67	<.0001
			Shrubby Edge			
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3456	0.3354	3.6882	5.0029	167.85	<.0001
Age	-0.0804	0.0167	-0.1131	-0.0477	23.17	<.0001
Shrubby Edge 50	-11.7052	4.7858	-21.0851	-2.3252	5.98	0.0145
Shrubby Edge 50^2	84.7826	30.7287	24.5554	145.0098	7.61	0.0058
Shrubby Edge 50^3	-131.678	50.1785	-230.026	-33.3298	6.89	0.0087
			Grassland			
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1488	0.2901	3.5802	4.7175	204.47	<.0001
Age	-0.0807	0.0167	-0.1135	-0.0479	23.22	<.0001
Grassland 200	0.3122	0.158	0.0025	0.6218	3.9	0.0482
Grassland 200^2	-0.0686	0.0306	-0.1286	-0.0086	5.01	0.0251
			Shrubby Edge, Grassland			
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value

Intercept	4.2153	0.3453	3.5385	4.8921	149.03	<.0001			
Age	-0.0837	0.0168	-0.1167	-0.0507	24.73	<.0001			
Shrubby Edge 50	-11.4076	4.8127	-20.8403	-1.9749	5.62	0.0178			
Shrubby Edge 50^2	85.8173	31.023	25.0134	146.6212	7.65	0.0057			
Shrubby Edge 50^3	-134.053	50.5916	-233.211	-34.8956	7.02	0.0081			
Grassland 200	0.3745	0.1592	0.0624	0.6866	5.53	0.0187			
Grassland 200^2	-0.0729	0.0304	-0.1324	-0.0133	5.75	0.0165			
			Wetland Shrubland						
	Estimat	Standard	Lower 95%	Upper 95%	Wald				
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value			
Intercept	4.274	0.2898	3.706	4.842	217.5	<.0001			
Age	-0.0784	0.0167	-0.1111	-0.0457	22.06	<.0001			
Wetland Shrubland 200	-0.0677	0.0415	-0.1491	0.0137	2.66	0.1029			
Shrubby Edge Wetland Shrubland									
			ooj Eago, "otiana oniac	land					
	Estimat	Standard	Lower 95%	Upper 95%	Wald				
Parameter	Estimat e	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Wald Chi-Square	P-value			
Parameter Intercept	Estimat e 4.491	Standard Error 0.3527	Lower 95% Confidence Limit 3.7997	Upper 95% Confidence Limit 5.1823	Wald Chi-Square 162.13	P-value <.0001			
Parameter Intercept Age	Estimat e 4.491 -0.082	Standard Error 0.3527 0.0168	Lower 95% Confidence Limit 3.7997 -0.1149	Upper 95% Confidence Limit 5.1823 -0.049	Wald Chi-Square 162.13 23.73	P-value <.0001 <.0001			
Parameter Intercept Age Shrubby Edge 50	Estimat e 4.491 -0.082 -12.4588	Standard Error 0.3527 0.0168 4.8248	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024	Wald Chi-Square 162.13 23.73 6.67	P-value <.0001 <.0001 0.0098			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2	Estimat e 4.491 -0.082 -12.4588 88.0269	Standard Error 0.3527 0.0168 4.8248 30.7999	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936	Wald Chi-Square 162.13 23.73 6.67 8.17	P-value <.0001 <.0001 0.0098 0.0043			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38	P-value <.0001 <.0001 0.0098 0.0043 0.0066			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55	P-value <.0001 <.0001 0.0098 0.0043 0.0066 0.1101			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486 assland, Wetland Shrubla	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151 and	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55	P-value <.0001 <.0001 0.0098 0.0043 0.0066 0.1101			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668 Estimat	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418 Gr Standard	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486 assland, Wetland Shrubla Lower 95%	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151 and Upper 95%	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55 Wald	P-value <.0001 <.0001 0.0098 0.0043 0.0066 0.1101			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200 Parameter	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668 Estimat e	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418 Gr Standard Error	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486 assland, Wetland Shrubla Lower 95% <u>Confidence Limit</u>	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151 and Upper 95% Confidence Limit	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55 Wald Chi-Square	P-value <.0001 <.0001 0.0098 0.0043 0.0066 0.1101 P-value			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200 Parameter Intercept	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668 Estimat e 4.2448	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418 Gr Standard Error 0.2972	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486 assland, Wetland Shrubla Lower 95% <u>Confidence Limit</u> 3.6622	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151 und Upper 95% Confidence Limit 4.8274	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55 Wald Chi-Square 203.93	P-value <.0001 <.0001 0.0098 0.0043 0.0066 0.1101 P-value <.0001			
Parameter Intercept Age Shrubby Edge 50 Shrubby Edge 50^2 Shrubby Edge 50^3 Wetland Shrubland 200 Parameter Intercept Age	Estimat e 4.491 -0.082 -12.4588 88.0269 -136.446 -0.0668 Estimat e 4.2448 -0.0824	Standard Error 0.3527 0.0168 4.8248 30.7999 50.2361 0.0418 Gr Standard Error 0.2972 0.0169	Lower 95% <u>Confidence Limit</u> 3.7997 -0.1149 -21.9151 27.6603 -234.907 -0.1486 <u>assland, Wetland Shrubla</u> Lower 95% <u>Confidence Limit</u> 3.6622 -0.1155	Upper 95% Confidence Limit 5.1823 -0.049 -3.0024 148.3936 -37.9854 0.0151 ind Upper 95% Confidence Limit 4.8274 -0.0493	Wald Chi-Square 162.13 23.73 6.67 8.17 7.38 2.55 Wald Chi-Square 203.93 23.86	P-value <.0001			

Grassland 200^2	-0.0808	0.0314	-0.1424	-0.0192	6.61	0.0101
Wetland Shrubland 200	-0.0884	0.0422	-0.1712	-0.0057	4.39	0.0362
		Shrubby E	dge, Grassland, Wetland	Shrubland		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	е	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3659	0.3584	3.6634	5.0683	148.38	<.0001
Age	-0.0862	0.017	-0.1195	-0.0528	25.67	<.0001
Shrubby Edge 50	-12.3802	4.8492	-21.8844	-2.876	6.52	0.0107
Shrubby Edge 50^2	91.11	31.0996	30.156	152.064	8.58	0.0034
Shrubby Edge 50^3	-142.303	50.6569	-241.589	-43.0173	7.89	0.005
Grassland 200	0.4515	0.1645	0.1291	0.7738	7.54	0.006
Grassland 200^2	-0.0854	0.0312	-0.1466	-0.0243	7.5	0.0062
Wetland Shrubland 200	-0.0924	0.042	-0.1748	-0.0101	4.84	0.0278
			Forested Wetland			
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	Estimat e	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	Wald Chi-Square	P-value
Parameter Intercept	Estimat e 4.1703	Standard Error 0.2804	Lower 95% Confidence Limit 3.6207	Upper 95% Confidence Limit 4.7199	Wald Chi-Square 221.2	P-value <.0001
Parameter Intercept Age	Estimat e 4.1703 -0.0793	Standard Error 0.2804 0.0166	Lower 95% Confidence Limit 3.6207 -0.1119	Upper 95% Confidence Limit 4.7199 -0.0467	Wald Chi-Square 221.2 22.74	P-value <.0001 <.0001
Parameter Intercept Age Forested Wetland 175	Estimat e 4.1703 -0.0793 0.4325	Standard Error 0.2804 0.0166 0.3054	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311	Wald Chi-Square 221.2 22.74 2	P-value <.0001 <.0001 0.1568
Parameter Intercept Age Forested Wetland 175	Estimat e 4.1703 -0.0793 0.4325	Standard Error 0.2804 0.0166 0.3054	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wet	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land	Wald Chi-Square 221.2 22.74 2	P-value <.0001 <.0001 0.1568
Parameter Intercept Age Forested Wetland 175	Estimat e 4.1703 -0.0793 0.4325 Estimat	Standard Error 0.2804 0.0166 0.3054 Shru Standard	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wet Lower 95%	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95%	Wald Chi-Square 221.2 22.74 2 Wald	P-value <.0001 <.0001 0.1568
Parameter Intercept Age Forested Wetland 175 Parameter	Estimat e 4.1703 -0.0793 0.4325 Estimat e	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wet Lower 95% Confidence Limit	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square	P-value <.0001 <.0001 0.1568 P-value
ParameterInterceptAgeForested Wetland 175ParameterIntercept	Estimat e 4.1703 -0.0793 0.4325 Estimat e 4.3375	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error 0.3353	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wet Lower 95% Confidence Limit 3.6803	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit 4.9946	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square 167.36	P-value <.0001 <.0001 0.1568 P-value <.0001
Parameter Intercept Age Forested Wetland 175 Parameter Intercept Age	Estimat e 4.1703 -0.0793 0.4325 Estimat e 4.3375 -0.0826	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error 0.3353 0.0167	Lower 95% <u>Confidence Limit</u> 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wett Lower 95% <u>Confidence Limit</u> 3.6803 -0.1154	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit 4.9946 -0.0498	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square 167.36 24.4	P-value <.0001
ParameterInterceptAgeForested Wetland 175ParameterInterceptAgeShrubby Edge 50	Estimat e 4.1703 -0.0793 0.4325 Estimat e 4.3375 -0.0826 -11.9839	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error 0.3353 0.0167 4.8073	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 abby Edge, Forested Wet Lower 95% Confidence Limit 3.6803 -0.1154 -21.4061	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit 4.9946 -0.0498 -2.5617	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square 167.36 24.4 6.21	P-value <.0001
ParameterInterceptAgeForested Wetland 175ParameterInterceptAgeShrubby Edge 50Shrubby Edge 50^2	Estimat e 4.1703 -0.0793 -0.4325 -0.4325 Estimat e 4.3375 -0.0826 -11.9839 86.8693	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error 0.3353 0.0167 4.8073 30.9045	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 ubby Edge, Forested Wett Lower 95% Confidence Limit 3.6803 -0.1154 -21.4061 26.2975	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit 4.9946 -0.0498 -2.5617 147.4411	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square 167.36 24.4 6.21 7.9	P-value <.0001
ParameterInterceptAgeForested Wetland 175ParameterInterceptAgeShrubby Edge 50Shrubby Edge 50^2Shrubby Edge 50^3	Estimat e 4.1703 -0.0793 0.4325 Estimat e 4.3375 -0.0826 -11.9839 86.8693 -134.57	Standard Error 0.2804 0.0166 0.3054 Shru Standard Error 0.3353 0.0167 4.8073 30.9045 50.4239	Lower 95% Confidence Limit 3.6207 -0.1119 -0.1662 abby Edge, Forested Weth Lower 95% Confidence Limit 3.6803 -0.1154 -21.4061 26.2975 -233.399	Upper 95% Confidence Limit 4.7199 -0.0467 1.0311 land Upper 95% Confidence Limit 4.9946 -0.0498 -2.5617 147.4411 -35.741	Wald Chi-Square 221.2 22.74 2 Wald Chi-Square 167.36 24.4 6.21 7.9 7.12	P-value <.0001

		G	rassland, Forested Wetlar	nd		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1399	0.2901	3.5713	4.7085	203.64	<.0001
Age	-0.0824	0.0168	-0.1152	-0.0495	24.15	<.0001
Grassland 200	0.3046	0.1588	-0.0067	0.6159	3.68	0.0551
Grassland 200^2	-0.0664	0.0308	-0.1268	-0.006	4.65	0.0311
Forested Wetland 175	0.3965	0.2953	-0.1823	0.9753	1.8	0.1794
		Shrubby l	Edge, Grassland, Forestec	l Wetland		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.2082	0.3445	3.533	4.8835	149.22	<.0001
Age	-0.0855	0.0168	-0.1185	-0.0525	25.8	<.0001
Shrubby Edge 50	-11.8294	4.8385	-21.3127	-2.3462	5.98	0.0145
Shrubby Edge 50^2	88.5053	31.2359	27.2841	149.7265	8.03	0.0046
Shrubby Edge 50^3	-137.664	50.88	-237.387	-37.9414	7.32	0.0068
Grassland 200	0.3675	0.1597	0.0545	0.6805	5.29	0.0214
Grassland 200^2	-0.0704	0.0305	-0.1303	-0.0106	5.32	0.021
Forested Wetland 175	0.4403	0.3003	-0.1483	1.0289	2.15	0.1426
		Wetlar	nd Shrubland, Forested W	vetland		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.2875	0.2904	3.7184	4.8566	218.03	<.0001
Age	-0.0811	0.0168	-0.114	-0.0483	23.45	<.0001
Wetland Shrubland 200	-0.0812	0.0411	-0.1616	-0.0007	3.91	0.048
Forested Wetland 175	0.5051	0.3133	-0.109	1.1193	2.6	0.107
		Shrubby Edge	, Wetland Shrubland, For	ested Wetland		

	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.5274	0.3547	3.8322	5.2227	162.91	<.0001
Age	-0.0853	0.0169	-0.1185	-0.0522	25.46	<.0001
Shrubby Edge 50	-13.1819	4.8725	-22.7317	-3.6321	7.32	0.0068
Shrubby Edge 50^2	92.7476	31.1112	31.7709	153.7244	8.89	0.0029
Shrubby Edge 50^3	-143.351	50.6474	-242.618	-44.0844	8.01	0.0046
Wetland Shrubland 200	-0.0846	0.0412	-0.1654	-0.0039	4.22	0.0398
Forested Wetland 175	0.5626	0.3193	-0.0633	1.1885	3.1	0.0781
		Grassland, V	Wetland Shrubland, Fores	ted Wetland		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.2483	0.2974	3.6654	4.8312	204.02	<.0001
Age	-0.0848	0.0169	-0.118	-0.0517	25.16	<.0001
Grassland 200	0.3926	0.1641	0.0709	0.7142	5.72	0.0167
Grassland 200^2	-0.0804	0.0317	-0.1426	-0.0183	6.44	0.0111
Wetland Shrubland 200	-0.1024	0.0419	-0.1845	-0.0203	5.97	0.0146
Forested Wetland 175	0.4799	0.3025	-0.113	1.0727	2.52	0.1126
	Shrul	bby Edge, Gras	ssland, Wetland Shrubland	d, Forested Wetland		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3947	0.3591	3.6909	5.0985	149.79	<.0001
Age	-0.0893	0.0171	-0.1227	-0.0558	27.39	<.0001
Shrubby Edge 50	-13.4474	4.9106	-23.072	-3.8228	7.5	0.0062
Shrubby Edge 50^2	98.025	31.544	36.1999	159.85	9.66	0.0019
Shrubby Edge 50^3	-152.415	51.246	-252.856	-51.975	8.85	0.0029
Grassland 200	0.4666	0.166	0.1413	0.792	7.9	0.0049
Grassland 200^2	-0.086	0.0315	-0.1477	-0.0243	7.46	0.0063

Wetland Shrubland 200	-0.1132	0.0417	-0.195	-0.0314	7.36	0.0067
Forested Wetland 175	0.5544	0.31	-0.0531	1.1619	3.2	0.0737
	0.5544 0.31 -0.0531 1.1619 3.2 0.0737 Estimat Standard Lower 95% Upper 95% Wald e Error Confidence Limit Confidence Limit Chi-Square P-value 4.1691 0.2807 3.6189 4.7194 220.53 <.0001					
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1691	0.2807	3.6189	4.7194	220.53	<.0001
Age	-0.0774	0.0166	-0.11	-0.0448	21.68	<.0001
Coniferous Forest 50	73.5495	182434.9	-357492	357639.4	0	0.9997
		Shru	ubby Edge, Coniferous Fo	prest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3478	0.3359	3.6894	5.0061	167.55	<.0001
Age	-0.0807	0.0167	-0.1135	-0.0479	23.26	<.0001
Shrubby Edge 50	-12.2947	4.7893	-21.6816	-2.9078	6.59	0.0103
Shrubby Edge 50^2	88.9043	30.7968	28.5437	149.265	8.33	0.0039
Shrubby Edge 50^3	-138.043	50.254	-236.539	-39.5473	7.55	0.006
Coniferous Forest 50	74.471	182555.5	-357728	357876.7	0	0.9997
		G	rassland, Coniferous Fore	est		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1363	0.2905	3.5669	4.7057	202.72	<.0001
Age	-0.0809	0.0168	-0.1138	-0.048	23.26	<.0001
Grassland 200	0.3216	0.1579	0.0121	0.6311	4.15	0.0417
Grassland 200^2	-0.0697	0.0306	-0.1297	-0.0098	5.2	0.0226
Coniferous Forest 50	73.9622	182598.3	-357812	357960.1	0	0.9997
		Shrubby I	Edge, Grassland, Coniferent	ous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value

Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
		Grassland, V	Wetland Shrubland, Conif	erous Forest		
Coniferous Forest 50	74.2673	182462.4	-357546	357694	0	0.9997
Wetland Shrubland 200	-0.0635	0.0419	-0.1456	0.0187	2.29	0.13
Shrubby Edge 50^3	-142.127	50.2881	-240.69	-43.5638	7.99	0.0047
Shrubby Edge 50^2	91.704	30.8495	31.24	152.168	8.84	0.003
Shrubby Edge 50	-12.9715	4.8247	-22.4276	-3.5153	7.23	0.0072
Age	-0.0822	0.0169	-0.1153	-0.0492	23.79	<.0001
Intercept	4.4859	0.353	3.7941	5.1777	161.53	<.0001
Parameter	е	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
		Shrubby Edge	, Wetland Shrubland, Cor	niferous Forest		
Coniferous Forest 50	73.2852	182336	-357299	357445.3	0	0.9997
Wetland Shrubland 200	-0.0653	0.0416	-0.1469	0.0163	2.46	0.1166
Age	-0.0785	0.0167	-0.1113	-0.0457	22.06	<.0001
Intercept	4.2634	0.2901	3.6948	4.832	215.97	<.0001
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
	1010170	Wetlar	nd Shrubland. Coniferous	Forest		0.7777
Coniferous Forest 50	75.0798	182729.9	-358069	358219.1	0	0.9997
Grassland 200 ²	-0.0748	0.0303	-0.1342	-0.0154	6.08	0.0136
Grassland 200	0.3913	0.1592	0.0793	0.7032	6.04	0.014
Shrubby Edge 50 [°] 2	-142.068	50.725	-241.487	-42.6488	7.84	0.0051
Shrubby Edge 50 ²	90,9984	31,1339	29.9772	152.0197	8.54	0.0035
Shrubby Edge 50	-12.1225	4.8185	-21.5666	-2.6784	6.33	0.0119
Age	-0.0842	0.0169	-0.1172	-0.0511	24 87	< 0001
Intercept	4.2063	0.3454	3.5293	4.8833	148.3	<.0001

