

# Discontinuities in body mass distributions of bird communities does not capture a large-scale and long-term woody plant encroachment in Kansas, United States

## Introduction

Much of the world's native grassland habitat has been lost in recent decades to agricultural and other anthropogenic land use conversion [1]. The conversion of native grassland to row crops which are increasingly subjected to intensified agricultural practices, have resulted in biodiversity loss which are easily measured by examining long-term changes in bird populations and communities. Native grasslands not converted for agricultural practice or other development are still subject to change due to changes in the feedbacks regulating native grass production, including a loss of wild and prescribed fire and woody plant encroachment [2, 3, 4]. Understanding whether these changes manifest in terrestrial communities is an important step towards understanding if, where, and how conservation efforts may be made to protect these areas.

Animal body mass distributions have been used to identify scaling structures of ecological communities [5, 6, 7]. Using statistical methods to identify gaps, or discontinuities, in body mass distributions, some patterns are observed within and across taxonomic groups and biomes. Given the ubiquity of discontinuities identified in body mass distributions of fauna and social systems [8], the ecological significance of these patterns may prove useful in understanding ecosystem structure and functioning [9]. Various hypotheses are postulated as drivers of the observed discontinuities in animal body mass distributions, including those related to resource use (the Energetic and Textural Discontinuity hypotheses), community interactions, biogeography, and evolution/phylogenetics [5, 7, 10, 11, 12].

Body size influences the frequency and intensity of inter- and intraspecific competition for resources, territory, and mates, thereby dictating the spatial and temporal scales at which a species of a distinct body size operates [13, 14, 15]. The scaling structure of terrestrial communities have been found to have 'lumpy' distributions; that is, they are not well-described using parametric statistical descriptions. If the scaling structure of a community manifests in the body mass distribution of the community, it is considered reflective of the discontinuous and heterogeneous nature of resource use. Specifically, [7] suggests that the body mass distribution of a community or group of species reflects the discontinuous nature of environmental structures and processes. Quantitative analyses of animal body sizes [16, 17] and other similar distributions has revealed the ubiquity of the discontinuous nature of distributions of animal body masses [18, 19], plant biomass [20], city population sizes [21], and animal home range sizes [22].

A recent study of the Central United States, including and beyond the Great Plains ecoregions, used discontinuity analysis of body mass distributions to identify the locations of what they refer to as 'spatial regimes' over an approximately 50 year period [23]. The authors concluded that a spatial regime boundary exists in this region, and has been moving poleward as a consequence of large-scale drivers including woody plant encroachment, fire suppression, and climate change. Using the boundaries identified in this study I seek to determine whether this 'shifting spatial regime' manifests in the grasslands of the Central Great Plains.

Avian distribution and presence data are abundant, easily accessible and, more importantly, provide insights into resource availability and structure at the local and landscape scales. In this Chapter, I first use discontinuity analysis of avian body mass distributions to identify the scaling structures of local avian communities in the Prairie Potholes, Central Mixed Grass, and Eastern Tall Grass regions of the central Great Plains of North America. I then use these distributions to determine whether the shifting spatial regime proposed by [23] manifests in the grassland bird community which is most susceptible to native grassland habitat loss or degradation [24]. Although I find no evidence to

support the hypothesis of the spatial regime boundary suggested in @roberts2019shifting, the results from this study support previous hypotheses that vulnerable species operate at the ‘edge’ of body mass aggregations.

## Methods

### Study area

A recent study [@roberts2019shifting] identified what they refer to as spatial regimes across a large portion of the central United States [see Figure @ref(fig:studyArea)]. The authors hypothesize that a spatial regime boundary exists in the Central Great Plains and suggests it has exhibited a Northward shift at a rate of  $\sim \frac{0.05^\circ \text{ latitude}}{\text{year}}$ . The authors used discontinuity analysis to identify these ‘spatial regimes’, using the body mass of breeding bird communities. Their hypothesized spatial regime boundary occurs at 39° latitude in year 1970, 39.5° latitude in year 1985, 40° latitude in year 2000, and 40.5° latitude in year 2015 (see Figure @ref(fig:routesWithSpatRegimes)). Sampling sites were classified each year as belonging to either the Southern or Northern regime according to whether the location was below (Southern) or above (Northern) the regimes identified by @roberts2019shifting.