Intercent	4 2308	0 2976	3 6476	4 8141	202 14	< 0001
Δα	-0.0826	0.2570	-0.1157	-0.0/195	202.14	< 0001
Grassland 200	0.3042	0.0107	-0.1157	-0.0+25	5.88	<.0001 0.0153
Grassland 200A2	0.3942	0.1020	0.0755	0.7129	5.88	0.0155
Grassland 200 ²	-0.0816	0.0314	-0.1431	-0.0201	6.//	0.0093
Wetland Shrubland 200	-0.0865	0.0423	-0.1694	-0.0037	4.19	0.0407
Coniferous Forest 50	73.7449	182505.7	-357631	357778.4	0	0.9997
	Shru	bby Edge, Gras	ssland, Wetland Shrubland	d, Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3532	0.3584	3.6507	5.0556	147.53	<.0001
Age	-0.0866	0.017	-0.12	-0.0531	25.78	<.0001
Shrubby Edge 50	-13.0184	4.8511	-22.5265	-3.5104	7.2	0.0073
Shrubby Edge 50^2	95.7988	31.1864	34.6745	156.9231	9.44	0.0021
Shrubby Edge 50^3	-149.553	50.7583	-249.038	-50.0689	8.68	0.0032
Grassland 200	0.4649	0.1642	0.1431	0.7868	8.02	0.0046
Grassland 200^2	-0.0868	0.0311	-0.1478	-0.0259	7.79	0.0052
Wetland Shrubland 200	-0.0899	0.0421	-0.1724	-0.0075	4.57	0.0326
Coniferous Forest 50	74.9191	182637	-357887	358036.8	0	0.9997
		Fores	ted Wetland, Coniferous I	Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1629	0.2808	3.6126	4.7132	219.8	<.0001
Age	-0.0795	0.0167	-0.1122	-0.0469	22.77	<.0001
Forested Wetland 175	0.4399	0.3065	-0.1608	1.0405	2.06	0.1512
Coniferous Forest 50	73.7462	182479.2	-357579	357726.4	0	0.9997
		Shrubby Edg	e, Forested Wetland, Con	iferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value

Intercept	4.3402	0.3358	3.6821	4.9984	167.07	<.0001
Age	-0.0831	0.0168	-0.1159	-0.0502	24.54	<.0001
Shrubby Edge 50	-12.6163	4.8123	-22.0483	-3.1844	6.87	0.0087
Shrubby Edge 50 [^] 2	91.3014	30.9857	30.5706	152.0323	8.68	0.0032
Shrubby Edge 50^3	-141.413	50.5167	-240.424	-42.4025	7.84	0.0051
Forested Wetland 175	0.4898	0.3134	-0.1245	1.1041	2.44	0.1181
Coniferous Forest 50	74.7184	182601.7	-357818	357967.5	0	0.9997
		Grassland,	Forested Wetland, Conife	erous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1272	0.2905	3.5578	4.6965	201.86	<.0001
Age	-0.0826	0.0168	-0.1155	-0.0497	24.21	<.0001
Grassland 200	0.3143	0.1588	0.0031	0.6255	3.92	0.0477
Grassland 200^2	-0.0676	0.0308	-0.128	-0.0073	4.83	0.028
Forested Wetland 175	0.4036	0.2961	-0.1768	0.9839	1.86	0.1729
Coniferous Forest 50	74.1385	182632	-357878	358026.3	0	0.9997
	Shru	bby Edge, Gra	ssland, Forested Wetland	, Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.1994	0.3446	3.524	4.8748	148.51	<.0001
Age	-0.086	0.0169	-0.1191	-0.0529	25.98	<.0001
Shrubby Edge 50	-12.6099	4.8475	-22.1108	-3.109	6.77	0.0093
Shrubby Edge 50^2	94.1342	31.3718	32.6466	155.6219	9	0.0027
Shrubby Edge 50^3	-146.352	51.0461	-246.401	-46.3036	8.22	0.0041
Grassland 200	0.3849	0.1596	0.0721	0.6977	5.82	0.0159
Grassland 200^2	-0.0724	0.0305	-0.1321	-0.0127	5.65	0.0175
Forested Wetland 175	0.4538	0.3018	-0.1377	1.0454	2.26	0.1326
Coniferous Forest 50	75.3267	182766.8	-358141	358291.7	0	0.9997

	V	Vetland Shrubl	and, Forested Wetland, C	oniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.2771	0.2907	3.7074	4.8468	216.51	<.0001
Age	-0.0813	0.0168	-0.1142	-0.0484	23.47	<.0001
Wetland Shrubland 200	-0.0789	0.0411	-0.1596	0.0017	3.68	0.0551
Forested Wetland 175	0.5101	0.3141	-0.1056	1.1259	2.64	0.1044
Coniferous Forest 50	73.4626	182355.7	-357337	357484	0	0.9997
	Shrubby	Edge, Wetland	I Shrubland, Forested We	tland, Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.5237	0.355	3.8279	5.2195	162.35	<.0001
Age	-0.0857	0.0169	-0.1189	-0.0525	25.57	<.0001
Shrubby Edge 50	-13.7304	4.8735	-23.2824	-4.1784	7.94	0.0048
Shrubby Edge 50^2	96.6692	31.1694	35.5783	157.76	9.62	0.0019
Shrubby Edge 50^3	-149.403	50.7105	-248.794	-50.0123	8.68	0.0032
Wetland Shrubland 200	-0.0817	0.0413	-0.1627	-0.0008	3.92	0.0478
Forested Wetland 175	0.5722	0.3208	-0.0564	1.2009	3.18	0.0744
Coniferous Forest 50	74.5157	182464.1	-357548	357697.5	0	0.9997
	Grassla	and, Wetland S	Shrubland, Forested Wetla	nd, Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.2344	0.2978	3.6508	4.818	202.22	<.0001
Age	-0.085	0.0169	-0.1182	-0.0518	25.21	<.0001
Grassland 200	0.3998	0.1639	0.0785	0.721	5.95	0.0147
Grassland 200^2	-0.0813	0.0316	-0.1433	-0.0192	6.6	0.0102
Wetland Shrubland 200	-0.1006	0.042	-0.1829	-0.0184	5.75	0.0165
Forested Wetland 175	0.4853	0.3032	-0.109	1.0795	2.56	0.1095

Coniferous Forest 50	73.9321	182525.1	-357669	357816.6	0	0.9997
S	hrubby Edge,	Grassland, W	vetland Shrubland, Foreste	d Wetland, Coniferous F	forest	
	Estimat	Standard	Lower 95%	Upper 95%	Wald	
Parameter	e	Error	Confidence Limit	Confidence Limit	Chi-Square	P-value
Intercept	4.3835	0.3591	3.6797	5.0873	149	<.0001
Age	-0.0898	0.0171	-0.1233	-0.0563	27.56	<.0001
Shrubby Edge 50	-14.1637	4.9164	-23.7996	-4.5277	8.3	0.004
Shrubby Edge 50^2	103.245	31.6598	41.1929	165.2971	10.63	0.0011
Shrubby Edge 50^3	-160.469	51.3867	-261.186	-59.7534	9.75	0.0018
Grassland 200	0.4816	0.1658	0.1566	0.8065	8.44	0.0037
Grassland 200^2	-0.0875	0.0314	-0.1491	-0.026	7.77	0.0053
Wetland Shrubland 200	-0.1114	0.0418	-0.1933	-0.0296	7.12	0.0076
Forested Wetland 175	0.5671	0.3116	-0.0437	1.1779	3.31	0.0688
Coniferous Forest 50	75.2318	182633.3	-357880	358030	0	0.9997

		Fledgling Da	y 1 to 3 Survival Models	8		
			Null Model			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	е	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.6238	0.4528	0.7249	2.5227	3.59	0.0005
Age	0.2497	0.1971	-0.1416	0.6411	1.27	0.2083
		De	ciduous Forest			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.1494	0.4592	0.2378	2.0609	2.5	0.014
Age	0.2378	0.1955	-0.1504	0.626	1.22	0.2269
Deciduous Forest 25	5.608	2.6599	0.3275	10.8885	2.11	0.0376
		S	hrubby Edge			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	8.6792	3.6315	1.4697	15.8886	2.39	0.0188
Age	0.2524	0.198	-0.1407	0.6454	1.27	0.2055
Shrubby Edge 200	-6.6939	3.5986	-13.8381	0.4502	-1.86	0.066
Shrubby Edge 200^2	1.8687	1.1255	-0.3656	4.103	1.66	0.1001
Shrubby Edge 200^3	-0.1583	0.1095	-0.3758	0.05913	-1.45	0.1516
		Deciduous	Forest, Shrubby Edge			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	4.9765	3.164	-1.3048	11.2579	1.57	0.1191
Age	0.2422	0.1957	-0.1463	0.6308	1.24	0.2189
Deciduous Forest 25	6.3094	2.7876	0.7754	11.8434	2.26	0.0259
Shrubby Edge 200	-3.3918	3.2773	-9.8981	3.1146	-1.03	0.3033

Shrubby Edge 200^2	0.861	1.0501	-1.2236	2.9456	0.82	0.4143
Shrubby Edge 200 [^] 3	-0.06585	0.1043	-0.2729	0.1412	-0.63	0.5293
			Grassland			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.8707	0.4903	0.8972	2.8441	3.81	0.0002
Age	0.2428	0.1966	-0.1476	0.6332	1.23	0.22
Grassland 200	-0.1927	0.1154	-0.4219	0.03639	-1.67	0.0982
		Deciduo	us Forest, Grassland			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.3954	0.5114	0.3801	2.4108	2.73	0.0076
Age	0.2334	0.1955	-0.1548	0.6215	1.19	0.2356
Deciduous Forest 25	4.9052	2.6915	-0.4382	10.2485	1.82	0.0715
Grassland 200	-0.1422	0.1142	-0.3689	0.08454	-1.24	0.2162
		Shrubb	by Edge, Grassland			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	9.0363	3.6827	1.7252	16.3474	2.45	0.016
Age	0.2386	0.1975	-0.1534	0.6306	1.21	0.2299
Shrubby Edge 200	-6.5014	3.63	-13.7079	0.7052	-1.79	0.0765
Shrubby Edge 200^2	1.7581	1.1349	-0.4949	4.0111	1.55	0.1247
Shrubby Edge 200^3	-0.1455	0.1106	-0.3651	0.07397	-1.32	0.1912
Grassland 200	-0.217	0.1166	-0.4485	0.01444	-1.86	0.0658
	D	Deciduous Fore	st, Shrubby Edge, Grass	and		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value

Age 0.2305 0.1957 -0.1581 0.6191 1.18 0.2419 Deciduous Forest 25 5.7451 2.8179 0.1509 11.3392 2.04 0.0442 Shrubby Edge 200 -3.4322 3.3307 -10.0445 3.1801 -1.03 0.3054 Shrubby Edge 200^2 0.8245 1.0672 -1.2941 2.9432 0.77 0.4417 Shrubby Edge 200^3 -0.05978 0.1061 -0.2704 0.1509 -0.56 0.5745 Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 FarametereErrorConfidence LimitConfidence LimittP-valueIntercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0121 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^{A2} -45.0087 28.3239 -101.24 11.2213 -1.59 0.1141 Forested Wetland 125A2 7.4954 11.0668 -4.475 39.4658 1.58 0.1172 Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1637 Forested Wetland 125A2 41.8326							
Deciduous Forest 25 5.7451 2.8179 0.1509 11.3392 2.04 0.0442 Shrubby Edge 200 -3.4322 3.3307 -10.0445 3.1801 -1.03 0.3054 Shrubby Edge 200^2 0.8245 1.0672 -1.2941 2.9432 0.77 0.4417 Shrubby Edge 200^3 -0.05978 0.1061 -0.2704 0.1509 -0.56 0.5745 Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 Forested WetlandForested WetlandIntercept EstimatStandardLower 95%Upper 95% Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1611 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^4 45.0087 28.3239 -101.24 11.2213 -1.59 0.1172 Deciduous Forest, Forested WetlandIntercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.43 0.1547 Forested Wetland 125^4 24.088 53.8921 1.43 0.1547 Forested Wetland 125^4 2.908 -9.95816 53.8921 1.43 0.1547 Forested Wetland 125^4<	Age	0.2305	0.1957	-0.1581	0.6191	1.18	0.2419
Shrubby Edge 200 -3.4322 3.3307 -10.0445 3.1801 -1.03 0.3054 Shrubby Edge 200^2 0.8245 1.0672 -1.2941 2.9432 0.77 0.4417 Shrubby Edge 200^3 -0.05978 0.1061 -0.2704 0.1509 0.56 0.5745 Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 Forested WetlandEstimatStandardLower 95%Upper 95%ParametereErrorConfidence LimittP-valueIntercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0124 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^*2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^*2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1547 Forested Wetland 125 2.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Greated Wetland 125^*2 -4.18326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125*	Deciduous Forest 25	5.7451	2.8179	0.1509	11.3392	2.04	0.0442
Shrubby Edge 200^2 0.8245 1.0672 -1.2941 2.9432 0.77 0.4417 Shrubby Edge 200^3 -0.05978 0.1061 -0.2704 0.1509 -0.56 0.5745 Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 Forested WetlandEstimatStandardLower 95%Upper 95%ParametereErrorConfidence LimittP-valueIntercept 1.4955 0.4463 0.6095 2.3815 3.35 0.012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^^2 45.0087 28.3239 -101.24 11.2213 -1.59 0.1172 Forested Wetland 125^^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^^2 45.0087 28.3239 -101.24 11.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0671 Age 0.2602 0.1959 -9.2886 53.8921 1.43 0.1547 Forested Wetland 125^2 2.058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^3<	Shrubby Edge 200	-3.4322	3.3307	-10.0445	3.1801	-1.03	0.3054
Shrubby Edge 200^3 -0.05978 0.1061 -0.2704 0.1509 -0.56 0.5745 Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 Forested Wetland Parameter Estimat Standard Lower 95% Upper 95% Outper 95% Parameter Estimat Standard Lower 95% Outper 95% Confidence Limit t P-value Intercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125^4 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^4 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^4 1.74954 Lower 95% Upper 95% Upper 95% 0.2114 Intercept 1.0727 0.4574 0.1647 1.9808	Shrubby Edge 200^2	0.8245	1.0672	-1.2941	2.9432	0.77	0.4417
Grassland 200 -0.1707 0.1163 -0.4016 0.06024 -1.47 0.1456 Forested Wetland Forested Wetland Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.4955 0.4463 0.6095 2.3815 3.35 0.012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1124 Forested Wetland 125^4 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^4 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^4 17.4954 10.0668 -4.475 39.4658 1.58 0.1172 Intercept e Error Confidence Limit Confidence Limit t P-value Intercept 1.0727 0.4574 0.1647 1.9808 </td <td>Shrubby Edge 200^3</td> <td>-0.05978</td> <td>0.1061</td> <td>-0.2704</td> <td>0.1509</td> <td>-0.56</td> <td>0.5745</td>	Shrubby Edge 200^3	-0.05978	0.1061	-0.2704	0.1509	-0.56	0.5745
Forested Wetland Parameter Estimat Standard Lower 95% Upper 95% I Parameter e Error Confidence Limit Confidence Limit I P-value Intercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^ 245.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^ 17.4954 11.0668 -4.475 39.4658 1.88 0.1172 Forested Wetland 125^ 17.4954 11.0668 -4.475 39.4658 1.89 0.1164 Intercept Estimat Standard Lower 95% Upper 95% 9.0214 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1547 Deciduous Forest 25	Grassland 200	-0.1707	0.1163	-0.4016	0.06024	-1.47	0.1456
FermEstimatStandardLower 95%Upper 95%ParametereErrorConfidence LimitConfidence LimittP-valueIntercept1.49550.44630.60952.38153.350.0012Age0.27450.1972-0.11690.66591.390.1671Forested Wetland 12523.789915.3467-6.677254.25691.550.1244Forested Wetland 125^4-45.008728.3239-101.2411.2213-1.590.1154Forested Wetland 125^517.495411.0668-4.47539.46581.580.1172Forested Wetland 125^417.495411.0668-4.47539.46581.580.1172ParametereErrorConfidence LimitVP-valueIntercept1.07270.45740.16471.98082.350.0211Age0.26020.1959-0.12860.64911.330.1871Deciduous Forest 255.03822.6719-0.266210.34251.890.0624Forested Wetland 125^2-4.1832629.089-99.581615.9165-1.440.1537Forested Wetland 125^216.134811.3626-6.422738.69241.420.1589Forested Wetland 125^316.134811.3626-6.422738.69241.420.1589Forested Wetland 125^316.134811.3626-6.422738.69241.420.1589Forested Wetland 125^316.134811.3626-6.4227<			Fo	prested Wetland			
Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Intercept 1.0727 0.4574 O.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 <t< td=""><td></td><td>Estimat</td><td>Standard</td><td>Lower 95%</td><td>Upper 95%</td><td></td><td></td></t<>		Estimat	Standard	Lower 95%	Upper 95%		
Intercept 1.4955 0.4463 0.6095 2.3815 3.35 0.0012 Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^3 17.4954 10.668 -4.475 39.4658 1.58 0.1172 Parameter e Error Confidence Limit Confidence Limit r P-value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1547 Forested Wetland 125 2.0588 <t< td=""><td>Parameter</td><td>e</td><td>Error</td><td>Confidence Limit</td><td>Confidence Limit</td><td>t</td><td>P-value</td></t<>	Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Age 0.2745 0.1972 -0.1169 0.6659 1.39 0.1671 Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^2 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^2 Estimat Standard Lower 95% Upper 95% P.value Parameter e Error Confidence Limit Confidence Limit t P.value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537	Intercept	1.4955	0.4463	0.6095	2.3815	3.35	0.0012
Forested Wetland 125 23.7899 15.3467 -6.6772 54.2569 1.55 0.1244 Forested Wetland 125^2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Forested Wetland 125^3 Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1537 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 <td< td=""><td>Age</td><td>0.2745</td><td>0.1972</td><td>-0.1169</td><td>0.6659</td><td>1.39</td><td>0.1671</td></td<>	Age	0.2745	0.1972	-0.1169	0.6659	1.39	0.1671
Forested Wetland 125^2 -45.0087 28.3239 -101.24 11.2213 -1.59 0.1154 Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Parameter Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125^2 24.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589	Forested Wetland 125	23.7899	15.3467	-6.6772	54.2569	1.55	0.1244
Forested Wetland 125^3 17.4954 11.0668 -4.475 39.4658 1.58 0.1172 Deciduous Forest, Forested Wetland Estimat Standard Lower 95% Upper 95% P-value Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Intercept <t< td=""><td>Forested Wetland 125^2</td><td>-45.0087</td><td>28.3239</td><td>-101.24</td><td>11.2213</td><td>-1.59</td><td>0.1154</td></t<>	Forested Wetland 125^2	-45.0087	28.3239	-101.24	11.2213	-1.59	0.1154
Deciduous Forested Wetland Parameter Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 P	Forested Wetland 125^3	17.4954	11.0668	-4.475	39.4658	1.58	0.1172
EstimatStandardLower 95%Upper 95%ParametereErrorConfidence LimitConfidence LimittP-valueIntercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 ParametereErrorConfidence LimittP-valueIntercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931			Deciduous l	Forest, Forested Wetland			
Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Parameter e Error Confidence Limit Confidence Limit t P-value Intercept <td< td=""><td></td><td>Estimat</td><td>Standard</td><td>Lower 95%</td><td>Upper 95%</td><td></td><td></td></td<>		Estimat	Standard	Lower 95%	Upper 95%		
Intercept 1.0727 0.4574 0.1647 1.9808 2.35 0.0211 Age 0.2602 0.1959 -0.1286 0.6491 1.33 0.1871 Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 3.7928 Lower 95%Upper 95%VVIntercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Age0.26020.1959-0.12860.64911.330.1871Deciduous Forest 255.03822.6719-0.266210.34251.890.0624Forested Wetland 12522.605815.7594-8.680553.89211.430.1547Forested Wetland 125^2-41.832629.089-99.581615.9165-1.440.1537Forested Wetland 125^316.134811.3626-6.422738.69241.420.1589Forested Wetland 125^316.134811.3626-6.4227Upper 95%VParametereErrorConfidence LimittP-valueIntercept9.35933.79281.829616.8892.470.0154Age0.25990.1983-0.13370.65351.310.1931	Intercept	1.0727	0.4574	0.1647	1.9808	2.35	0.0211
Deciduous Forest 25 5.0382 2.6719 -0.2662 10.3425 1.89 0.0624 Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^* 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125*3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125*3 16.1348 11.3626 -6.4227 Upper 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit <i>t</i> P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Age	0.2602	0.1959	-0.1286	0.6491	1.33	0.1871
Forested Wetland 125 22.6058 15.7594 -8.6805 53.8921 1.43 0.1547 Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Forested Wetland Estimat Standard Lower 95% Upper 95% V Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Deciduous Forest 25	5.0382	2.6719	-0.2662	10.3425	1.89	0.0624
Forested Wetland 125^2 -41.8326 29.089 -99.5816 15.9165 -1.44 0.1537 Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Shrubby Edge, Forested Wetland Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Forested Wetland 125	22.6058	15.7594	-8.6805	53.8921	1.43	0.1547
Forested Wetland 125^3 16.1348 11.3626 -6.4227 38.6924 1.42 0.1589 Shrubby Edge, Forested Wetland Standard Lower 95% Upper 95% V V Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Forested Wetland 125^2	-41.8326	29.089	-99.5816	15.9165	-1.44	0.1537
Shrubby Edge, Forested Wetland Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931	Forested Wetland 125^3	16.1348	11.3626	-6.4227	38.6924	1.42	0.1589
Estimat Standard Lower 95% Upper 95% Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931			Shrubby E	Edge, Forested Wetland			
Parameter e Error Confidence Limit Confidence Limit t P-value Intercept 9.3593 3.7928 1.8296 16.889 2.47 0.0154 Age 0.2599 0.1983 -0.1337 0.65355 1.31 0.1931					Upper 05%		
Intercept9.35933.79281.829616.8892.470.0154Age0.25990.1983-0.13370.65351.310.1931	Paramotor	Estimat	Standard	Lower 95%	Opper 9576		
Age 0.2599 0.1983 -0.1337 0.6535 1.31 0.1931		Estimat e	Standard Error	Confidence Limit	Confidence Limit	t	P-value
•	Intercept	Estimat <u>e</u> 9.3593	Standard Error 3.7928	Confidence Limit 1.8296	Confidence Limit 16.889	<i>t</i> 2.47	P-value 0.0154

Shrubby Edge 200	-7.2872	3.701	-14.6346	0.06013	-1.97	0.0519		
Shrubby Edge 200 ²	2.0321	1.1472	-0.2453	4.3095	1.77	0.0797		
Shrubby Edge 200 [^] 3	-0.173	0.1109	-0.3931	0.04716	-1.56	0.1221		
Forested Wetland 125	1.4739	4.3793	-7.22	10.1679	0.34	0.7372		
Forested Wetland 125^2	-4.481	7.1371	-18.6499	9.688	-0.63	0.5316		
Forested Wetland 125^3	1.8956	2.6095	-3.2849	7.0761	0.73	0.4694		
Deciudous Forest, Shrubby Edge, Forested Wetland								
	Estimat	Standard	Lower 95%	Upper 95%				
Parameter	е	Error	Confidence Limit	Confidence Limit	t	P-value		
Intercept	5.6469	3.3144	-0.9331	12.2269	1.7	0.0917		
Age	0.2417	0.1963	-0.148	0.6314	1.23	0.2213		
Deciduous Forest 25	6.7063	2.8902	0.9685	12.4442	2.32	0.0225		
Shrubby Edge 200	-4.023	3.3814	-10.7359	2.69	-1.19	0.2371		
Shrubby Edge 200^2	1.0377	1.0745	-1.0954	3.1709	0.97	0.3366		
Shrubby Edge 200^3	-0.0817	0.1061	-0.2924	0.129	-0.77	0.4433		
Forested Wetland 125	0.7067	3.7744	-6.7864	8.1998	0.19	0.8519		
Forested Wetland 125^2	-2.2875	5.7456	-13.694	9.119	-0.4	0.6914		
Forested Wetland 125^3	1.0249	1.9772	-2.9003	4.9501	0.52	0.6054		
		Grasslar	nd, Forested Wetland					
	Estimat	Standard	Lower 95%	Upper 95%				
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value		
Intercept	1.739	0.4804	0.7852	2.6927	3.62	0.0005		
Age	0.2694	0.1965	-0.1207	0.6596	1.37	0.1736		
Grassland 200	-0.1991	0.1126	-0.4226	0.02437	-1.77	0.0801		
Forested Wetland 125	24.5647	15.461	-6.1294	55.2587	1.59	0.1154		
Forested Wetland 125^2	-45.5651	28.5199	-102.18	11.0541	-1.6	0.1134		
Forested Wetland 125 ³	17.523	11.1388	-4.5904	39.6364	1.57	0.119		

	Dee	ciduous Forest	, Grassland, Forested We	etland		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.335	0.5062	0.33	2.3399	2.64	0.0098
Age	0.2574	0.1957	-0.1311	0.646	1.32	0.1915
Deciduous Forest 25	4.2653	2.6936	-1.0822	9.6128	1.58	0.1166
Grassland 200	-0.1572	0.1126	-0.3807	0.06624	-1.4	0.1657
Forested Wetland 125	23.497	15.8544	-7.978	54.972	1.48	0.1416
Forested Wetland 125^2	-42.9372	29.2566	-101.02	15.1445	-1.47	0.1455
Forested Wetland 125^3	16.4338	11.4252	-6.2482	39.1158	1.44	0.1536
	S	hrubby Edge, (Grassland, Forested Wetl	and		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	9.7982	3.8703	2.1146	17.4817	2.53	0.013
Age	0.2467	0.1978	-0.1459	0.6393	1.25	0.2153
Shrubby Edge 200	-7.2312	3.7518	-14.6794	0.2169	-1.93	0.0569
Shrubby Edge 200^2	1.974	1.1606	-0.33	4.278	1.7	0.0922
Shrubby Edge 200 ³	-0.1659	0.1121	-0.3884	0.05671	-1.48	0.1423
Grassland 200	-0.211	0.1159	-0.4411	0.01909	-1.82	0.0718
Forested Wetland 125	1.9677	4.225	-6.42	10.3554	0.47	0.6425
Forested Wetland 125^2	-4.8559	6.7336	-18.2238	8.512	-0.72	0.4726
Forested Wetland 125^3	1.9225	2.4231	-2.888	6.7331	0.79	0.4295
	Deciduous	Forest, Shrubb	y Edge, Grassland, Fore	sted Wetland		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	9.7953	3.894	2.0648	17.5258	2.52	0.0136
Age	0.2331	0.1966	-0.1571	0.6234	1.19	0.2386
Deciduous Forest 25	4.6292	2.8372	-1.0034	10.2617	1.63	0.1061

Shrubby Edge 200	-7.6603	3.7957	-15.1957	-0.1248	-2.02	0.0464
Shrubby Edge 200^2	2.1211	1.171	-0.2037	4.4459	1.81	0.0733
Shrubby Edge 200^3	-0.1824	0.1128	-0.4063	0.04156	-1.62	0.1092
Grassland 200	-0.1755	0.115	-0.4038	0.05285	-1.53	0.1304
Forested Wetland 125	3.0997	4.4571	-5.7487	11.9481	0.7	0.4885
Forested Wetland 125^2	-6.2293	7.26	-20.6422	8.1836	-0.86	0.393
Forested Wetland 125^3	2.3686	2.6556	-2.9034	7.6406	0.89	0.3747
		Co	niferous Forest			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.513	0.4358	0.6478	2.3782	3.47	0.0008
Age	0.2728	0.194	-0.1124	0.6579	1.41	0.163
Coniferous Forest 50	-110.68	7363.38	-14729	14507	-0.02	0.988
Coniferous Forest 25 ²	373.71	27301	-53826	54574	0.01	0.9891
		Deciduous F	orest, Coniferous Forest			
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.0633	0.4363	0.197	1.9295	2.44	0.0167
Age	0.2594	0.1922	-0 1222	0.641	1 35	0.1804
Deciduous Forest 25		0.1722	0.1222	0.041	1.55	012001
Deciduous Forest 25	5.316	2.4492	0.4538	10.1783	2.17	0.0325
Coniferous Forest 50	5.316 -116.48	2.4492 15016	0.4538 -29927	10.1783 29694	2.17 -0.01	0.0325 0.9938
Coniferous Forest 25 Coniferous Forest 25^2	5.316 -116.48 399.66	2.4492 15016 55674	0.4538 -29927 -110128	10.1783 29694 110927	2.17 -0.01 0.01	0.0325 0.9938 0.9943
Coniferous Forest 50 Coniferous Forest 25^2	5.316 -116.48 399.66	2.4492 15016 55674 Shrubby E	0.4538 -29927 -110128 dge, Coniferous Forest	10.1783 29694 110927	2.17 -0.01 0.01	0.0325 0.9938 0.9943
Coniferous Forest 50 Coniferous Forest 25^2	5.316 -116.48 399.66 Estimat	2.4492 15016 55674 Shrubby E Standard	0.4538 -29927 -110128 dge, Coniferous Forest Lower 95%	10.1783 29694 110927 Upper 95%	2.17 -0.01 0.01	0.0325 0.9938 0.9943
Coniferous Forest 25 Coniferous Forest 50 Coniferous Forest 25^2 Parameter	5.316 -116.48 399.66 Estimat e	2.4492 15016 55674 Shrubby E Standard Error	0.4538 -29927 -110128 dge, Coniferous Forest Lower 95% Confidence Limit	10.1783 29694 110927 Upper 95% Confidence Limit	1.35 2.17 -0.01 0.01	0.0325 0.9938 0.9943 P-value
Coniferous Forest 25 Coniferous Forest 25^2 Parameter Intercept	5.316 -116.48 399.66 Estimat e 8.0632	2.4492 15016 55674 Shrubby E Standard Error 3.6832	0.4538 -29927 -110128 dge, Coniferous Forest Lower 95% Confidence Limit 0.7512	10.1783 29694 110927 Upper 95% Confidence Limit 15.3753	1.33 2.17 -0.01 0.01 <u>t</u> 2.19	0.0325 0.9938 0.9943 P-value 0.031
Coniferous Forest 25 Coniferous Forest 50 Coniferous Forest 25^2 Parameter Intercept Age	5.316 -116.48 399.66 Estimat e 8.0632 0.254	2.4492 15016 55674 Shrubby E Standard Error 3.6832 0.2006	0.4538 -29927 -110128 dge, Coniferous Forest Lower 95% Confidence Limit 0.7512 -0.1443	10.1783 29694 110927 Upper 95% Confidence Limit 15.3753 0.6522	1.33 2.17 -0.01 0.01 t 2.19 1.27	0.0325 0.9938 0.9943 P-value 0.031 0.2086

Shrubby Edge 200^2	1.701	1.1355	-0.5533	3.9553	1.5	0.1374				
Shrubby Edge 200^3	-0.1436	0.1105	-0.3629	0.07571	-1.3	0.1968				
Coniferous Forest 50	-2.0415	20.1273	-41.9992	37.9162	-0.1	0.9194				
Coniferous Forest 25^2	0.2387	57.613	-114.14	114.61	0	0.9967				
Deciduous Forest, Shrubby Edge, Coniferous Forest										
	Estimat	Standard	Lower 95%	Upper 95%						
Parameter	е	Error	Confidence Limit	Confidence Limit	t	P-value				
Intercept	7.712	3.7003	0.3661	15.058	2.08	0.0398				
Age	0.2372	0.1994	-0.1586	0.6329	1.19	0.2372				
Deciduous Forest 25	6.0279	2.8543	0.3615	11.6944	2.11	0.0373				
Shrubby Edge 200	-6.1514	3.6804	-13.4579	1.155	-1.67	0.0979				
Shrubby Edge 200^2	1.7085	1.1487	-0.5721	3.989	1.49	0.1403				
Shrubby Edge 200^3	-0.1458	0.1115	-0.3672	0.07554	-1.31	0.1941				
Coniferous Forest 50	0.6648	21.2644	-41.5503	42.88	0.03	0.9751				
Coniferous Forest 25^2	1.5718	59.4838	-116.52	119.66	0.03	0.979				
	Grassland Coniferous Forest									
Estimat Standard Lower 95% Unner 95%										
	Estimat	Standard	Lower 95%	Upper 95%						
Parameter	Estimat e	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	t	P-value				
Parameter Intercept	Estimat e 1.7743	Standard Error 0.4645	Lower 95% Confidence Limit 0.8522	Upper 95% Confidence Limit 2.6964	<i>t</i> 3.82	P-value 0.0002				
Parameter Intercept Age	Estimat e 1.7743 0.2664	Standard Error 0.4645 0.1925	Lower 95% Confidence Limit 0.8522 -0.1157	Upper 95% Confidence Limit 2.6964 0.6484	<i>t</i> 3.82 1.38	P-value 0.0002 0.1696				
Parameter Intercept Age Grassland 200	Estimat e 1.7743 0.2664 -0.2064	Standard Error 0.4645 0.1925 0.1025	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298	<i>t</i> 3.82 1.38 -2.01	P-value 0.0002 0.1696 0.0468				
Parameter Intercept Age Grassland 200 Coniferous Forest 50	Estimat e 1.7743 0.2664 -0.2064 -108.73	Standard Error 0.4645 0.1925 0.1025 5505.78	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822	<i>t</i> 3.82 1.38 -2.01 -0.02	P-value 0.0002 0.1696 0.0468 0.9843				
Parameter Intercept Age Grassland 200 Coniferous Forest 50 Coniferous Forest 25^2	Estimat e 1.7743 0.2664 -0.2064 -108.73 363.13	Standard Error 0.4645 0.1925 0.1025 5505.78 20414	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039 -40164	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822 40890	<i>t</i> 3.82 1.38 -2.01 -0.02 0.02	P-value 0.0002 0.1696 0.0468 0.9843 0.9858				
Parameter Intercept Age Grassland 200 Coniferous Forest 50 Coniferous Forest 25^2	Estimat e 1.7743 0.2664 -0.2064 -108.73 363.13 De	Standard Error 0.4645 0.1925 0.1025 5505.78 20414 ciduous Forest,	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039 -40164 Grassland, Coniferous I	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822 40890 Forest	<i>t</i> 3.82 1.38 -2.01 -0.02 0.02	P-value 0.0002 0.1696 0.0468 0.9843 0.9858				
Parameter Intercept Age Grassland 200 Coniferous Forest 50 Coniferous Forest 25^2	Estimat e 1.7743 0.2664 -0.2064 -108.73 363.13 De Estimat	Standard Error 0.4645 0.1925 0.1025 5505.78 20414 ciduous Forest, Standard	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039 -40164 Grassland, Coniferous I Lower 95%	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822 40890 Forest Upper 95%	t 3.82 1.38 -2.01 -0.02 0.02	P-value 0.0002 0.1696 0.0468 0.9843 0.9858				
Parameter Intercept Age Grassland 200 Coniferous Forest 50 Coniferous Forest 25^2 Parameter	Estimat e 1.7743 0.2664 -0.2064 -108.73 363.13 De Estimat e	Standard Error 0.4645 0.1925 0.1025 5505.78 20414 ciduous Forest. Standard Error	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039 -40164 Grassland, Coniferous I Lower 95% Confidence Limit	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822 40890 Forest Upper 95% Confidence Limit	t 3.82 1.38 -2.01 -0.02 0.02 t	P-value 0.0002 0.1696 0.0468 0.9843 0.9858				
ParameterInterceptAgeGrassland 200Coniferous Forest 50Coniferous Forest 25^2ParameterIntercept	Estimat e 1.7743 0.2664 -0.2064 -108.73 363.13 De Estimat e 1.3512	Standard Error 0.4645 0.1925 0.1025 5505.78 20414 ciduous Forest Standard Error 0.4862	Lower 95% Confidence Limit 0.8522 -0.1157 -0.4098 -11039 -40164 Grassland, Coniferous I Lower 95% Confidence Limit 0.3859	Upper 95% Confidence Limit 2.6964 0.6484 -0.00298 10822 40890 Forest Upper 95% Confidence Limit 2.3165	t 3.82 1.38 -2.01 -0.02 0.02 t 2.78	P-value 0.0002 0.1696 0.0468 0.9843 0.9858				

Deciduous Forest 25	4.3597	2.4828	-0.5692	9.2887	1.76	0.0823
Grassland 200	-0.154	0.1036	-0.3597	0.05179	-1.49	0.1407
Coniferous Forest 50	-114.86	11373	-22693	22463	-0.01	0.992
Coniferous Forest 25^2	390.23	42168	-83323	84104	0.01	0.9926
	S	hrubby Edge, (Grassland, Coniferous Fo	prest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	7.5756	3.5253	0.5771	14.5742	2.15	0.0342
Age	0.2403	0.2002	-0.1571	0.6377	1.2	0.233
Shrubby Edge 200	-5.023	3.4851	-11.9419	1.8959	-1.44	0.1528
Shrubby Edge 200^2	1.3198	1.0989	-0.8619	3.5015	1.2	0.2327
Shrubby Edge 200 ³	-0.1055	0.1078	-0.3195	0.1085	-0.98	0.3301
Grassland 200	-0.2344	0.1179	-0.4684	-0.0003	-1.99	0.0497
Coniferous Forest 50	-3.0045	20.8083	-44.3142	38.3052	-0.14	0.8855
Coniferous Forest 25^2	-0.1792	59.7839	-118.87	118.51	0	0.9976
	Deciduous	Forest, Shrubb	by Edge, Grassland, Con	iferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	8.3822	3.831	0.7766	15.9877	2.19	0.0311
Age	0.2276	0.1988	-0.167	0.6222	1.15	0.255
Deciduous Forest 25	5.2301	2.8903	-0.5078	10.968	1.81	0.0735
Shrubby Edge 200	-6.3088	3.7819	-13.8167	1.1992	-1.67	0.0986
Shrubby Edge 200^2	1.7139	1.1771	-0.6231	4.0508	1.46	0.1487
Shrubby Edge 200^3	-0.1442	0.1141	-0.3707	0.08222	-1.26	0.2092
Grassland 200	-0.1727	0.1169	-0.4048	0.05937	-1.48	0.1429
Coniferous Forest 50	-0.2436	21.3594	-42.6473	42.1601	-0.01	0.9909
Coniferous Forest 25 ²	1.4501	59.679	-117.03	119.93	0.02	0.9807