The study area is designed such that there is minimal crossing of very different BCR, or habitat types (Figure @ref(fig:studyarea)). In other words, this study area largely falls within BCRs which can be generally classified as grassland habitat (BCR 11, Prairie Potholes; BCR 19, Central Mixed Grass ; BCR 22, Eastern Tall Grass). Using this design we should expect that the functional groups within our avian communities should be similar across BCR boundaries, despite a potential turnover in species identity. Accounting for change in habitat across space allows us to assume that any observed change in the scaling structure of the avian community is due to changes in habitat and resource availability such that similar species are or are not included in the community.

### Data

#### Avian census data - North American Breeding Bird Survey

I constructed body mass distributions using route-level data from the North American Breeding Bird Survey hereafter [NABBS; @bbsData]. The NABBS uses citizen scientist volunteers to annually collect data using a standardized roadside, single observer, 3-minute point count protocol and has organized data collection annually across North America (Figure @ref(fig:bbsPoints)) since 1966. Each roadside survey consists of 50, 3-minute point counts (data collected using sight and sound) along  $\sim 24.5$  mile stretch of road. Although the point counts are designed to collect estimates of relative abundance, the method for building body mass distributions used in this chapter require only presence absence data. I therefore converted abundances to presence-absence data. I considered a species as ‘present’ if it was detected on the year in question or the  $\pm 1$  year to account for potential false negative observations (i.e., a species was not detected in the NABBS route despite its presence in the local community).

#### Identifying avian census locations

To determine whether the spatial regime shifts identified in @roberts2019shifting manifested in local avian community structure, I restricted analysis to the grassland habitat of the Central Great Plains. All routes falling within a rectangular area bounded by coordinates 37.8° and 44.5° latitude, and  $-101^\circ$  and  $-95.5^\circ$  longitude [see Figure @ref(fig:routesWithSpatRegimes)]. I retained all NABBS routes which used the sampling protocol ‘101’, which is the standard method for conducting NABBS point count surveys.

#### Avian body mass data

Species operating at similar spatial and temporal scales are those which are close in body size as identified using statistical aggregation identification techniques [allen\_body\_1999; Section @ref(discontAnaly)]. The interactions among species within a single body mass aggregation are presumed to experience a higher frequency and intensity of interspecific interactions with each other as opposed to those in different aggregations [peterson1998ecological]. Although some species of birds are sexually size dimorphic, I am unaware of any sexually size-dimorphic birds that would likely operate at different spatial and temporal. Therefore, I