	Forested We	etland, Coniferous Forest	ţ		
Estimat	Standard	Lower 95%	Upper 95%		
e	Error	Confidence Limit	Confidence Limit	t	P-value
1.3568	0.4264	0.5102	2.2034	3.18	0.002
0.3091	0.1932	-0.07436	0.6926	1.6	0.1129
21.9879	13.7418	-5.2931	49.2689	1.6	0.1129
-41.8562	25.2304	-91.9448	8.2324	-1.66	0.1004
16.3034	9.832	-3.2157	35.8224	1.66	0.1006
-97.1977	2446.97	-4955.05	4760.65	-0.04	0.9684
325.37	9072.63	-17686	18337	0.04	0.9715
Decidu	ous Forest, For	rested Wetland, Coniferent	ous Forest		
Estimat	Standard	Lower 95%	Upper 95%		
e	Error	Confidence Limit	Confidence Limit	t	P-value
0.9797	0.4287	0.1287	1.8307	2.29	0.0245
0.2912	0.192	-0.09002	0.6725	1.52	0.1327
4.6392	2.445	-0.2147	9.4931	1.9	0.0608
21.0726	14.0422	-6.8046	48.9498	1.5	0.1368
-39.2768	25.7931	-90.4826	11.9291	-1.52	0.1311
15.1878	10.051	-4.7658	35.1415	1.51	0.1341
-105.27	5889.25	-11797	11586	-0.02	0.9858
359.09	21836	-42990	43708	0.02	0.9869
Shrut	by Edge, Fore	sted Wetland, Coniferou	is Forest		
Estimat	Standard	Lower 95%	Upper 95%		
e	Error	Confidence Limit	Confidence Limit	t	P-value
8.6754	3.931	0.8713	16.4794	2.21	0.0297
0.2622	0.2023	-0.1393	0.6638	1.3	0.1979
-6.6393	3.7993	-14.182	0.9033	-1.75	0.0838
1.85	1.1768	-0.4861	4.1862	1.57	0.1192
	Estimat e 1.3568 0.3091 21.9879 -41.8562 16.3034 -97.1977 325.37 Decidu Estimat e 0.9797 0.2912 4.6392 21.0726 -39.2768 15.1878 -105.27 359.09 Shrut Estimat e 8.6754 0.2622 -6.6393 1.85	Forested We Estimat Standard e Error 1.3568 0.4264 0.3091 0.1932 21.9879 13.7418 -41.8562 25.2304 16.3034 9.832 -97.1977 2446.97 325.37 9072.63 Deciduus Forest, For Estimat Standard e Error 0.9797 0.4287 0.2912 0.192 4.6392 2.445 21.0726 14.0422 -39.2768 25.7931 15.1878 10.051 -105.27 5889.25 359.09 21836 Shruby Edge, Fore Estimat Standard e Error 8.6754 3.931 0.2622 0.2023 -6.6393 3.7993 1.85 1.1768	Forested Wetland, Coniferous ForestEstimatStandardLower 95%eErrorConfidence Limit1.35680.42640.51020.30910.1932-0.0743621.987913.7418-5.2931-41.856225.2304-91.944816.30349.832-3.2157-97.19772446.97-4955.05325.379072.63-17686Deciduous Forest, Forested Wetland, ConiferedEstimatStandardLower 95%eErrorConfidence Limit0.97970.42870.12870.29120.192-0.090024.63922.445-0.214721.072614.0422-6.8046-39.276825.7931-90.482615.187810.051-4.7658-105.275889.25-11797359.0921836-42990Shrubby Edge, Forested Wetland, ConiferouEstimat8.67543.9310.87130.26220.2023-0.1393-6.63933.7993-14.1821.851.1768-0.4861	Forested Wetland, Coniferous Forest Estimat Standard Lower 95% Upper 95% e Error Confidence Limit Confidence Limit 1.3568 0.4264 0.5102 2.2034 0.3091 0.1932 -0.07436 0.6926 21.9879 13.7418 -5.2931 49.2689 -41.8562 25.2304 -91.9448 8.2324 16.3034 9.832 -3.2157 35.8224 -97.1977 2446.97 -4955.05 4760.65 325.37 9072.63 -17686 18337 Decidutionary Forest, Forested Wetland, Coniferous Forest Forest Estimat Standard Lower 95% Upper 95% e Error Confidence Limit Confidence Limit 0.9797 0.4287 0.1287 1.8307 0.2912 0.192 -0.09002 0.6725 4.6392 2.445 -0.2147 9.4931 21.0726 14.0422 -6.8046 48.9498 -39.2768<	Forested Wetland, Coniferous Forest Estimat Standard Lower 95% Upper 95% e Error Confidence Limit Confidence Limit <i>t</i> 1.3568 0.4264 0.5102 2.2034 3.18 0.3091 0.1932 -0.07436 0.6926 1.6 21.9879 13.7418 -5.2931 49.2689 1.6 -41.8562 25.2304 -91.9448 8.2324 -1.66 16.3034 9.832 -3.2157 35.8224 1.66 -97.1977 2446.97 -4955.05 4760.65 -0.04 325.37 9072.63 -17686 18337 0.04 325.37 9072.63 -17686 18337 0.04 325.37 9072.63 -17686 18337 0.04 325.37 9072.63 -17686 18337 0.29 0.6714000 Confidence Limit Confidence Limit t 0.9797 0.4287 0.1287 1.8307 2.29 0.2912

Shrubby Edge 200^3	-0.1571	0.1135	-0.3824	0.06813	-1.38	0.1694
Forested Wetland 125	1.2419	4.2355	-7.1666	9.6504	0.29	0.77
Forested Wetland 125^2	-4.0946	6.8202	-17.6345	9.4453	-0.6	0.5497
Forested Wetland 125^3	1.7502	2.4706	-3.1546	6.6549	0.71	0.4804
Coniferous Forest 50	-2.2855	20.5375	-43.0576	38.4867	-0.11	0.9116
Coniferous Forest 25^2	0.3393	58.9504	-116.69	117.37	0.01	0.9954
D	eciduous For	est, Shrubby E	dge, Forested Wetland,	Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	8.4204	3.9271	0.6241	16.2167	2.14	0.0346
Age	0.2387	0.201	-0.1603	0.6377	1.19	0.238
Deciduous Forest 25	6.197	2.9617	0.3174	12.0767	2.09	0.0391
Shrubby Edge 200	-6.8012	3.844	-14.4325	0.8302	-1.77	0.0801
Shrubby Edge 200^2	1.8882	1.1878	-0.47	4.2463	1.59	0.1152
Shrubby Edge 200^3	-0.1618	0.1144	-0.3889	0.06526	-1.41	0.1604
Forested Wetland 125	2.1499	4.1835	-6.1553	10.4552	0.51	0.6085
Forested Wetland 125^2	-4.7582	6.6574	-17.9749	8.4585	-0.71	0.4765
Forested Wetland 125^3	1.9032	2.3915	-2.8446	6.6509	0.8	0.4281
Coniferous Forest 50	0.8119	21.893	-42.6511	44.275	0.04	0.9705
Coniferous Forest 25^2	1.9176	60.8916	-118.97	122.8	0.03	0.9749
	Gra	assland, Foreste	ed Wetland, Coniferous	Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.6187	0.4487	0.7279	2.5094	3.61	0.0005
Age	0.3041	0.1908	-0.07463	0.6829	1.59	0.1142
Grassland 200	-0.2114	0.09716	-0.4043	-0.01852	-2.18	0.032
Forested Wetland 125	22.6182	13.5594	-4.3006	49.5371	1.67	0.0986
Forested Wetland 125^2	-42.1915	24.8731	-91.5708	7.1877	-1.7	0.0931

Forested Wetland 125 ³	16.2475	9.6866	-2.9829	35.478	1.68	0.0968
Coniferous Forest 50	-108.51	6288.55	-12593	12376	-0.02	0.9863
Coniferous Forest 25^2	364	23316	-45925	46652	0.02	0.9876
	Deciudous F	orest, Grasslan	d, Forested Wetland, Co	oniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	1.2972	0.475	0.3541	2.2402	2.73	0.0075
Age	0.2879	0.1911	-0.09151	0.6673	1.51	0.1353
Deciduous Forest 25	3.5273	2.4746	-1.3855	8.44	1.43	0.1573
Grassland 200	-0.1701	0.1006	-0.3699	0.02957	-1.69	0.0941
Forested Wetland 125	21.97	13.9593	-5.7427	49.6828	1.57	0.1188
Forested Wetland 125 ²	-40.4661	25.6383	-91.3645	10.4322	-1.58	0.1178
Forested Wetland 125 ³	15.5242	9.9887	-4.3058	35.3542	1.55	0.1235
Coniferous Forest 50	-105.67	5329.23	-10686	10474	-0.02	0.9842
Coniferous Forest 25^2	356.82	19759	-38870	39584	0.02	0.9856
	Shrubby E	dge, Grassland	, Forested Wetland, Con	iferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	9.8762	4.2452	1.4485	18.3039	2.33	0.0221
Age	0.2486	0.2018	-0.152	0.6493	1.23	0.2209
Shrubby Edge 200	-7.3321	4.0383	-15.3492	0.685	-1.82	0.0726
Shrubby Edge 200^2	2.0162	1.2381	-0.4417	4.4741	1.63	0.1067
Shrubby Edge 200^3	-0.1709	0.1184	-0.4059	0.06412	-1.44	0.1522
Grassland 200	-0.2193	0.1159	-0.4493	0.01068	-1.89	0.0614
Forested Wetland 125	2.5389	4.4666	-6.3285	11.4062	0.57	0.5711
Forested Wetland 125^2	-5.812	7.3126	-20.3293	8.7053	-0.79	0.4287
Forested Wetland 125 ³	2.2593	2.6821	-3.0653	7.5839	0.84	0.4017
Coniferous Forest 50	-1.8687	21.9329	-45.4109	41.6735	-0.09	0.9323

Coniferous Forest 25 ²	1.2863	61.7964	-121.39	123.97	0.02	0.9834
Deciduo	ous Forest, SI	hrubby Edge, C	Grassland, Forested Wetl	land, Coniferous Forest		
	Estimat	Standard	Lower 95%	Upper 95%		
Parameter	e	Error	Confidence Limit	Confidence Limit	t	P-value
Intercept	9.1053	4.0779	1.0096	17.2011	2.23	0.0279
Age	0.2314	0.2003	-0.1662	0.629	1.16	0.2508
Deciduous Forest 25	5.4386	3.0076	-0.5322	11.4093	1.81	0.0737
Shrubby Edge 200	-7.0342	3.9643	-14.9043	0.836	-1.77	0.0792
Shrubby Edge 200^2	1.928	1.2203	-0.4946	4.3507	1.58	0.1174
Shrubby Edge 200^3	-0.1643	0.1171	-0.3968	0.0683	-1.4	0.1641
Grassland 200	-0.1654	0.1166	-0.397	0.06619	-1.42	0.1595
Forested Wetland 125	2.68	4.1899	-5.638	10.9981	0.64	0.5239
Forested Wetland 125^2	-5.4174	6.6484	-18.6162	7.7813	-0.81	0.4172
Forested Wetland 125^3	2.0679	2.3832	-2.6634	6.7993	0.87	0.3877
Coniferous Forest 50	-0.1033	21.9338	-43.6475	43.4409	0	0.9963
Coniferous Forest 25^2	1.8028	60.9141	-119.13	122.73	0.03	0.9765

		Fledgling Day 4	to 8 Survival Models			
		Nı	ıll Model			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.3593	0.7221	2.922	5.7966	6.04	1
		Decie	luous Forest			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.4797	0.7274	2.0319	4.9275	4.78	1
Deciduous Forest 25	8.5152	5.4759	-2.3844	19.4148	1.56	0.1239
		Shr	ubby Edge			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	6.0779	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200	-0.00186	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200 ²	3.547E-07	N/A	N/A	N/A	N/A	1
		Deciduous Fo	orest, Shrubby Edge			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
_			/.	/.	/ .	<.000
Intercept	6.0778	N/A	N/A	N/A	N/A	1
	1.070				NT / A	<.000
Deciduous Forest 25	1.079	N/A	N/A	N/A	N/A	1

						<.000
Shrubby Edge 200	-0.00228	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200^2	4.812E-07	N/A	N/A	N/A	N/A	1
		G	irassland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.9746	0.731	2.5196	5.4295	5.44	1
Grassland 175	2.2597	1.2881	-0.3043	4.8236	1.75	0.0833
Grassland 175^2	-0.7233	0.3338	-1.3877	-0.05892	-2.17	0.0333
		Deciduous	Forest, Grassland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	3.9465	1.1673	1.6232	6.2699	3.38	0.0011
Deciduous Forest 25	0.3593	5.5427	-10.6731	11.3917	0.06	0.9485
Grassland 175	2.269	1.2934	-0.3054	4.8434	1.75	0.0833
Grassland 175^2	-0.7227	0.3363	-1.3921	-0.05325	-2.15	0.0347
		Shrubby	Edge, Grassland			
		Standard	Lower 95%	Upper 95%		P-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.1984	0.000682	4.197	4.1997	6153.71	1
						<.000
Shrubby Edge 200	-0.0007	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200 ²	1.763E-07	N/A	N/A	N/A	N/A	1
~		0.01105		• 400-	• • • • • •	<.000
Grassland 175	2.4762	0.01135	2.4536	2.4987	218.14	1

						<.000
Grassland 175 ²	-0.7458	0.04419	-0.8338	-0.6579	-16.88	1
	Dec	ciduous Forest,	Shrubby Edge, Grasslan	d		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.2093	0.000686	4.208	4.2107	6133.31	1
						<.000
Deciduous Forest 25	0.3362	0.000137	0.3359	0.3365	2450.02	1
	0.0007		27/4		NT / A	<.000
Shrubby Edge 200	-0.0007	N/A	N/A	N/A	N/A	1
Should be Edge 20042	1 7295 07	NT / A	NT/A	NT / A	NT / A	<.000
Shrubby Edge 200-2	1./28E-0/	IN/A	IN/A	1N/A	1N/A	1
Grassland 175	2 5356	0.01120	2 5131	2 5581	224 52	<.000 1
Grassland 175	2.3330	0.01127	2.3131	2.3361	224.32	< 000
Grassland 175^2	-0.7617	0.04401	-0.8493	-0.6741	-17.31	1
		Fores	ted Wetland			
		Standard	Lower 95%	Upper 95%		P-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.6595	0.7038	2.2587	5.0603	5.2	1
Forested Wetland 400	7.2503	5.3831	-3.4644	17.965	1.35	0.1819
Forested Wetland 400 ²	-3.3376	2.6937	-8.6993	2.0241	-1.24	0.219
Forested Wetland 400 [^] 3	0.3706	0.3362	-0.2986	1.0399	1.1	0.2737
		Deciduous For	est, Forested Wetland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	3.8291	N/A	N/A	N/A	N/A	<.000

						1
						<.000
Deciduous Forest 25	2.5017	N/A	N/A	N/A	N/A	1
						<.000
Forested Wetland 400	7.4236	N/A	N/A	N/A	N/A	1
						<.000
Forested Wetland 400 ²	-3.4838	N/A	N/A	N/A	N/A	1
						<.000
Forested Wetland 400 ³	0.3946	N/A	N/A	N/A	N/A	1
		Shrubby Edge	e, Forested Wetland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	6.0274	0.000008287	6.0274	6.0275	727367	1
						<.000
Shrubby Edge 200	-0.00233	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200 ²	4.605E-07	N/A	N/A	N/A	N/A	1
		0.00000	5 7550		50605 0	<.000
Forested Wetland 400	5./561	0.000096	5./559	5.7563	59685.3	1
	1 0 1 0 2	0.000661	1.0207	1.010	2004 5	<.000
Forested wetland 400 ²	-1.9193	0.000661	-1.9206	-1.918	-2904.5	1
Ecrected Watland 400A2	0 1522	0.004605	0 1/21	0 1614	22.06	<.000
Folested wettallu 400.5	0.1322	0.004003	0.1431	0.1014	55.00	1
	Decidi	Lous Forest, Shru	Lage, Forested We			
D		Standard	Lower 95%	Upper 95%	4	r -
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	ľ	
T ()	C 00 48	0.000025	C 00 10	C 0240	045000	<.000
Intercept	6.0248	0.000025	6.0248	6.0249	245250	1

						<.000
Deciduous Forest 25	1.1745	N/A	N/A	N/A	N/A	1
		/ .			/ .	<.000
Shrubby Edge 200	-0.00242	N/A	N/A	N/A	N/A	1
Sharbha Edae 20042	4 7595 07	NT / A	NT/A	NT / A	NT / A	<.000
Shrubby Edge 200^2	4./38E-0/	IN/A	IN/A	N/A	N/A	1
Forested Wetland 400	5 6982	0.000254	5 6977	5 6987	22461.2	<.000 1
Torested wethind 100	5.0702	0.000251	5.0711	5.0707	22101.2	<.000
Forested Wetland 400 ²	-2.1209	0.001348	-2.1236	-2.1182	-1573.4	1
						<.000
Forested Wetland 400^3	0.1862	0.007372	0.1715	0.2009	25.26	1
		Grassland,	Forested Wetland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	4.0726	1.0532	1.9762	6.1689	3.87	0.0002
Grassland 175	1.9236	1.412	-0.887	4.7341	1.36	0.177
Grassland 175^2	-0.6428	0.3612	-1.3618	0.07611	-1.78	0.079
Forested Wetland 400	1.3991	2.4536	-3.4846	6.2828	0.57	0.5701
Forested Wetland 400 ²	-0.8858	1.445	-3.762	1.9904	-0.61	0.5416
Forested Wetland 400 ³	0.11	0.2064	-0.3009	0.5208	0.53	0.5957
	Decie	duous Forest, G	rassland, Forested Wetla	and		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	4.2524	1.4916	1.2834	7.2215	2.85	0.0056
Deciduous Forest 25	0.3456	7.7601	-15.1005	15.7917	0.04	0.9646
Grassland 175	1.9286	1.7954	-1.6451	5.5023	1.07	0.286
Grassland 175^2	-0.7014	0.5165	-1.7295	0.3268	-1.36	0.1784

Forested Wetland 400	1.4917	1.7319	-1.9556	4.939	0.86	0.3917
Forested Wetland 400 ²	-0.6348	0.7896	-2.2066	0.9369	-0.8	0.4238
Forested Wetland 400 ³	0.05929	0.09133	-0.1225	0.2411	0.65	0.5181
	Shr	ubby Edge, Gra	assland, Forested Wetlar	nd		
		Standard	Lower 95%	Upper 95%		P-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.318	0.000392	4.3172	4.3188	11004.6	1
			/.		/ .	<.000
Shrubby Edge 200	-0.00089	N/A	N/A	N/A	N/A	1
	2 0025 07				NT / A	<.000
Shrubby Edge 200^2	2.092E-07	N/A	N/A	N/A	IN/A	1
Greedend 175	2 2090	0.011/1	2 2760	2 1216	207 99	<.000
Grassfand 175	5.5909	0.01141	5.5702	3.4210	291.00	1
Grassland 175^2	-1 0002	0.04532	-1 0904	-0.91	-22 07	<.000 1
Grusshund 175 2	1.0002	0.01352	1.0701	0.91	22.07	< .000
Forested Wetland 400	2.7757	0.000294	2.7751	2.7762	9433.86	1
					,	<.000
Forested Wetland 400 ²	-1.0626	0.001086	-1.0647	-1.0604	-978.68	1
						<.000
Forested Wetland 400 ³	0.08698	0.005682	0.07567	0.09829	15.31	1
	Deciduous F	orest, Shrubby I	Edge, Grassland, Foreste	ed Wetland		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.3125	0.000435	4.3116	4.3134	9903.76	1
						<.000
Deciduous Forest 25	0.3399	0.000173	0.3395	0.3402	1966.9	1

						<.000
Shrubby Edge 200	-0.00093	N/A	N/A	N/A	N/A	1
~						<.000
Shrubby Edge 200^2	2.091E-07	N/A	N/A	N/A	N/A	1
Creaseland 175	2 2022	0.0112	2 2700	2 1155	202.0	<.000
Grassland 175	3.3932	0.0112	5.5709	5.4155	302.9	1 < 000
Grassland 175^2	-0 9849	0 04454	-1 0735	-0 8962	-22.11	<.000 1
Grubblund 175 Z	0.9019	0.01151	1.0755	0.0702	22.11	<.000
Forested Wetland 400	2.684	0.000711	2.6826	2.6854	3776.83	1
						<.000
Forested Wetland 400 ²	-1.3777	0.00271	-1.3831	-1.3723	-508.47	1
						<.000
Forested Wetland 400 ³	0.1484	0.01167	0.1252	0.1717	12.72	1
		Wetlar	nd Shruhland			
		wettai	ia Sili dolalia			
		Standard	Lower 95%	Upper 95%		P-
Parameter	Estimate	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	t	P- value
Parameter	Estimate	Standard Error	Lower 95% Confidence Limit	Upper 95% Confidence Limit	t	P- value <.000
Parameter Intercept	Estimate 4.0786	Standard Error 0.7166	Lower 95% Confidence Limit 2.6523	Upper 95% Confidence Limit 5.5048	<i>t</i> 5.69	P- value <.000 1
Parameter Intercept Wetland Shrubland	Estimate 4.0786 1.7259	Standard Error 0.7166 1.1319	Lower 95% Confidence Limit 2.6523 -0.5271	Upper 95% Confidence Limit 5.5048 3.979	<i>t</i> 5.69 1.52	P- value <.000 1 0.1313
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2	Estimate 4.0786 1.7259 -0.6663	Standard Error 0.7166 1.1319 0.3534	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698	Upper 95% Confidence Limit 5.5048 3.979 0.03719	<i>t</i> 5.69 1.52 -1.89	P- value <.000 1 0.1313 0.0631
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3	Estimate 4.0786 1.7259 -0.6663 0.05411	Standard Error 0.7166 1.1319 0.3534 0.02792	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097	<i>t</i> 5.69 1.52 -1.89 1.94	P- value <.000 1 0.1313 0.0631 0.0562
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3	Estimate 4.0786 1.7259 -0.6663 0.05411	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Forest	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097	<i>t</i> 5.69 1.52 -1.89 1.94	P- value <.000 1 0.1313 0.0631 0.0562
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3	Estimate 4.0786 1.7259 -0.6663 0.05411	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Fores Standard	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland Lower 95%	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097 Upper 95%	<i>t</i> 5.69 1.52 -1.89 1.94	P- value <.000 1 0.1313 0.0631 0.0562 P-
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3 Parameter	Estimate 4.0786 1.7259 -0.6663 0.05411	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Fores Standard Error	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland Lower 95% Confidence Limit	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097 Upper 95% Confidence Limit	t 5.69 1.52 -1.89 1.94 t	P- value <.000 1 0.1313 0.0631 0.0562 P- value
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3	Estimate 4.0786 1.7259 -0.6663 0.05411	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Fore Standard Error	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland Lower 95% Confidence Limit	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097 Upper 95% Confidence Limit	t 5.69 1.52 -1.89 1.94 t	P- value <.000 1 0.1313 0.0631 0.0562 P- value <.000
Parameter Intercept Wetland Shrubland Wetland Shrubland 300^2 Wetland Shrubland 300^3 Parameter Intercept	Estimate 4.0786 1.7259 -0.6663 0.05411 Estimate 4.0017	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Fore: Standard Error 0.9741	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland Lower 95% Confidence Limit 2.0629	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097 Upper 95% Confidence Limit 5.9405	t 5.69 1.52 -1.89 1.94 t 4.11	P- value <.000
ParameterInterceptWetland ShrublandWetland Shrubland 300^2Wetland Shrubland 300^3ParameterInterceptDeciduous Forest 25	Estimate 4.0786 1.7259 -0.6663 0.05411 I Estimate 4.0017 0.68	Standard Error 0.7166 1.1319 0.3534 0.02792 Deciduous Fores Standard Error 0.9741 4.2225	Lower 95% Confidence Limit 2.6523 -0.5271 -1.3698 -0.00146 st, Wetland Shrubland Lower 95% Confidence Limit 2.0629 -7.7247	Upper 95% Confidence Limit 5.5048 3.979 0.03719 0.1097 Upper 95% Confidence Limit 5.9405 9.0848	t 5.69 1.52 -1.89 1.94 t 4.11 0.16	P- value <.000

Wetland Shrubland 300^2	-0.6597	0.3742	-1.4044	0.08509	-1.76	0.0818
Wetland Shrubland 300 ³	0.05439	0.02976	-0.00486	0.1136	1.83	0.0714
		Shrubby Edge	, Wetland Shrubland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.2178	0.001819	4.2142	4.2214	2318.87	1
						<.000
Shrubby Edge 200	-0.00077	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200^2	2.192E-07	N/A	N/A	N/A	N/A	1
						<.000
Wetland Shrubland	1.6796	0.02215	1.6355	1.7237	75.83	1
						<.000
Wetland Shrubland 300 ²	-0.593	0.07402	-0.7403	-0.4457	-8.01	1
	0.045.61	0.01050	0.00464	0.04450	4.00	<.000
Wetland Shrubland 300 [×] 3	0.04561	0.01053	0.02464	0.06658	4.33	l
	Deciduo	ous Forest, Shru	bby Edge, Wetland Shru	ıbland		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.2177	0.001456	4.2148	4.2206	2896.36	1
						<.000
Deciduous Forest 25	0.4524	0.00002	0.4524	0.4524	23154.6	1
						<.000
Shrubby Edge 200	-0.00095	N/A	N/A	N/A	N/A	1
			NT / 1			<.000
Shrubby Edge 200 ²	2.745E-07	N/A	N/A	N/A	N/A	1
Wetland Shrubland	1.6789	0.01943	1.6402	1.7176	86.4	<.000

						1
						<.000
Wetland Shrubland 300^2	-0.5959	0.06656	-0.7284	-0.4634	-8.95	1
						<.000
Wetland Shrubland 300^3	0.0454	0.009339	0.02681	0.06399	4.86	1
		Grassland, V	Wetland Shrubland			
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	4.136	1.0484	2.0491	6.2229	3.94	0.0002
Grassland 175	1.5116	1.2758	-1.0278	4.0509	1.18	0.2396
Grassland 175 ²	-0.4924	0.3364	-1.162	0.1772	-1.46	0.1472
Wetland Shrubland	1.0147	1.191	-1.3558	3.3853	0.85	0.3968
Wetland Shrubland 300^2	-0.4048	0.3988	-1.1986	0.389	-1.01	0.3132
Wetland Shrubland 300^3	0.03408	0.03378	-0.03316	0.1013	1.01	0.3161
	Decid	uous Forest, Gr	assland, Wetland Shrubl	and		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	4.1366	1.8034	0.547	7.7263	2.29	0.0245
Deciduous Forest 25	0.3772	6.3872	-12.3363	13.0906	0.06	0.9531
Grassland 175	1.5249	1.3058	-1.0743	4.124	1.17	0.2464
Grassland 175 ²	-0.4766	0.3358	-1.145	0.1918	-1.42	0.1598
Wetland Shrubland	1.0221	1.2049	-1.3763	3.4204	0.85	0.3989
Wetland Shrubland 300^2	-0.3932	0.3789	-1.1474	0.361	-1.04	0.3026
Wetland Shrubland 300^3	0.03125	0.02998	-0.02841	0.09092	1.04	0.3003
	Shru	ıbby Edge, Gras	ssland, Wetland Shrublan	nd		
		Standard	Lower 95%	Upper 95%		P-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
τ., ,	4.0500	0.000 - <0	4.0577	10007	5000 0 4	000

						1
						<.000
Shrubby Edge 200	-0.00097	N/A	N/A	N/A	N/A	1
G1 11 E1 20042	0 (005 07					<.000
Shrubby Edge 200 ²	2.692E-07	N/A	N/A	N/A	N/A	1
Grassland 175	2 6293	0.0102	2 609	2 6496	257 87	<.000
Grassfand 175	2.0275	0.0102	2.007	2.0470	257.07	<.000
Grassland 175^2	-0.6679	0.04081	-0.7492	-0.5867	-16.37	1
						<.000
Wetland Shrubland	1.3928	0.007161	1.3786	1.4071	194.51	1
			0	0.50.40		<.000
Wetland Shrubland 300 ²	-0.5732	0.02431	-0.6216	-0.5248	-23.58	1
Wetland Shrubland 300^3	0.0464	0.004983	0.03648	0.05632	9.31	<.000 1
	Deciduous Fo	rest, Shrubby E	Edge, Grassland, Wetland	d Shrubland		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.0589	0.00057	4.0578	4.06	7121.37	1
	0.2512	0.000116	0.251	0.2514	2020 41	<.000
Deciduous Forest 25	0.3512	0.000116	0.351	0.3514	3028.41	1 < 000
Shrubby Edge 200	-0.00101	N/Δ	N/Δ	N/Δ	N/Δ	<.000
Shiubby Luge 200	-0.00101	11/11	11/11	14/24	14/71	<.000
Shrubby Edge 200^2	2.824E-07	N/A	N/A	N/A	N/A	1
						<.000
Grassland 175	2.6287	0.009041	2.6107	2.6467	290.76	1
						<.000
Grassland 175 ²	-0.6692	0.03581	-0.7405	-0.5979	-18.69	1

						<.000
Wetland Shrubland	1.3978	0.006712	1.3844	1.4111	208.24	1
						<.000
Wetland Shrubland 300^2	-0.5526	0.02361	-0.5996	-0.5056	-23.41	1
						<.000
Wetland Shrubland 300 ³	0.04305	0.00434	0.03441	0.05168	9.92	1
Forested Wetland, Wetland Shrubland						
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	4.027	0.8285	2.3779	5.676	4.86	1
Forested Wetland 400	1.859	2.2443	-2.6083	6.3262	0.83	0.41
Forested Wetland 400 ²	-0.7629	1.2265	-3.2042	1.6784	-0.62	0.5357
Forested Wetland 400 ³	0.08236	0.169	-0.2539	0.4186	0.49	0.6273
Wetland Shrubland	1.3736	1.249	-1.1125	3.8596	1.1	0.2748
Wetland Shrubland 300^2	-0.61	0.4003	-1.4069	0.1868	-1.52	0.1315
Wetland Shrubland 300^3	0.0524	0.03222	-0.01174	0.1165	1.63	0.1079
Deciduous Forest, Forested Wetland, Wetland Shrubland						
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
Intercept	4.1023	1.1279	1.8573	6.3473	3.64	0.0005
Deciduous Forest 25	0.6308	5.564	-10.444	11.7056	0.11	0.91
Forested Wetland 400	1.8357	2.2859	-2.7142	6.3857	0.8	0.4243
Forested Wetland 400 ²	-0.6373	0.9067	-2.442	1.1674	-0.7	0.4842
Forested Wetland 400 [^] 3	0.0557	0.0882	-0.1199	0.2313	0.63	0.5295
Wetland Shrubland	1.3754	1.4169	-1.445	4.1957	0.97	0.3347
Wetland Shrubland 300^2	-0.5651	0.4363	-1.4336	0.3034	-1.3	0.1991
Wetland Shrubland 300^3	0.04662	0.03371	-0.02048	0.1137	1.38	0.1706
	Shrubby	Edge, Forester	d Wetland, Wetland Shru	ubland		
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		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.7176	0.000601	3.7164	3.7188	6181.1	1
						<.000
Shrubby Edge 200	-0.00071	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200^2	2.548E-07	N/A	N/A	N/A	N/A	1
						<.000
Forested Wetland 400	1.7533	0.002481	1.7483	1.7582	706.63	1
	0.4500	0.00500	0.4040	0.4600	7 0.04	<.000
Forested Wetland 400 ²	-0.4729	0.00599	-0.4848	-0.4609	-/8.94	1
	0.02296	0.005404	0.0221	0.04461	<i>с</i> о <i>с</i>	<.000
Forested Wetland 400 ³	0.03386	0.005404	0.0231	0.04461	6.26	1
Watland Chaphland	0.0112	0.01965	0.0741	0.0494	10.05	<.000
wettand Shrubland	0.9115	0.01803	0.8741	0.9464	48.83	1
Wetland Shruhland 300^2	-0.4162	0.06/18	-0 5/139	-0.2885	-6 49	<.000
Wetland Shrubland 300^3	-0.4102	0.00410	-0.3+37	-0.2005	-0.+)	0.0002
	0.03443	Shrubby Edge	Ecrected Watland Wa	tland Shruhland	5.71	0.0002
De	ciduous roiest	, Shiubby Euge	L ower 05%	Linnor 05%		D
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	ı - vəlue
Turumeter	Lotinute	LIIOI	Communee Emme	Connuclice Linit	l	< 000
Intercept	3 7193	0.001082	3 7171	3 7214	3438 37	1
mercept	5.7175	0.001002	5.7171	5.7211	5150.57	<.000
Deciduous Forest 25	0.3355	0.000057	0.3354	0.3356	5902.38	1
	0.0000	5.000027	0.000	0.0000	2702.00	<.000
Shrubby Edge 200	-0.0005	N/A	N/A	N/A	N/A	1

		Standard		epper >e /v		-
		Standard	Lower 95%	Upper 95%		Р-
	Deciduous Fore	est, Grassland, H	Forested Wetland, Wetla	nd Shrubland		
Wetland Shrubland 300 ³	0.03542	0.03893	-0.04207	0.1129	0.91	0.3657
Wetland Shrubland 300 ²	-0.4011	0.4697	-1.336	0.5339	-0.85	0.3958
Wetland Shrubland	0.8372	1.3952	-1.94	3.6143	0.6	0.5502
Forested Wetland 400 [^] 3	0.04337	0.09109	-0.1379	0.2247	0.48	0.6353
Forested Wetland 400^2	-0.4771	0.9207	-2.3097	1.3556	-0.52	0.6058
Forested Wetland 400	1.2325	2.1798	-3.1062	5.5712	0.57	0.5734
Grassland 175^2	-0.4114	0.3286	-1.0656	0.2427	-1.25	0.2143
Grassland 175	1.3879	1.2674	-1.1347	3.9105	1.1	0.2768
Intercept	4.0616	1.1343	1.8038	6.3195	3.58	0.0006
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
	C14001	Standard	Lower 95%	Upper 95%		Р-
ri ettaila Sili astalla 500 5	Grassl	and. Forested V	Vetland. Wetland Shrub	land	5.71	0.0002
Wetland Shrubland 300^3	0.03818	0.009774	0.01872	0.05763	3.91	0.0002
Wetland Shrubland 300^2	-0.4415	0.06976	-0.5803	-0.3027	-6.33	<.000 1
Wetland Shrubland	0.9094	0.02126	0.867	0.9517	42.78	1 < 000
W (1 101 11 1	0.0004	0.00106	0.067	0.0517	40.70	<.000
Forested Wetland 400 ³	0.02343	0.00472	0.01403	0.03282	4.96	1
						<.000
Forested Wetland 400 ²	-0.4088	0.004767	-0.4183	-0.3993	-85.75	1
Polesieu wenand 400	1.7802	0.002033	1.7701	1.7645	800.22	< 000
Forested Watland 400	1 7802	0.002055	1 7761	1 78/2	866 22	<.000
Shrubby Edge 200^2	1.766E-07	N/A	N/A	N/A	N/A	1
						<.000

Intercept	4.2415	1.833	0.593	7.8899	2.31	0.0233
Deciduous Forest 25	0.3767	6.6152	-12.7906	13.544	0.06	0.9547
Grassland 175	1.4121	1.4314	-1.437	4.2611	0.99	0.3269
Grassland 175^2	-0.4047	0.373	-1.1472	0.3377	-1.09	0.2812
Forested Wetland 400	1.2388	2.6582	-4.0522	6.5297	0.47	0.6425
Forested Wetland 400 ²	-0.4374	1.1519	-2.7301	1.8554	-0.38	0.7052
Forested Wetland 400 ³	0.03817	0.1156	-0.192	0.2683	0.33	0.7421
Wetland Shrubland	0.8979	1.4348	-1.9579	3.7537	0.63	0.5332
Wetland Shrubland 300^2	-0.3985	0.4552	-1.3046	0.5076	-0.88	0.384
Wetland Shrubland 300^3	0.03258	0.03553	-0.03814	0.1033	0.92	0.3619
	Shrubby Edge	e, Grassland, Fo	rested Wetland, Wetland	d Shrubland		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.6849	0.000416	3.6841	3.6857	8855	1
	0.00070		NT / A		NT / A	<.000
Shrubby Edge 200	-0.00072	N/A	N/A	N/A	N/A	1
Shrubby Edge 200^2	$2.415E_{-}07$	N/A	N/A	N/A	N/A	<.000 1
Shirubby Edge 200-2	2.41512-07	\mathbf{N}/\mathbf{A}	1N/PX	IN/A	1N/A	< 000
Grassland 175	1.9857	0.008467	1.9689	2.0026	234.54	<.000 1
	1,, 00,	0.000.07	10,000	210020	20 110 1	<.000
Grassland 175^2	-0.4917	0.03353	-0.5584	-0.425	-14.66	1
						<.000
Forested Wetland 400	1.7183	0.000816	1.7167	1.7199	2105.96	1
						<.000
Forested Wetland 400 ²	-0.3529	0.003748	-0.3603	-0.3454	-94.15	1
Forested Wetland 400 [^] 3	0.01406	0.003643	0.006804	0.02131	3.86	0.0002
Wetland Shrubland	0.8608	0.007115	0.8467	0.875	120.98	<.000

						1
Wetland Shrubland 300^2	-0.4162	0.02557	-0.4671	-0.3653	-16.28	<.000 1
Wetland Shrubland 300^3	0.03423	0.004293	0.02568	0.04277	7.97	<.000 1
Decidue	ous Forest. Shru	ubby Edge, Gras	ssland. Forested Wetland	d. Wetland Shrubland		
		Standard	Lower 95%	Upper 95%		Р-
Parameter	Estimate	Error	Confidence Limit	Confidence Limit	t	value
						<.000
Intercept	3.6687	0.000534	3.6676	3.6698	6870.13	1
Ĩ						<.000
Deciduous Forest 25	0.2978	0.000116	0.2976	0.298	2563.74	1
						<.000
Shrubby Edge 200	-0.0006	N/A	N/A	N/A	N/A	1
						<.000
Shrubby Edge 200^2	2.024E-07	N/A	N/A	N/A	N/A	1
						<.000
Grassland 175	1.9392	0.009721	1.9199	1.9586	199.49	1
						<.000
Grassland 175 ²	-0.5188	0.03921	-0.5969	-0.4408	-13.23	1
	1 101	0.00115	1 4505	1 4024	10.00 10	<.000
Forested Wetland 400	1.481	0.00117	1.4787	1.4834	1265.46	1
	1.0204	0.004641	1.0207	1 0111	210.96	<.000
Forested wettand 400 ²	-1.0204	0.004641	-1.0290	-1.0111	-219.80	1
Forested Wetland 40042	0.16	0.01055	0 121	0 1080	8 18	<.000
Polested wettallu 400°5	0.10	0.01755	0.121	0.1707	0.10	ı 2000 -
Wetland Shrubland	0 8395	0.006873	0.8258	0.8531	122 13	<.000
Wedning Shi ubland	0.0575	0.000075	0.0250	0.0551	122.13	< 000
Wetland Shrubland 300^2	-0.3797	0.02435	-0.4282	-0.3313	-15.59	1
Wetland Shrubland 300^2	-0.3797	0.02435	-0.4282	-0.3313	-15.59	<

						<.000
Wetland Shrubland 300 ³	0.03135	0.004662	0.02207	0.04063	6.73	1

Appendix C. Instructions and code for implementing spatially explicit models of fullseason productivity in ARC GIS 10.1.