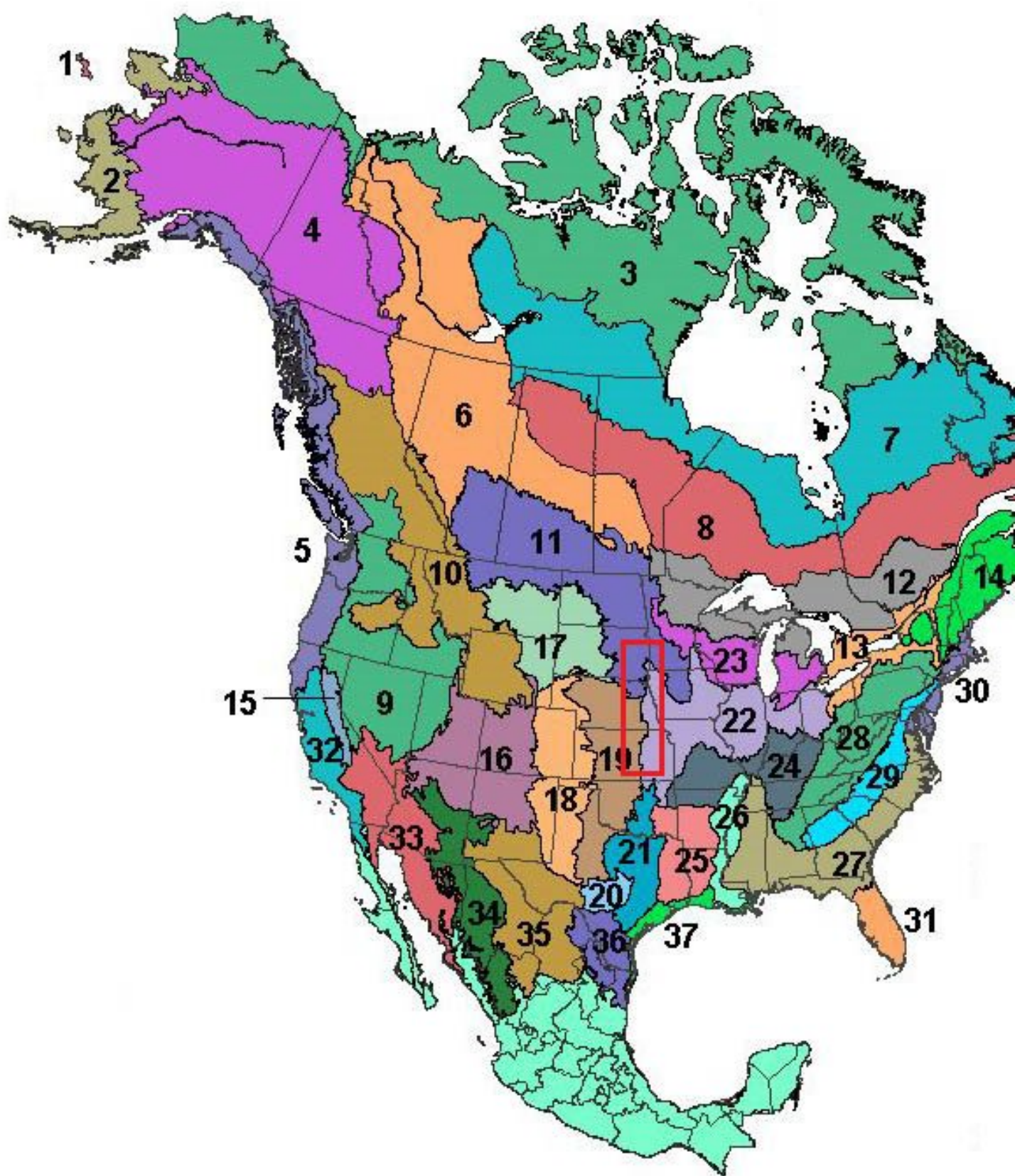


Figure 1: My study area (red box) overlaying the terrestrial Breeding Conservation Regions (BCR) in North America.

constructed body mass distributions of each avian census using the sex-averaged body masses published in @dunning2007crc (available for download at CRC press).

### Removing species from analysis

Due to strict reliance on volunteers, some routes are not covered every year. Although NABBS volunteers attempt identify all species in the point-count area, biases exist in data collection. Rather than retain observations of cryptic or species with low detection rates, I removed select species from the censuses (see Methods section in Chapter @ref(fisherSpatial) for further discussion of this topic). I analyzed species of the following taxonomic families: Accipitriformes, Apodiformes, Cathartiformes, Charadriiformes, Columbiformes, Coraciiformes, Cuculiformes, Galliformes, Gruiformes, Passeriformes and Piciformes. Although removing cryptic, nocturnal, and some crepuscular species (e.g. Caprimulgiformes) from the analysis may yield a more conservative body mass distribution, including them may result in correctly identifying additional scaling structures (or body mass aggregations) in some routes but not in others. This method of exclusion also results in a loss of some medium- and larger-bodied Ciconiiformes (Podicipediformes, Phoenicopteriformes, Ciconiiformes; e.g. grebes, pelicans).

### Taxonomic munging of the census data

Although the NABBS survey reports species-specific abundances, some birds are only classified to genera or order. Common examples of these species are those which are nearly indistinguishable from each other (e.g., Glossy Ibis and White-faced Ibis), birds which are difficult to see under certain conditions (e.g., hummingbirds, fast-moving hawks or accipiters), or species whose songs are similar. Numerous species were presented as identified to family or genus (e.g., Accipiter sp., Buteo sp., and Trochilids sp.) and others are categorized as hybrid.

I made decisions regarding species-specific classification based on the North American breeding range maps provided by the Cornell Lab of Ornithology. Many unidentified species were easily categorized given the lack of overlap in species' ranges in our study area. For example, *Baeolophus bicolor* is nearly indistinguishable from *Baeolophus atricristatus*, however *B. atricristatus* is not known to occur in our study area (Figure @ref(fig:studyarea))—therefore all accounts classified as either *B. bicolor* or *B. atricristatus* were classified as the former. This example occurred for. Informed decisions like of this nature were made regarding the following unidentified species, where the second name in the binomial was assigned as the species preceding the “/”: *Passerina cyanea* / *amoena*, *Corvus brachyrhynchos* / *ossifragus*, *Petrochelidon pyrrhonota* / *fulva*, *Corvus brachyrhynchos*, *Quiscalus major* / *mexicanus*, *Pipilo maculatus* / *erythrophthalmus*, *Sturnella magna* / *neglect*, *Plegadis chihi* / *falcinellus*, *Coccyzus erythrophthalmus* / *americanus*, *Empidonax traillii* / *alnorum*, *Icterus galbula* / *bullockii*, *Nyctanassa nycticorax* / *violacea*, and *Poecile atricapillus* / *carolinensis* were all classified according to their known distributions. I classified unidentified hummingbirds (*Trochilid* sp.) as *Selasphorus rufus*, and unidentified Terns (Tern sp.) as *Chlidonias niger*. All unidentified Accipiters (Accipiter sp.), Buteos (Buteo sp.), and Gulls (Gull sp.) were removed from analysis entirely as there are no clear differences in the probability of occurrence in our study area.

### Identifying species of interest

@allen2006body propose alternative hypotheses for the relative locations of species within the body mass aggregation distributions as a function of ‘distance-to-edge’, a measure indicating the distance (in log-mass units) of each species to the edge of a body mass aggregation (methods described in Section @ref(discontAnaly)). This distance-to-edge measure is zero when the species falls at the edge of a statistically identified body mass aggregation. This species is often referred to as an ‘edge species’.

To determine the effect of spatial regime shifts on edge species, I identified two types of species of interest: (1) grassland obligates species and (2) species with declining trends over last 5 decades.