Estimating Full-Season Productivity on a Landscape

Step 1: Variable Selection

Determine Landscape Variables to be used for logistic exposure.

Note: If Linear variables are selected, analyses must be performed in ARC GIS 10.1

Example:

Variables selected for Golden-winged Warbler Full-Season Productivity modeling:

-Deciduous Forest (Area) -Grassland (Area) -Upland Shrubland (Area) -Wetland Shrubland (Area) -Forested Wetland (Area) -Coniferous Forest (Area) -Shrubby Edge (Linear)

Step 2: Scale Selection

Determine the scales at which Landscape Variables will be investigated.

Example:

Scales selected for Golden-winged Warbler Full-Season Productivity modeling:
-Nest success and fledgling survival from days 1 – 3: 25 – 200 m (25 m increments)
-Fledgling survival from days 4 – 8: 25 – 200 m (25 m increments) and 300 – 500 m (100 m increments)

Step 3: Calculation of Landscape Variables for Nest Locations

Input:

-Landscape -Nest Locations

Output:

-Values for each covariate for each nest.

Process:

1) Delineate all cover types in ARC GIS.

2) Merge all individual cover type shape files into ONE shape file.

-Note: If you're using a linear variable (e.g., Shrubby Edges for Golden-winged Warblers):

-Data Management -> Features -> Polygon to Line to create shrubby edge buffer.

-Delete line segments that border same cover types or would be inappropriate for the type of edge you are using.

-**Example:** to delineate Shrubby Edges for Golden-winged Warblers, I deleted all edges that did not qualify as shrubby (so, if the edge was between grassland and road, I deleted it)

3) Buffer the nest points at the appropriate scales (Geoprocessing -> Buffer)
4) Intersect Buffers with Cover Type Shape File (Analysis -> Overlay -> Intersect)

5) Export data from Intersected Buffers (Right-click Layer, "Open Attribute Table"; In attribute table, Menu -> Export...)

6) Use exported data to create a table with a value for each landscape variable at each scale

7) Calculate exponential values for variables that may be non-linear (e.g., quadratic or quartic)

Example Table Segment (values in ha):

Nest ID	Forest	Forest	Forest	Forest	Forest	Forest
	25m	$25m^2$	$25m^3$	50m	$50m^2$	$50m^3$
1	0.06545	0.00428	0.00028	0.2618	0.06854	0.01784
2	0.15708	0.02467	0.00388	0.62832	0.39478	0.24805

Step 4: Determine Scale of Variables in SAS

Input:

-Landcape Values for each nest at each scale measured for each survival period -Nest survival and fledgling survival for each nest

Output:

-List of informative Landscape Variables and scale (Impact Radius) and linear relationship for each Landscape Variable

Process:

1) In SAS, create a logistic exposure model for each landscape variable scale and linear relationship combination

2) In SAS, create a "Null" logistic exposure model using no landscape variables3) Rank all models using AICc

4) Record the top-ranked model for each landscape variable with a Scale/Linear Relationship model ranked higher than the Null Model

5) Discard all landscape variables with all models ranked below the Null Model as non-informative

6) Repeat this process for each survival period

Step 5: Create Landscape Variable Combinations

Input:

-Selected Landscape Variables

Output:

-Unique value assigned to each combination of Landscape Variables for each survival period (Nest success, fledgling survival days 1 - 3, and fledgling survival days 4 - 8).

Example:

-Landscape Variable Combinations for Golden-winged Warbler Nest Success were as follows:

			Shrubby	Forested	Coniferous
Combination	Edge	Grassland	Wetland	Wetland	Forest
Null (0)					
1					
2		\checkmark			
3	\checkmark	\checkmark			
4			\checkmark		
5	\checkmark		\checkmark		
6		\checkmark			
7		\checkmark			
8					
9					
10		\checkmark			
11	\checkmark	\checkmark		\checkmark	
12					
13	\checkmark		\checkmark	\checkmark	
14		\checkmark	\checkmark		
15	\checkmark	\checkmark	\checkmark	\checkmark	
16					\checkmark
17	\checkmark				\checkmark
18		\checkmark			\checkmark

19 √				\checkmark	
20		\checkmark			
21 √		\checkmark			
22	\checkmark	\checkmark			
23 √	\checkmark	\checkmark			
24					
25 √					
26	\checkmark				
27 √			\checkmark		
28		\checkmark	\checkmark		
29 √		\checkmark			
30		\checkmark	\checkmark		
31 √		\checkmark		\checkmark	

Step 6: Create Logistic Exposure Models in SAS

Input:

-Landcape Values for each nest

- -Nest survival and fledgling survival for each nest
- -List of Landscape Variable Combinations

Output:

-Logistic Exposure models with β coefficients for each Landscape Variable.

Process:

 For each Landscape Combination, implement a logistic exposure model using the Landscape Variables included in that Landscape Variable Composition.
 Record Coefficients for each Landscape Variable Composition.

Step 7: Create Raster Layers for Landscape Variables

*****NOTE: LINEAR CALCULATIONS REQUIRE ARCGIS 10.1*****

Input:

-Cover type layers

Output:

-Raster values indicating the area or linear length of edge around each pixel for each Impact Radius

Process:

For area calculations:

 Convert Cover Type Polygon to Raster (Conversion -> Polygon to Raster [on Cover Type Layer, Cell Size = 1m])
 Reclassify cover type (Spatial Analyst Tools -> Reclass -> Reclassify [Set values of desired cover types to 1, others to 0, set "Null Value" to 0])
 Calculate landscape area values for each pixel (Spatial Analyst -> Neighborhood -> Focal Statistics [Set Neighborhood to "Circle" and "Cells" to the impact radius for that landscape variable, statistic type to "Sum", cell size to 1m])
 Repeat steps 2 - 3 for each landscape variable

For linear calculations:

1) Calculate linear edge values for each pixel (Spatial Analyst -> Neighborhood -> Focal Statistics [Set Neighborhood to "Circle" and "Cells" to the impact radius for that landscape variable, Statistic type to "Length", "Field" to "None", Cell size to 1m])

2) Repeat step 1 for each linear variable

Step 8: Create Landscape Composition Layer

Input:

-Landscape Variable Raster Layers (Step 7 output)

Output:

-Raster Layer identifying Landscape Composition for each individual pixel

Process:

Using the assigned Landscape Composition Values for each Landscape composition (Step 5 output), I used the following code for Golden-winged Warbler nest success:

-In Raster Calculator (Spatial Analyst -> Map Algebra -> Raster Calculator), input:

 $Con(Grassland_{200m} > 0,$ Con(Edge_50m > 0, 19, 18), $Con(Edge_50m > 0, 17, 16)))),$ Con(Forested Wetland 175m > 0, $Con(Shrubby_Wetland_200m > 0,$ Con(Grassland 200m > 0,Con(Edge_50m > 0, 15, 14), $Con(Edge_50m > 0, 13, 12)),$ $Con(Grassland_{200m} > 0.$ $Con(Edge_{50m} > 0, 11, 10),$ $Con(Edge_{50m} > 0, 9, 8))),$ Con(Shrubby Wetland 200m > 0, $Con(Grassland_{200m} > 0,$ Con(Edge 50m > 0, 7, 6), $Con(Edge_50m > 0, 5, 4)),$ Con(Grassland 200m > 0, $Con(Edge_{50m} > 0, 3, 2),$ $Con(Edge_{50m} > 0, 1, 0)))))$

Step 9: Assign Coefficients to the landscape

Input:

-Logistic exposure coefficients (Step 6 output) -Landscape Composition layer (Step 8 output)

Output:

-A layer for each beta coefficient with the value assigned by SAS set to the appropriate landscape composition value.

Process:

Using the assigned Landscape Composition Values for each Landscape composition (Step 5 output), I used the following code for the intercept coefficient for Golden-winged Warbler nest success:

-In Raster Calculator (Spatial Analyst -> Map Algebra -> Raster Calculator), input:

Con(Landscape_Composition == 1, 4.3456, Con(Landscape_Composition == 2, 4.1488, Con(Landscape_Composition == 3, 4.2153, Con(Landscape_Composition == 4, 4.274, Con(Landscape_Composition == 5, 4.491, Con(Landscape_Composition == 6, 4.2448, Con(Landscape_Composition == 7, 4.3659, Con(Landscape_Composition == 8, 4.1703, Con(Landscape_Composition == 9, 4.3375,

Con(Landscape_Composition == 10, 4.1399,
Con(Landscape_Composition == 11, 4.2082,
Con(Landscape_Composition == 12, 4.2875,
$Con(Landscape_Composition == 13, 4.5274,$
Con(Landscape_Composition == 14, 4.2483,
$Con(Landscape_Composition == 15, 4.3947,$
Con(Landscape_Composition == 16, 4.1691,
Con(Landscape_Composition == 17, 4.3478,
Con(Landscape_Composition == 18, 4.1363,
Con(Landscape_Composition == 19, 4.2063,
Con(Landscape_Composition == 20, 4.2634,
Con(Landscape_Composition == 21, 4.4859,
Con(Landscape_Composition == 22, 4.2308,
Con(Landscape_Composition == 23, 4.3532,
Con(Landscape_Composition == 24, 4.1629,
Con(Landscape_Composition == 25, 4.3402,
Con(Landscape_Composition == 26, 4.1272,
Con(Landscape_Composition == 27, 4.1994,
Con(Landscape_Composition == 28, 4.2771,
Con(Landscape_Composition == 29, 4.5237,
Con(Landscape_Composition == 30, 4.2344,
Con(Landscape_Composition == 31, 4.3835,
4.1765))))))))))))))))))))))))))))))))))))

Note: The last value is the value assigned to the Null model (in which none of the selected landscape variables were present at the correct impact radius)

Step 10: Estimation of survival

Input:

-Logistic Exposure coefficient layers (Step 9) -Landscape Value raster layers (Step 7)

Output:

-Raster layer estimating survival for every pixel on the landscape

Process:

For the first day of Golden-winged Warbler nest success, I used the following code (converting m^2 to ha and m to km):

-In Raster Calculator (Spatial Analyst -> Map Algebra -> Raster Calculator), input:

 $\begin{array}{l} 1000)) + (b4*(Grassland_{200m} / 10000)) + (b5*(Grassland_{200m} / 10000)*\\ (Grassland_{200m} / 10000)) + (b6*(Shrubby_Wetland_{200m} / 10000)) + (b7*\\ (Forested_Wetland_{175m} / 10000)) + (b8"*(Coniferous_Forest_{50m} / 10000))) / (1 + \\ Exp(a + (b*1) + (b1*(Edge_{50m} / 1000)) + (b2*(Edge_{50m} / 1000))*(Edge_{50m} / 1000)) + (b3*(Edge_{50m} / 1000)) + (b2*(Edge_{50m} / 1000)) + (b4*(Grassland_{200m} / 10000)) + (b5*(Grassland_{200m} / 10000)) + (b4*(Grassland_{200m} / 10000)) + (b5*(Grassland_{200m} / 10000)) * (Grassland_{200m} / 10000)) + (b6*(Shrubby_Wetland_{200m} / 10000)) + (b7*(Forested_Wetland_{175m} / 10000)) + (b8*(Coniferous_Forest_{50m} / 10000)))) \\ \end{array}$

Note: For each additional day, add a copy of this code and update the Age value (b0 * N) to the appropriate age.

-Repeat this process for each Survival Period.

Step 11: Estimating Productivity

Input:

-Survival estimates for each Survival Period (Step 10) -Number of fledglings produced per nest -Renesting rate for failed nests

Output:

-Raster layer estimating the number of fledglings produced for a nesting attempt at each pixel.

Process:

For Golden-winged Warbler productivity with an estimate of 4 fledglings per nest and one renest attempt for failed nests, I used the following code: -In Raster Calculator (Spatial Analyst -> Map Algebra -> Raster Calculator), input:

(("Nest_Survival" * (1 - "Nest_Survival")) * 4) * "Fledgling_Early_Survival" * "Fledgling_Late_Survival"

The following is the complete ARC GIS code for a site in Manitoba:

Nest Success

Con("mb_gr200" > 0, Con("mb e50" > 0, 27, 26), $Con("mb_e50" > 0, 25, 24))),$ Con("mb sw200" > 0,Con("mb_gr200" > 0, Con("mb e50" > 0, 23, 22), $Con("mb_e50" > 0, 21, 20)),$ $Con("mb_gr200" > 0,$ Con("mb_e50" > 0, 19, 18), $Con("mb_e50" > 0, 17, 16)))),$ Con("mb_fw175" > 0, Con("mb sw200" > 0, $Con("mb_gr200" > 0,$ $Con("mb_e50" > 0, 15, 14),$ $Con("mb_e50" > 0, 13, 12)),$ Con("mb gr200" > 0, $Con("mb_e50" > 0, 11, 10),$ $Con("mb_e50" > 0, 9, 8))),$ Con("mb_sw200" > 0, $Con("mb_gr200" > 0,$ Con("mb e50" > 0, 7, 6), $Con("mb_e50" > 0, 5, 4)),$ $Con("mb_gr200" > 0,$ Con("mb e50" > 0, 3, 2), $Con("mb_e50" > 0, 1, 0)))))$

a

 $Con("mb1_lc" == 1, 4.3456)$, $Con("mb1 \ lc" == 2, 4.1488$ $, Con("mb1_lc" == 3, 4.2153)$, Con("mb1_lc" == 4, 4.274 , Con("mb1_lc" == 5, 4.491 , $Con("mb1_lc" == 6, 4.2448)$, Con("mb1_lc" == 7, 4.3659 , $Con("mb1 \ lc" == 8, 4.1703$, Con("mb1_lc" == 9, 4.3375 , $Con("mb1_lc" == 10, 4.1399)$ $, Con("mb1_lc" == 11, 4.2082)$, Con("mb1_lc" == 12, 4.2875 , $Con("mb1_lc" == 13, 4.5274)$, Con("mb1 lc" == 14, 4.2483, Con("mb1_lc" == 15, 4.3947 , Con("mb1_lc" == 16, 4.1691 , Con("mb1_lc" == 17, 4.3478

b

Con("mb1_lc" == 1, -0.0804 , $Con("mb1_lc" == 2, -0.0807)$ $, Con("mb1_lc" == 3, -0.0837)$, $Con("mb1_lc" == 4, -0.0784)$, Con("mb1_lc" == 5, -0.082 $, Con("mb1_lc" == 6, -0.0824)$ $, Con("mb1_lc" == 7, -0.0862)$, $Con("mb1_lc" == 8, -0.0793)$, $Con("mb1 \ lc" == 9, -0.0826$, $Con("mb1_lc" == 10, -0.0824$ $, Con("mb1_lc" == 11, -0.0855)$, $Con("mb1_lc" == 12, -0.0811)$, $Con("mb1 \ lc" == 13, -0.0853$, $Con("mb1_lc" == 14, -0.0848)$ $, Con("mb1_lc" == 15, -0.0893)$, $Con("mb1_lc" == 16, -0.0774$, $Con("mb1_lc" == 17, -0.0807)$, $Con("mb1_lc" == 18, -0.0809$ Con("mb1 lc" == 19, -0.0842, $Con("mb1_lc" == 20, -0.0785)$ $, Con("mb1_lc" == 21, -0.0822)$ $, Con("mb1_lc" == 22, -0.0826)$, $Con("mb1 \ lc" == 23, -0.0866$, Con("mb1_lc" == 24, -0.0795 , $Con("mb1 \ lc" == 25, -0.0831$, $Con("mb1_lc" == 26, -0.0826)$, Con("mb1_lc" == 27, -0.086 , $Con("mb1_lc" == 28, -0.0813)$

b1

 $Con("mb1_lc" == 1, -11.7052)$ $, Con("mb1_lc" == 3, -11.4076)$ $, Con("mb1_lc" == 5, -12.4588)$ $, Con("mb1_lc" == 7, -12.3802)$ $, Con("mb1_lc" == 9, -11.9839)$, Con("mb1_lc" == 11, -11.8294 , $Con("mb1 \ lc" == 13, -13.1819$, Con("mb1_lc" == 15, -13.4474 , Con("mb1_lc" == 17, -12.2947 , Con("mb1_lc" == 19, -12.1225 , $Con("mb1 \ lc" == 21, -12.9715$, $Con("mb1_lc" == 23, -13.0184)$, Con("mb1_lc" == 25, -12.6163 , Con("mb1_lc" == 27, -12.6099 $, Con("mb1_lc" == 29, -13.7304)$

b2

Con("mb1_lc" == 1, 84.7826 , $Con("mb1 \ lc" == 3, 85.8173$, Con("mb1_lc" == 5, 88.0269 $, Con("mb1_lc" == 7, 91.11)$, Con("mb1_lc" == 9, 86.8693 , $Con("mb1 \ lc" == 11, 88.5053)$ $, Con("mb1_lc" == 13, 92.7476)$, Con("mb1_lc" == 15, 98.025 , $Con("mb1_lc" == 17, 88.9043)$ $, Con("mb1_lc" == 19, 90.9984)$, Con("mb1_lc" == 21, 91.704 , Con("mb1 lc" == 23, 95.7988 , Con("mb1_lc" == 25, 91.3014 , Con("mb1_lc" == 27, 94.1342 , Con("mb1_lc" == 29, 96.6692 b3