### Grassland obligates

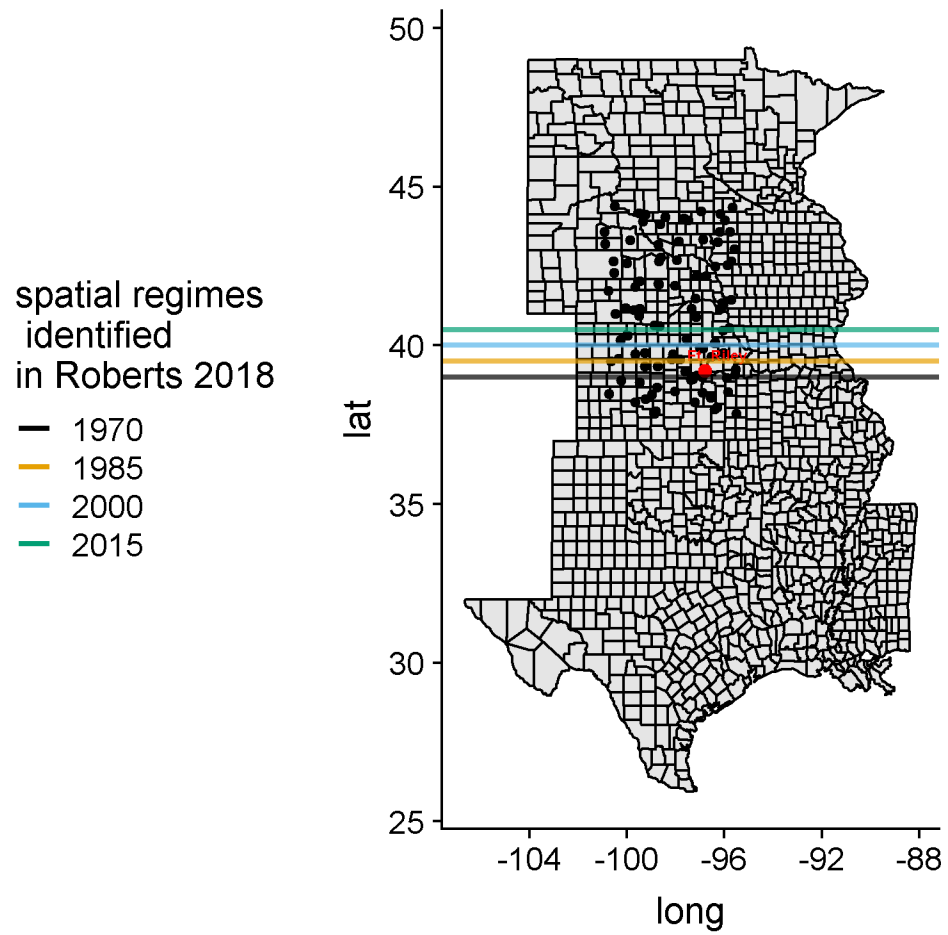


Figure 2: North American Breeding Bird Survey routes (points), latitudinal locations (horizontal bars) of the spatial regimes identified by @roberts2019shifting.

The spatial regimes identified in @roberts2019shifting are attributed to large-scale changes in the landscape, including woody plant invasion. The loss of native grassland in our study area due to land conversion is largely attributed to anthropogenic land use change (e.g., development) and fire suppression. Numerous species have been negatively impacted by this widespread habitat loss, but grassland obligates are particularly at risk. I identified 22 North American grassland obligate species (Table @ref(tab:sppIntTab)) from the grey literature [@shriver2005distribution; @north2009state] and white literatures [@peterjohn1999population]. Although some grassland obligates were positively impacted by the Conservation Reserve Program [CRP; @peterjohn1999population], this group of birds exhibited strong declines in North America until approximately 2003, the year the Farm Bill was adopted [@north2009state].

Grassland obligates should be strong indicators of the large-scale spatial regime shifts identified in @roberts2019shifting, given their high sensitivity to grassland habitat loss [@herkert1994effects; @].

## Declining species

CENTRAL BBS REGION: [https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwiP8Oy8m\\_\\_biAhWrsVQKHx4UCPoQjRx6BAgBEAU&url=https%3A%2F%2Fwww.mbr-pwrc.usgs.gov%2Fbbs%2Ftrend\\_info09.html&psig=AOvVaw3VuZg7WgeEtSj5sRQ7gRRD&ust=1561056688844889](https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwiP8Oy8m__biAhWrsVQKHx4UCPoQjRx6BAgBEAU&url=https%3A%2F%2Fwww.mbr-pwrc.usgs.gov%2Fbbs%2Ftrend_info09.html&psig=AOvVaw3VuZg7WgeEtSj5sRQ7gRRD&ust=1561056688844889) - I used DECLINING SPECIES according to the BBS - those with BLUE trend estimates and NEGATIVE estimates from 1966-2015 - Although other species are declining, their credibilities are lower than blue and therefore are not considered to be species of interest. . . .

BCR - I also included any additionally declining blue species in BCRs 11 (Prairie Potholes) and 22 (Eastern Tallgrass Prairie) - BCR map [http://nabci-us.org/assets/images/bcr\\_map2.jpg](http://nabci-us.org/assets/images/bcr_map2.jpg)

, on the censuses in our study area (Figure @ref(fig:studyarea)) from the Grassland obligate

## Statistical analysis

### Identifying scaling structure of avian communities using body mass distributions

Discontinuities in body mass distributions been quantified using various methods (e.g., multivariate time series models, regression trees, and gap rarity index) which are collectively referred to as 'discontinuity analyses' [@nash2014discontinuities; @barichievy2018method; @stow2007evaluating; @allen2009discontinuities]. Using various methods, the discontinuous nature of body masses of ecological communities is well-documented, having been observed in various taxa of both terrestrial [@allen2006patterns] and aquatic [@spanbauer2016body] communities.

### Identifying the Mixed modelling to *xxx*

If the spatial regime shift occurred in the bird community, it should manifest in the local community scaling structure through one or both of species turnover and a shift in the number of body mass aggregations.

## NOTES random

I first identify the discontinuous structure of the bird community before and after woody encroachment occurring at the landscape-scale. Next, I

on a local bird community

use the body mass distributions of bird communities in the Central Great Plains before and after a large-scale shift in vegetative structure to

bird test the Biotic Interaction Hypothesis, which suggests that the biotic interactions within a community operates at the local scale over a relatively short time scale, thus shaping the body mass distribution of the community.