Con("mb1_lc" == 1, -131.678 , Con("mb1_lc" == 3, -134.053 , Con("mb1_lc" == 5, -136.446

b4

Con("mb1 lc" == 2, 0.3122), Con("mb1_lc" == 3, 0.3745 , $Con("mb1_lc" == 6, 0.3873)$ $, Con("mb1_lc" == 7, 0.4515)$, $Con("mb1_lc" == 10, 0.3046)$, Con("mb1_lc" == 11, 0.3675 $, Con("mb1_lc" == 14, 0.3926)$ $, Con("mb1_lc" == 15, 0.4666)$ $, Con("mb1_lc" == 18, 0.3216)$, Con("mb1 lc" == 19, 0.3913 , Con("mb1_lc" == 22, 0.3942 , Con("mb1_lc" == 23, 0.4649 , $Con("mb1_lc" == 26, 0.3143)$, Con("mb1 lc" == 27, 0.3849, Con("mb1_lc" == 30, 0.3998

b5

Con("mb1_lc" == 2, -0.0686 , Con("mb1_lc" == 3, -0.0729 , Con("mb1_lc" == 6, -0.0808 , Con("mb1_lc" == 7, -0.0854 , Con("mb1_lc" == 10, -0.0664 , Con("mb1_lc" == 11, -0.0704 , Con("mb1_lc" == 14, -0.0804 , Con("mb1_lc" == 15, -0.086 , Con("mb1_lc" == 18, -0.0697 , Con("mb1_lc" == 19, -0.0748 , Con("mb1_lc" == 22, -0.0816

b6

```
Con("mb1_lc" == 4, -0.0677)
, Con("mb1_lc" == 5, -0.0668)
, Con("mb1_lc" == 6, -0.0884)
, Con("mb1_lc" == 7, -0.0924
, Con("mb1 \ lc" == 12, -0.0812
, Con("mb1_lc" == 13, -0.0846
, Con("mb1_lc" == 14, -0.1024)
, Con("mb1_lc" == 15, -0.1132)
, Con("mb1 \ lc" == 20, -0.0653
, Con("mb1_lc" == 21, -0.0635
, Con("mb1_lc" == 22, -0.0865)
, Con("mb1_lc" == 23, -0.0899)
, Con("mb1_lc" == 28, -0.0789)
, Con("mb1 \ lc" == 29, -0.0817
, Con("mb1_lc" == 30, -0.1006)
```

b7

 $Con("mb1_lc" == 8, 0.4325)$ $, Con("mb1_lc" == 9, 0.4771)$, Con("mb1_lc" == 10, 0.3965 , $Con("mb1 \ lc" == 11, 0.4403$, $Con("mb1_lc" == 12, 0.5051)$ $, Con("mb1_lc" == 13, 0.5626)$ $, Con("mb1_lc" == 14, 0.4799)$ $, Con("mb1_lc" == 15, 0.5544)$, $Con("mb1_lc" == 24, 0.4399)$ Con("mb1 lc" == 25, 0.4898) $, Con("mb1_lc" == 26, 0.4036)$, $Con("mb1_lc" == 27, 0.4538)$, $Con("mb1_lc" == 28, 0.5101)$, Con("mb1 lc" == 29, 0.5722 $, Con("mb1_lc" == 30, 0.4853)$

b8

Con("mb1_lc" == 16, 73.5495

 $(Exp("mb1_a" + ("mb1_b" * 1) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 1)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 1) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 1)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw20" * ("mb_sw20$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 2) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 2) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * ("mb1_b1" * ("mb1_b1" * 2) + ("mb1_b1" * ("mb1_b1" * 2))) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 2)))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 3) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *)$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 3) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$

 $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 4) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000)) + (1 + 100000)) + (1 + 1000000)) + (1 + 100000)) + (1 + 100000)) + (1$ $Exp("mb1_a" + ("mb1_b" * 4) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 5) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 5) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 6) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 6))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" / 1000)) + ("mb_sw200" / 1000)) + ("mb_sw200" / 0)) + ("mb_sw$ $Exp("mb1_a" + ("mb1_b" * 6) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 6)$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) *$ $(Exp("mb1_a" + ("mb1_b" * 7) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 0.5))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 7) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 0.5)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 8) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 0))$

 $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + $Exp("mb1_a" + ("mb1_b" * 8) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 0.5)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b6" * ("mb1$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 9) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 0))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $(1000) * ("mb_e50" / 1000)) + ("mb1_b4" * ("mb_gr200" / 10000)) + ("mb1_b5" * 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000)) / (1 + 10000))) / (1 + 10000)) / (1 + 10000))) / (1 + 10000)) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000))))) / (1 + 10000))))) / (1 + 10000)))))) / (1 + 10000)))) / (1 + 10000))))))) / (1 + 10000)))) / (1 + 10000))))))))$ $Exp("mb1_a" + ("mb1_b" * 9) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b6" * ("mb1$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $(1000) * ("mb_e50" / 1000)) + ("mb1_b4" * ("mb_gr200" / 10000)) + ("mb1_b5" * 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / ("mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + (10000)) / (1 + 100000)) / (1 + 10000)) / (1 + 10000)) / (1 + 100000)) / (1 + 100000)) / (1 + 10$ $Exp("mb1_a" + ("mb1_b" * 10) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 10)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 11) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 11) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" + ("mb1_b1" * ("mb1_b1" + ("mb1$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + (10000)) / (1 + 100000)) / (1 + 10000)) / (1 + 10000)) / (1 + 100000)) / (1 + 100000)) / (1 + 10$ $Exp("mb1_a" + ("mb1_b" * 11) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 11) + ("mb1_b1" * ("mb1_b1" + ("mb1_$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 12) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 12) + ("mb1_b1" * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1" * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1")$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw20" /$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + (10000)) / (1 + 100000)) / (1 + 10000)) / (1 + 10000)) / (1 + 100000)) / (1 + 100000)) / (1 + 10$

 $Exp("mb1_a" + ("mb1_b" * 12) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 12)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 13) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 13) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 13))) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 13)))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $Exp("mb1_a" + ("mb1_b" * 13) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 13)$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw200" / 10000)) + ("mb_sw200" / ("mb_sw20" /$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 14) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 14) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" + ("mb1$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $Exp("mb1_a" + ("mb1_b" * 14) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 14)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $Exp("mb1_a" + ("mb1_b" * 15) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 15) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" + ("mb1_$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b6" * ("mb1$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 16) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 16) + ("mb1_b1" * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1" * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw20" * ("mb_sw20$ $Exp("mb1_a" + ("mb1_b" * 16) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 16)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / ("mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw$

("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 17) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 17) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" + ("mb1$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000)$ $(1000) * ("mb_e50" / 1000)) + ("mb1_b4" * ("mb_gr200" / 10000)) + ("mb1_b5" * 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ $Exp("mb1_a" + ("mb1_b" * 17) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 17)$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000) + ("mb_sw20" / ("mb_sw20" / ("mb_s$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 18) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 18) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" + ("mb1$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $Exp("mb1_a" + ("mb1_b" * 18) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 18) + ("mb1_b1" * ("mb1_b1" + ("mb1_$ ("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000)))) *$ $(Exp("mb1_a" + ("mb1_b" * 19) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 19) + ("mb1_b1" * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1") * ("mb1_b1" * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1")) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1" * ("mb1_b1"))) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1")) * ("mb1_b1") * ("mb1_b1")) * ("mb1_b1"$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000)$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $Exp("mb1_a" + ("mb1_b" * 19) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 19)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000) + ("mb_sw200" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw20" / 10000)) + ("mb_sw20" / 10000) + ("mb_sw$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 20) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * ("mb1_b1" * ("mb1_b1" * 20) + ("mb1_b1" * ("mb1_b1" * 20))) + ("mb1_b1" * ("mb1_b1" * 20)) + ("mb1_b1" * 20)) + ("mb1_b1" * 20) + ("mb1_b1" * 20) + ("mb1_b1" * 20)) + ("mb1_b1" * 20) + ("mb1_b1" * 20) + ("mb1_b1" * 20)) + ("mb1_b1" * 20) + ("mb1_b1" * 20) + ("mb1_b1" * 20)) + ("mb1_b2" * 20) + ("mb1_b1" * 2$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw2$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + (10000)) / (1 + 100000)) / (1 + 10000)) / (1 + 10000)) / (1 + 100000)) / (1 + 100000)) / (1 + 10$ $Exp("mb1_a" + ("mb1_b" * 20) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * ("mb1_b1" * ("mb1_b1" * 20)) + ("mb1_b1" * 20) +$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$

 $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / ("mb_sw20" / 10000)) + ("mb_sw20" / ("mb_sw$ $Exp("mb1_a" + ("mb1_b" * 21) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * ("mb1_b1" * ("mb1_b1" * 21) + ("mb1_b1" * ("mb1_b1" * 21))) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 21)))$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 22) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * ("mb1_b1" * ("mb1_b1" * 22) + ("mb1_b1" * ("mb1_b1" * 22))) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 22))) + ("mb1_b1" * ("mb1_b1" * ("mb1_b1" * 22))) + ("mb1_b1" * ("mb1_b1" * 22)) + ("mb1_b1" * ("mb1_b1" * 22)) + ("mb1_b1" * 22)) + ("mb1_b1" * ("mb1_b1" * 22)) + ("mb1_b1" * 22$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) +$ $("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000))) / (1 + 10000)) + ("mb1_b7" * ("mb_cf50" / 10000))) / (1 + 10000)))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000))) / (1 + 10000)))) / (1 + 10000))) / (1 + 10$ $Exp("mb1_a" + ("mb1_b" * 22) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" * 22)$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $(Exp("mb1_a" + ("mb1_b" * 23) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $(1000) * ("mb_e50" / 1000)) + ("mb1_b4" * ("mb_gr200" / 10000)) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5"))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5"))))) + ("mb1_b5" * ("mb1_b5")))))))) + ("mb1_b5" * ("mb1_b5")))))))))))))))))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + $Exp("mb1_a" + ("mb1_b" * 23) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw20" * ("mb_sw20$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000))))) * $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $(1000) * ("mb_e50" / 1000)) + ("mb1_b4" * ("mb_gr200" / 10000)) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5" * ("mb1_b5"))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5")))) + ("mb1_b5" * ("mb1_b5"))))) + ("mb1_b5" * ("mb1_b5")))))))) + ("mb1_b5" * ("mb1_b5")))))))))))))))))$ ("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + $Exp("mb1_a" + ("mb1_b" * 24) + ("mb1_b1" * ("mb_e50" / 1000)) + ("mb1_b2" *$ $("mb_e50" / 1000) * ("mb_e50" / 1000)) + ("mb1_b3" * ("mb_e50" / 1000) * ("mb_e50" / 1000))$ $("mb_gr200" / 10000) * ("mb_gr200" / 10000)) + ("mb1_b6" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw200" * ("mb_sw200" / 10000)) + ("mb_sw20" / 0000)) + ("mb_sw20" / ("mb_sw20" / 0000))$ ("mb1_b7" * ("mb_fw175" / 10000)) + ("mb1_b8" * ("mb_cf50" / 10000)))))

Fledgling Survival Days 1–3

Con("mb_cf50" > 0, Con("mb_fw125" > 0, Con("mb_gr200" > 0,

```
Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 31, 30),
                     Con("mb_df25" > 0, 29, 28)),
              Con("mb e200" > 0,
                     Con("mb_df25" > 0, 27, 26),
                     Con("mb df25" > 0, 25, 24))),
       Con("mb_gr200" > 0,
              Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 23, 22),
                     Con("mb_df25" > 0, 21, 20)),
              Con("mb_e200" > 0,
                     Con("mb df25" > 0, 19, 18),
                     Con("mb_df25" > 0, 17, 16)))),
Con("mb fw125" > 0,
       Con("mb_gr200" > 0,
              Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 15, 14),
                     Con("mb_df25" > 0, 13, 12)),
              Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 11, 10),
                     Con("mb_df25" > 0, 9, 8))),
       Con("mb_gr200" > 0,
              Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 7, 6),
                     Con("mb df25" > 0, 5, 4)),
              Con("mb_e200" > 0,
                     Con("mb_df25" > 0, 3, 2),
                     Con("mb_df25" > 0, 1, 0)))))
```

a

Con("mb2_lc" == 1, 1.1494 , Con("mb2_lc" == 2, 8.6792 , Con("mb2_lc" == 3, 4.9765 , Con("mb2_lc" == 4, 1.8707 , Con("mb2_lc" == 5, 1.3954 , Con("mb2_lc" == 6, 9.0363 , Con("mb2_lc" == 7, 5.527 , Con("mb2_lc" == 8, 1.4955 , Con("mb2_lc" == 9, 1.0727 , Con("mb2_lc" == 10, 9.3593 , Con("mb2_lc" == 11, 5.6469 , Con("mb2_lc" == 12, 1.739 , Con("mb2_lc" == 13, 1.335 , Con("mb2_lc" == 14, 9.7982

, Con("mb2_lc" == 15, 9.7953
, Con("mb2_lc" == 16, 1.513
, Con("mb2_lc" == 17, 1.0633
, Con("mb2_lc" == 18, 8.0632
$, Con("mb2_lc" == 19, 7.712)$
$, Con("mb2_lc" == 20, 1.7743)$
$, Con("mb2_lc" == 21, 1.3512)$
, Con("mb2_lc" == 22, 7.5756
, Con("mb2_lc" == 23, 8.3822
$, Con("mb2_lc" == 24, 1.3568)$
$, Con("mb2_lc" == 25, 0.9797)$
$, Con("mb2_lc" == 26, 8.6754)$
$, Con("mb2_lc" == 27, 8.4204)$
, Con("mb2_lc" == 28, 1.6187
, Con("mb2_lc" == 29, 1.2972
$, Con("mb2_lc" == 30, 9.8762)$
, Con("mb2_lc" == 31, 9.1053, 1.6238))))))))))))))))))))))))))))))))))))

b

 $Con("mb2_lc" == 1, 0.2378)$, Con("mb2_lc" == 2, 0.2524 $, Con("mb2_lc" == 3, 0.2422)$, $Con("mb2_lc" == 4, 0.2428)$ $, Con("mb2_lc" == 5, 0.2334)$ $, Con("mb2_lc" == 6, 0.2386)$ $, Con("mb2_lc" == 7, 0.2305)$, Con("mb2_lc" == 8, 0.2745 , Con("mb2_lc" == 9, 0.2602 , Con("mb2 lc" == 10, 0.2599 $, Con("mb2_lc" == 11, 0.2417)$, Con("mb2_lc" == 12, 0.2694 $, Con("mb2_lc" == 13, 0.2574)$, $Con("mb2_lc" == 14, 0.2467)$, Con("mb2_lc" == 15, 0.2331 , Con("mb2_lc" == 16, 0.2728 , $Con("mb2_lc" == 17, 0.2594)$ $, Con("mb2_lc" == 18, 0.254)$ $, Con("mb2_lc" == 19, 0.2372)$, Con("mb2_lc" == 20, 0.2664 , $Con("mb2_lc" == 21, 0.2544)$, Con("mb2_lc" == 22, 0.2403 , $Con("mb2_lc" == 23, 0.2276)$, $Con("mb2_lc" == 24, 0.3091)$, Con("mb2_lc" == 25, 0.2912

b1

 $Con("mb2_lc" == 1, 5.608)$ $, Con("mb2_lc" == 3, 6.3094)$, Con("mb2_lc" == 5, 4.9052 , $Con("mb2 \ lc" == 7, 5.7451$, Con("mb2_lc" == 9, 5.0382 $, Con("mb2_lc" == 11, 6.7063)$, Con("mb2_lc" == 13, 4.2653 , Con("mb2_lc" == 15, 4.6292 , Con("mb2_lc" == 17, 5.316 , Con("mb2_lc" == 19, 6.0279 , Con("mb2_lc" == 21, 4.3597 , $Con("mb2_lc" == 23, 5.2301)$, Con("mb2_lc" == 25, 4.6392 $, Con("mb2_lc" == 27, 6.197)$, $Con("mb2_lc" == 29, 3.5273)$

b2

```
Con("mb2_lc" == 2, -6.6939
, Con("mb2_lc" == 3, -3.3918)
, Con("mb2 \ lc" == 6, -6.5014
, Con("mb2_lc" == 7, -3.4322)
, Con("mb2_lc" == 10, -7.2872)
, Con("mb2_lc" == 11, -4.023)
, Con("mb2_lc" == 14, -7.2312)
, Con("mb2_lc" == 15, -7.6603)
, Con("mb2 \ lc" == 18, -6.104
, Con("mb2_lc" == 19, -6.1514)
, Con("mb2_lc" == 22, -5.023)
, Con("mb2_lc" == 23, -6.3088)
, Con("mb2 \ lc" == 26, -6.6393)
, Con("mb2_lc" == 27, -6.8012
, Con("mb2 \ lc" == 30, -7.3321
```

```
Con("mb2_lc" == 2, 1.8687
, Con("mb2_lc" == 3, 0.861)
, Con("mb2_lc" == 6, 1.7581)
, Con("mb2 \ lc" == 7, 0.8245
, Con("mb2_lc" == 10, 2.0321
, Con("mb2 \ lc" == 11, 1.0377)
, Con("mb2_lc" == 14, 1.974)
, Con("mb2_lc" == 15, 2.1211)
, Con("mb2_lc" == 18, 1.701)
, Con("mb2_lc" == 19, 1.7085)
, Con("mb2_lc" == 22, 1.3198
, Con("mb2 lc" == 23, 1.7139
, Con("mb2_lc" == 26, 1.85
, Con("mb2_lc" == 27, 1.8882)
, Con("mb2_lc" == 30, 2.0162
```

b4

Con("mb2_lc" == 2, -0.1583 $, Con("mb2_lc" == 3, -0.06585)$, $Con("mb2 \ lc" == 6, -0.1455$, Con("mb2_lc" == 7, -0.05978 , $Con("mb2_lc" == 10, -0.173)$, $Con("mb2_lc" == 11, -0.0817)$, $Con("mb2_lc" == 14, -0.1659)$, $Con("mb2_lc" == 15, -0.1824)$ $, Con("mb2_lc" == 18, -0.1436)$, $Con("mb2_lc" == 19, -0.1458)$, Con("mb2 lc" == 22, -0.1055, $Con("mb2_lc" == 23, -0.1442)$, Con("mb2_lc" == 26, -0.1571 , $Con("mb2_lc" == 27, -0.1618)$, $Con("mb2_lc" == 30, -0.1709)$

b5

Con("mb2_lc" == 4, -0.1927 , Con("mb2_lc" == 5, -0.1422 , Con("mb2_lc" == 6, -0.217 , Con("mb2_lc" == 7, -0.1707 , Con("mb2_lc" == 12, -0.1991 , Con("mb2_lc" == 13, -0.1572 , Con("mb2_lc" == 14, -0.211 , Con("mb2_lc" == 15, -0.1755

b6

```
Con("mb2_lc" == 8, 23.7899
, Con("mb2 lc" == 9, 22.6058
, Con("mb2_lc" == 10, 1.4739
, Con("mb2_lc" == 11, 0.7067)
, Con("mb2_lc" == 12, 24.5647)
, Con("mb2 lc" == 13, 23.497
, Con("mb2_lc" == 14, 1.9677)
, Con("mb2_lc" == 15, 3.0997
, Con("mb2_lc" == 24, 21.9879
, Con("mb2_lc" == 25, 21.0726
, Con("mb2 lc" == 26, 1.2419
, Con("mb2_lc" == 27, 2.1499
, Con("mb2_lc" == 28, 22.6182)
, Con("mb2_lc" == 29, 21.97
, Con("mb2_lc" == 30, 2.5389
b7
Con("mb2 lc" == 8, -45.0087
, Con("mb2_lc" == 9, -41.8326)
, Con("mb2_lc" == 10, -4.481)
, Con("mb2_lc" == 11, -2.2875)
, Con("mb2_lc" == 12, -45.5651)
, Con("mb2_lc" == 13, -42.9372
, Con("mb2 \ lc" == 14, -4.8559
, Con("mb2_lc" == 15, -6.2293)
, Con("mb2_lc" == 24, -41.8562
, Con("mb2_lc" == 25, -39.2768)
, Con("mb2 \ lc" == 26, -4.0946
, Con("mb2_lc" == 27, -4.7582)
, Con("mb2 lc" == 28, -42.1915
, Con("mb2_lc" == 29, -40.4661)
, Con("mb2 \ lc" == 30, -5.812)
```

b8 $Con("mb2_lc" == 8, 17.4954)$, $Con("mb2 \ lc" == 9, 16.1348$, Con("mb2_lc" == 10, 1.8956 , $Con("mb2 \ lc" == 11, 1.0249$, Con("mb2_lc" == 12, 17.523 , Con("mb2_lc" == 13, 16.4338 , Con("mb2_lc" == 14, 1.9225 $, Con("mb2_lc" == 15, 2.3686)$, Con("mb2_lc" == 24, 16.3034 , Con("mb2 lc" == 25, 15.1878 , Con("mb2_lc" == 26, 1.7502 , $Con("mb2_lc" == 27, 1.9032)$, Con("mb2_lc" == 28, 16.2475 , Con("mb2 lc" == 29, 15.5242 , Con("mb2_lc" == 30, 2.2593

b9

 $Con("mb2 \ lc" == 16, -110.68$, Con("mb2_lc" == 17, -116.48 , $Con("mb2_lc" == 18, -2.0415)$, Con("mb2_lc" == 19, 0.6648 , $Con("mb2_lc" == 20, -108.73)$ $, Con("mb2_lc" == 21, -114.86)$, $Con("mb2_lc" == 22, -3.0045)$, $Con("mb2_lc" == 23, -0.2436)$, Con("mb2 lc" == 24, -97.1977 , $Con("mb2_lc" == 25, -105.27)$, Con("mb2_lc" == 26, -2.2855 , $Con("mb2_lc" == 27, 0.8119)$, $Con("mb2_lc" == 28, -108.51)$, Con("mb2_lc" == 29, -105.67 , $Con("mb2 \ lc" == 30, -1.8687$

b10

 $Con("mb2_lc" == 16, 373.71)$

, Con("mb2_lc" == 17, 399.66

- , Con("mb2_lc" == 18, 0.2387
- , $Con("mb2_lc" == 19, 1.5718$
- , $Con("mb2_lc" == 20, 363.13)$
- , Con("mb2_lc" == 21, 390.23