For example, a recent comparison of body mass distributions in streams of varying quality revealed discontinuous body mass distributions, but no difference in the number of aggregations in the presence of disturbances [@bibi2019body].

extinction @wardwell2009variability - population variability

invasion @allen1999body

regime shifts @spanbauer2016body, suggested in @angeler2016management

@nash2014discontinuities -

as manifested in animal body masses is well-documented, however, the ecological significance of such discontinuous structure remains unknown.

The interactions among species in a single aggregation presumably experience a higher frequency and intensity of interspecific interactions with each other as opposed to those in different aggregations (Peterson and others 1998).

- Given the extent and resolution of our data, we are able to only test the biotic interaction and textural discontinuity hypotheses [@allen2006patterns].
- I used discontinuity analysis to identify potential scales in the body mass distribution of local avian communities [@barichievy2018method].
- “If scale dependent resource variability is introduced into the model, then a single mode can separate into multiple modes (Marquet et al. 1995), indicating an interaction between the distribution of resources in the landscape and body mass aggregations.” from allen2006patterns

## Bibliography: grassland birds in NA

@vickery2001recent – grassland birds experienced widespread declines, in part spurring the beginning of the NABBS program. BBS trend estimates estimated at least 15 species declining over the period of 1966-1996, (Peterjohn and Sauer 1999). Compared to other functional groups or species guilds, grassland obligates seemed to have fared worst. These declines are primarily attributed to habitat loss and degradation. And it is no secret that native grasslands are among the most endangered biomes on the planet (Referece).

The CRP program (beginning in the mid 1980s) appears to have benefitted some species, however. Bobolink, Sedge Wrens, Dickcissels, Le Conte’s sparrows, Henslow’s sparrows.

Species not positively influenced have been the Grasshopper Sparrow, Eastern and Western Meadowlarks (Sauer et al. 1999), despite these species utilizing CRP habitat and for resources . . . . cribbed . . . (Johnson and Schwartz 1993, Best et al. 1997).

@brennan2005north – prairie vegetation loss, intensifying agricultural efficiency and practices, lack of fire, and habitat loss all contribute to the ongoing “crisis” with the loss of grassland and grass-shrub avifauna.

@correll2019quantifying –

## Results

the data summarised

```
temp <- getTab(fn="richTurnStatsTab") %>%
  rename(Year = year,
    `$$\bar{x}$` = meanRich,
    `$$\sigma$` = sdRich,
    `N` = sampSizeRich,
    `$$\bar{x}$` = meanTurn,
    `$$\sigma$` = sdTurn,
    `N` = sampSizeTurn)
  # `Mean richness` = meanRich,
  # `SD` = sdRich,
  # `N` = sampSizeRich,
  # `Mean turnover` = meanTurn,
```



```

# `SD` = sdTurn,
# `N` = sampSizeTurn)

kableExtra::kable(temp, escape = FALSE,
  caption = "Summary statistics for annual species richness and annual turnover in all 1",
  "latex",
  booktabs=TRUE) %>%
  add_header_above(c(" ", "Annual Richness" = 3, "Annual Turnover" = 3))

temp <- getTab(fn="nRtesPerRegimePerYear") %>%
  rename(
    # `# BBS routes` = nLoc,
    Year = year, Regime = regime)
temp <- temp %>% spread(key="Regime",value="nLoc")
kableExtra::kable(temp,
  caption = "Number of NABBS in each regime (South, North) per year.",
  "latex",
  booktabs=TRUE)

```

## interpreting the lme

[http://www.bodowinter.com/tutorial/bw\\_LME\\_tutorial.pdf](http://www.bodowinter.com/tutorial/bw_LME_tutorial.pdf) ## Discussion

South-North shifts in the past 50 years have been demonstrated in bird population ranges (XXX some ornith. papers), climate zones (??? is this true) and in garden hardening zones (USDA; papers talking about this?). The concept of spatial regimes has recently been introduced as a way to describe this shifting of dynamics over space-time [roberts2019shifting; an angeler paper i think did this?; sundstrom2017detecting].

While identifying discontinuities in body mass aggregations and other systems is ubiquitous, much work is needed to sift through the hypotheses for drivers of these patterns [allen2006patterns].

## Study limitations

1. Cross-taxa interactions – bm dists assumes that the bird comm is not competing for resources with other taxa...
2. Annual BBS surveys may not represent true census of the area (aggregating the pres/abs data over multiple years...)
- 3.



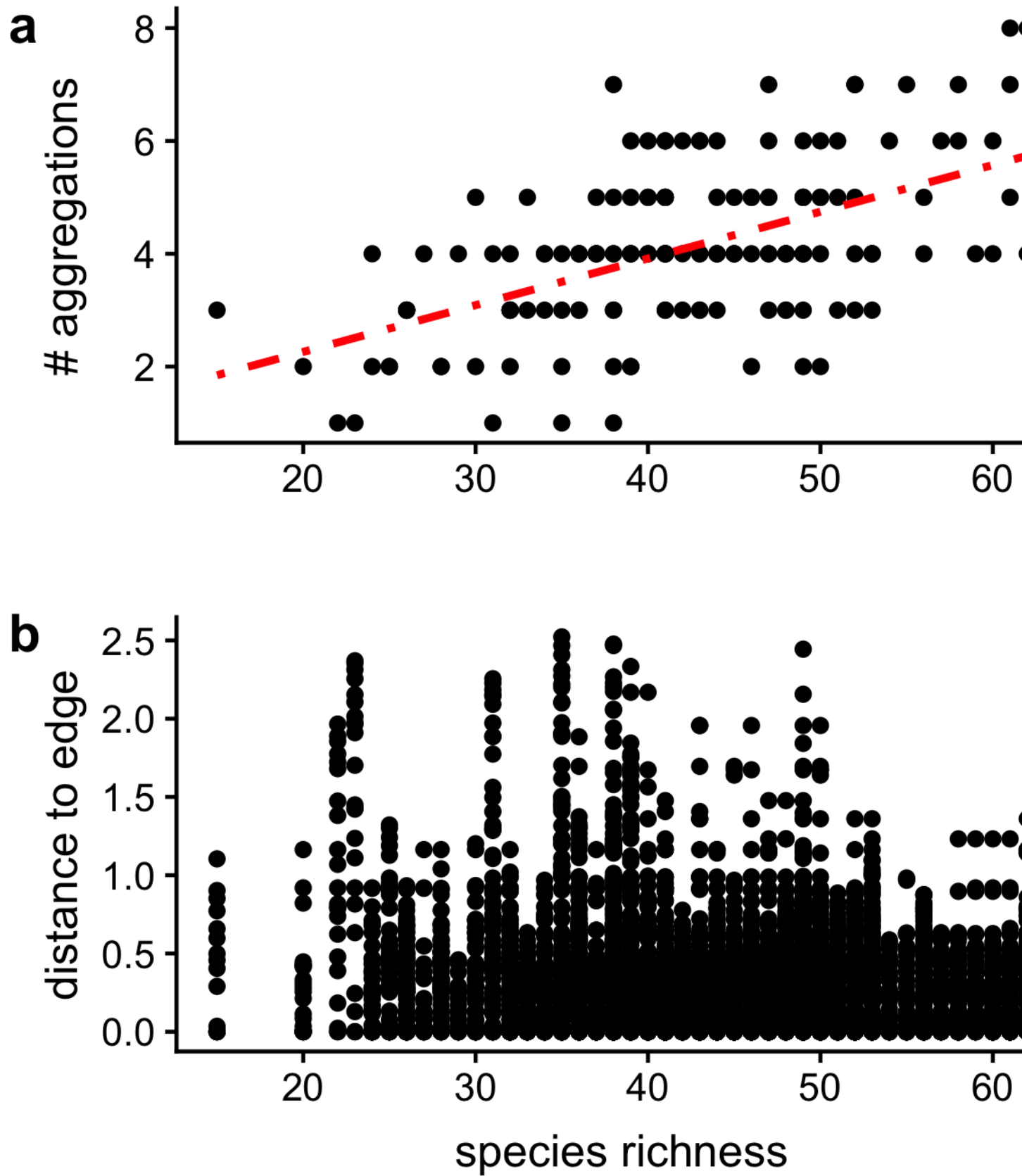


Figure 3: Relationship between species richness per route and (a) the number of aggregations identified in body mass distributions and (b) distance to the edge (units log body mass) of aggregations.