 $(Exp("mb2_a" + ("mb2_b" * 1) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * 1) + ("mb2_b1" * ("mb2_b1" * ("mb2_b1" + ("mb2$ $("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ $("mb2_b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ $("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) +$ ("mb2_b7" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b9" * $("mb_cf50" / 10000)) + ("mb2_b10" * ("mb_cf50" / 10000) * ("mb_cf50" / 10000))) / (1)$ $+ Exp("mb2_a" + ("mb2_b" * 1) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * 1)$ $("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ ("mb2_b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + $("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) +$ ("mb2_b7" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b9" * ("mb_cf50" / 10000)) + ("mb2_b10" * ("mb_cf50" / 10000) * ("mb_cf50" / 10000))))) * $(Exp("mb2_a" + ("mb2_b" * 2) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * 10000))$ $("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ ("mb2_b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) + ("mb2_b7" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b8" * $("mb_cf50" / 10000)) + ("mb2_b10" * ("mb_cf50" / 10000) * ("mb_cf50" / 10000))) / (1)$ + $Exp("mb2_a" + ("mb2_b" * 2) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * 2)$ $("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ $("mb2b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ ("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) + ("mb2_b7" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b9" * ("mb_cf50" / 10000)) + ("mb2_b10" * ("mb_cf50" / 10000) * ("mb_cf50" / 10000))))) * $(Exp("mb2_a" + ("mb2_b" * 3) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * 10000))$ $("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) +$ ("mb2_b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + $("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) +$

- , Con("mb2_lc" == 30, 1.2863
- , Con("mb2_lc" == 29, 356.82
- , Con("mb2_lc" == 28, 364
- , Con("mb2_lc" == 27, 1.9176

- , Con("mb2_lc" == 26, 0.3393

- , Con("mb2_lc" == 25, 359.09

- , Con("mb2_lc" == 24, 325.37
- , Con("mb2_lc" == 23, 1.4501
- , Con("mb2_lc" == 22, -0.1792

```
 ("mb_b7" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b9" * ("mb_cf50" / 10000)) + ("mb2_b10" * ("mb_cf50" / 10000)) * ("mb_cf50" / 10000))) / (1 + Exp("mb2_a" + ("mb2_b" * 3) + ("mb2_b1" * ("mb_df25" / 10000)) + ("mb2_b2" * ("mb_e200" / 1000)) + ("mb2_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb2_b4" * ("mb_e200" / 1000) * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb2_b5" * ("mb_gr200" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) + ("mb2_b7" * ("mb_fw125" / 10000)) + ("mb2_b6" * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000) * ("mb_fw125" / 10000)) + ("mb2_b9" * ("mb_fw125" / 10000)) + ("mb2_b8" * ("mb_fw125" / 10000)) + ("mb2_b10" * ("mb_fw125" / 10000)) + ("mb2_b9" * ("mb_f50" / 10000)) + ("mb2_b9" * ("mb_f50" / 10000))))
```

Fledgling Survival Days 3–8

```
Con("mb sw300" > 0,
      Con("mb_fw400" > 0,
             Con("mb gr175" > 0,
                    Con("mb_e200" > 0,
                           Con("mb_df25" > 0, 31, 30),
                           Con("mb_df25" > 0, 29, 28)),
                    Con("mb_e200" > 0,
                           Con("mb_df25" > 0, 27, 26),
                           Con("mb df25" > 0, 25, 24))),
             Con("mb_gr175" > 0,
                    Con("mb_e200" > 0,
                           Con("mb_df25" > 0, 23, 22),
                           Con("mb_df25" > 0, 21, 20)),
                    Con("mb e200" > 0,
                           Con("mb_df25" > 0, 19, 18),
                           Con("mb df25" > 0, 17, 16)))),
      Con("mb_fw400" > 0,
             Con("mb gr175" > 0,
                    Con("mb_e200" > 0,
                           Con("mb_df25" > 0, 15, 14),
                           Con("mb_df25" > 0, 13, 12)),
                    Con("mb e200" > 0,
                           Con("mb_df25" > 0, 11, 10),
                           Con("mb df25" > 0, 9, 8))),
             Con("mb_gr175" > 0,
                    Con("mb e200" > 0,
                           Con("mb_df25" > 0, 7, 6),
                           Con("mb df25" > 0, 5, 4)),
                    Con("mb_e200" > 0,
                           Con("mb df25" > 0, 3, 2),
                           Con("mb_df25" > 0, 1, 0)))))
```

a Con("mb3 lc" == 1, 3.4797), Con("mb3_lc" == 2, 6.0779 , Con("mb3 lc" == 3, 6.0778), Con("mb3_lc" == 4, 3.9746 , Con("mb3_lc" == 5, 3.9465 , Con("mb3_lc" == 6, 4.1984 $, Con("mb3_lc" == 7, 4.2093)$, Con("mb3_lc" == 8, 3.6595 , Con("mb3 lc" == 9, 3.8291, Con("mb3_lc" == 10, 6.0274 $, Con("mb3_lc" == 11, 6.0248)$, $Con("mb3_lc" == 12, 4.0726)$, Con("mb3_lc" == 13, 4.2524 , $Con("mb3_lc" == 14, 4.318)$, Con("mb3_lc" == 15, 4.3125 , Con("mb3_lc" == 16, 4.0786 , $Con("mb3_lc" == 17, 4.0017)$, Con("mb3_lc" == 18, 4.2178 $, Con("mb3_lc" == 19, 4.2177)$ $, Con("mb3_lc" == 20, 4.136)$, Con("mb3_lc" == 21, 4.1366 , Con("mb3_lc" == 22, 4.0592 , Con("mb3_lc" == 23, 4.0589 $, Con("mb3_lc" == 24, 4.027)$, Con("mb3_lc" == 25, 4.1023 , Con("mb3 lc" == 26, 3.7176, $Con("mb3_lc" == 27, 3.7193)$, Con("mb3_lc" == 28, 4.0616 $, Con("mb3_lc" == 29, 4.2415)$, Con("mb3_lc" == 30, 3.6849

```
b1
```

Con("mb3_lc" == 1, 8.5152 , Con("mb3_lc" == 3, 1.079 , Con("mb3_lc" == 5, 0.3593 , Con("mb3_lc" == 7, 0.3362 , Con("mb3_lc" == 9, 2.5017 , Con("mb3_lc" == 11, 1.1745 , Con("mb3_lc" == 13, 0.3456 , Con("mb3_lc" == 15, 0.3399

```
b2
```

```
Con("mb3_lc" == 2, -0.00186
, Con("mb3 lc" == 3, -0.00228
, Con("mb3_lc" == 6, -0.0007
, Con("mb3_lc" == 7, -0.0007)
, Con("mb3_lc" == 10, -0.00233)
, Con("mb3 lc" == 11, -0.00242
, Con("mb3_lc" == 14, -0.00089)
, Con("mb3_lc" == 15, -0.00093
, Con("mb3_lc" == 18, -0.00077
, Con("mb3_lc" == 19, -0.00095)
, Con("mb3 lc" == 22, -0.00097
, Con("mb3_lc" == 23, -0.00101)
, Con("mb3_lc" == 26, -0.00071)
, Con("mb3_lc" == 27, -0.0005)
, Con("mb3_lc" == 30, -0.00072
b3
Con("mb3 lc" == 2, 0.000003547
, Con("mb3_lc" == 3, 0.0000004812
, Con("mb3_lc" == 6, 0.0000001763
, Con("mb3_lc" == 7, 0.000001728)
, Con("mb3_lc" == 10, 0.0000004605)
, Con("mb3_lc" == 11, 0.0000004758
, Con("mb3 lc" == 14, 0.000002092
, Con("mb3_lc" == 15, 0.000002091)
, Con("mb3_lc" == 18, 0.000002192
, Con("mb3_lc" == 19, 0.000002745
, Con("mb3 lc" == 22, 0.000002692
, Con("mb3_lc" == 23, 0.000002824
, Con("mb3 lc" == 26, 0.000002548
, Con("mb3_lc" == 27, 0.000001766
, Con("mb3 lc" == 30, 0.000002415
```

b4 $Con("mb3_lc" == 4, 2.2597)$, Con("mb3 lc" == 5, 2.269), Con("mb3_lc" == 6, 2.4762 , Con("mb3 lc" == 7, 2.5356), Con("mb3_lc" == 12, 1.9236 , Con("mb3_lc" == 13, 1.9286 , Con("mb3_lc" == 14, 3.3989 , Con("mb3_lc" == 15, 3.3932 , Con("mb3_lc" == 20, 1.5116 , Con("mb3 lc" == 21, 1.5249 , Con("mb3_lc" == 22, 2.6293 , Con("mb3_lc" == 23, 2.6287 , Con("mb3_lc" == 28, 1.3879 , Con("mb3 lc" == 29, 1.4121 , Con("mb3_lc" == 30, 1.9857

b5

Con("mb3 lc" == 4, -0.7233) $, Con("mb3_lc" == 5, -0.7227)$, $Con("mb3_lc" == 6, -0.7458)$ $, Con("mb3_lc" == 7, -0.7617)$, Con("mb3 lc" == 12, -0.6428, $Con("mb3_lc" == 13, -0.7014$, Con("mb3_lc" == 14, -1.0002 , $Con("mb3_lc" == 15, -0.9849)$, Con("mb3 lc" == 20, -0.4924 $, Con("mb3_lc" == 21, -0.4766)$, $Con("mb3_lc" == 22, -0.6679)$, $Con("mb3_lc" == 23, -0.6692)$, $Con("mb3_lc" == 28, -0.4114$ $, Con("mb3_lc" == 29, -0.4047)$, Con("mb3 lc" == 30, -0.4917

b6

Con("mb3_lc" == 8, 7.2503 , Con("mb3_lc" == 9, 7.4236

- , Con("mb3 lc" == 10, 5.7561
- $Con("mb3_lc" == 11, 5.6982)$
- , $Con("mb3_lc" == 12, 1.3991)$
- , Con("mb3_lc" == 13, 1.4917

b7

Con("mb3_lc" == 8, -3.3376 $, Con("mb3_lc" == 9, -3.4838)$, $Con("mb3_lc" == 10, -1.9193)$, Con("mb3 lc" == 11, -2.1209, Con("mb3_lc" == 12, -0.8858 , $Con("mb3_lc" == 13, -0.6348)$, $Con("mb3_lc" == 14, -1.0626$, $Con("mb3_lc" == 15, -1.3777)$, Con("mb3 lc" == 24, -0.7629, $Con("mb3_lc" == 25, -0.6373)$, $Con("mb3_lc" == 26, -0.4729)$, $Con("mb3_lc" == 27, -0.4088)$, $Con("mb3_lc" == 28, -0.4771$ $, Con("mb3_lc" == 29, -0.4374)$, $Con("mb3_lc" == 30, -0.3529)$

b8

Con("mb3_lc" == 8, 0.3706 , Con("mb3_lc" == 9, 0.3946 , Con("mb3_lc" == 10, 0.1522 , Con("mb3_lc" == 11, 0.1862 , Con("mb3_lc" == 12, 0.11 , Con("mb3_lc" == 13, 0.05929 , Con("mb3_lc" == 14, 0.08698 , Con("mb3_lc" == 15, 0.1484 , Con("mb3_lc" == 24, 0.08236 , Con("mb3_lc" == 25, 0.0557 , Con("mb3_lc" == 26, 0.03386 , Con("mb3_lc" == 27, 0.02343 , Con("mb3_lc" == 28, 0.04337

, Con("mb3_lc" == 29, 0.03817
b9

Con("mb3_lc" == 16, 1.7259 , Con("mb3_lc" == 17, 1.6815 , Con("mb3_lc" == 18, 1.6796 , Con("mb3_lc" == 19, 1.6789 , Con("mb3_lc" == 20, 1.0147 , $Con("mb3_lc" == 21, 1.0221)$, Con("mb3_lc" == 22, 1.3928 , Con("mb3 lc" == 23, 1.3978, Con("mb3_lc" == 24, 1.3736 , Con("mb3_lc" == 25, 1.3754 , Con("mb3_lc" == 26, 0.9113 , Con("mb3 lc" == 27, 0.9094 , Con("mb3_lc" == 28, 0.8372 , Con("mb3_lc" == 29, 0.8979 , Con("mb3_lc" == 30, 0.8608 b10

 $Con("mb3_lc" == 16, -0.6663)$, $Con("mb3_lc" == 17, -0.6597)$, Con("mb3 lc" == 18, -0.593 , Con("mb3_lc" == 19, -0.5959 , $Con("mb3_lc" == 20, -0.4048)$, $Con("mb3_lc" == 21, -0.3932)$, Con("mb3 lc" == 22, -0.5732, $Con("mb3_lc" == 23, -0.5526)$, $Con("mb3_lc" == 24, -0.61)$ $, Con("mb3_lc" == 25, -0.5651)$, $Con("mb3_lc" == 26, -0.4162)$ $, Con("mb3_lc" == 27, -0.4415)$, Con("mb3 lc" == 28, -0.4011, Con("mb3_lc" == 29, -0.3985 , $Con("mb3_lc" == 30, -0.4162)$

b11 Con("mb3_lc" == 16, 0.05411 , Con("mb3_lc" == 17, 0.05439 , Con("mb3_lc" == 18, 0.04561 , Con("mb3_lc" == 19, 0.0454 $(Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)))$ + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * $("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000))$ + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) $("mb_sw300" / 10000))) / (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb3_b1" * ("mb3_b1" * ("mb3_b1" + ("mb3_b1$ ("mb3_b2" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * ("mb_fw400" / 10000)) + ("mb3_b7" * $("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) * ("mb_fw400" / 10000)) * ("mb_fw400" / 10000)) * ("mb3_b8" * ("mb400" / 10000)) * ("mb3_b8" * ("mb400" / 10000)) * ("mb400" / 10000)) * ("mb400" / 10000) * ("mb400" / 10000)) * ("mb400" / 1000" / 10000)) * ("mb400" / 1000" / 1000)) * ("mb400" / 1000" / 1000")) * ("mb400" / 1000" / 1000") * ("mb400" / 1000")) * ("mb400" / 1000" / 1000")) * ("mb400" / 1000" / 1000" / 1000" / 1000") * ("mb400" / 1000" / 1000") * ("mb400" / 1000" / 1000" / 1000") * ("mb400" / 1000" / 1000") * ("mb400" / 100" / 100") * ("mb400" / 100") * ("mb400" / 100" / 1000") * ("mb400" / 100" / 100" / 100" / 100") * ("mb400" / 100" / 100") * ("mb400" / 100" / 100" / 10$ ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb sw300" / 10000) * ("mb sw300" / 10000) * ("mb sw300" / 10000))))) * $(Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)))$ + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * $("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000))$ + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) $("mb_sw300" / 10000))) / (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb3_b1" * ("mb3_b1" * ("mb3_b1" + ("mb3_b1$ ("mb3_b2" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * $("mb_gr175" / 10000)) + ("mb3_b6" * ("mb_fw400" / 10000)) + ("mb3_b7" * "mb3_b7" * "mb$ ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) * ("mb_sw300" / 10000))))) *

 $(Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)))$ + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * $("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000))$ + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) $("mb_sw300" / 10000))) / (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb3_b1" * ("mb3_b1" * ("mb3_b1" + ("mb3_b1$ ("mb3_b2" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * ("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b8" * ("mb_fw400" / 10000) * $("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000))$ + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) * ("mb_sw300" / 10000))))) * $(Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)))$ + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / $^{-1}$ 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * $("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000))$ + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) * ("mb_sw300" / 10000))) / (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * $("mb_gr175" / 10000)) + ("mb3_b6" * ("mb_fw400" / 10000)) + ("mb3_b7" * "mb3_b7" * "mb$ ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b8" * ("mb_fw400" / 10000) * $("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000))$ + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) * ("mb_sw300" / 10000))))) * $(Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + ("mb3_b2" * ("mb_e200" / 1000)))$ $+("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000)) + ("mb3_b4" * ("mb_gr175" / 1000)) + ("mb3_b4" * ("mb3_b4"$ 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * ("mb_gr175" / 10000)) + ("mb3_b6" * $("mb_fw400" / 10000)) + ("mb3_b7" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000))$ + ("mb3_b8" * ("mb_fw400" / 10000) * ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000)) + ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) $("mb_sw300" / 10000))) / (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000)) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb_df25" / 10000))) + (1 + (Exp("mb3_a" + ("mb3_b1" * ("mb3_b1" * ("mb3_b1" * ("mb3_b1" + ("mb3_b1$ $("mb3_b2" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000) * ("mb_e200" / 1000) + ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e200" / 1000)) + ("mb3_b3" * ("mb_e300" / 1000)) + ("mb3_b3" * ("mb3_b3") * ("mb3_b3") * ("mb3_b3" * ("mb3_b3" * ("mb3_b3" * ("mb3_b3" * ("mb3_b3" * ("mb3_b3" * ("mb3_b3") * ("mb3_b3") * ("mb3_b3" * ("mb3_b3") * ("mb3_b3" * ("mb3_b3") * ("mb3_b3") * ("mb3_b3" * ("mb3_b3") * ("mb3_b3")) * ("mb3_b3") * ("mb3_$ 1000)) + ("mb3_b4" * ("mb_gr175" / 10000)) + ("mb3_b5" * ("mb_gr175" / 10000) * $("mb_gr175" / 10000)) + ("mb3_b6" * ("mb_fw400" / 10000)) + ("mb3_b7" * "mb3_b7" * "mb$ ("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b8" * ("mb_fw400" / 10000) * $("mb_fw400" / 10000) * ("mb_fw400" / 10000)) + ("mb3_b9" * ("mb_sw300" / 10000))$

 $+ ("mb3_b10" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000)) + ("mb3_b11" * ("mb_sw300" / 10000) * ("mb_sw300" / 10000) * ("mb_sw300" / 10000))))))\\$

(("mb1_s" * (1 - " mb1_s ")) * 4) * "mb2_s" * "mb3_s"