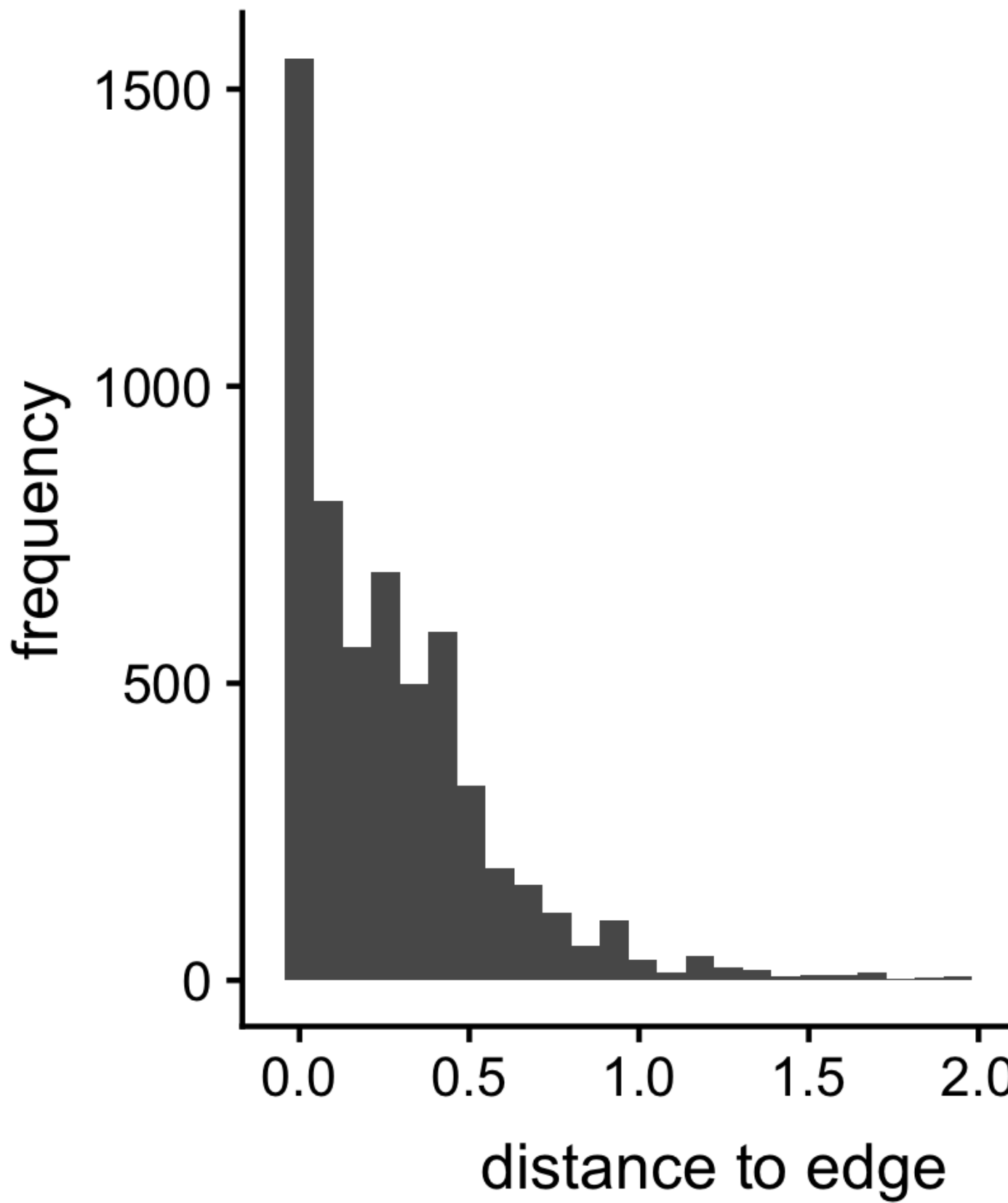


Table 1: Grassland obligates and species with declining trends (1966-2015) in our study area.

English Common Name	Grassland Obligate
\textcolor{red}{American Crow}	
\textcolor{red}{Baltimore Oriole}	
\textcolor{red}{Barn Swallow}	
\textcolor{red}{Belted Kingfisher}	
\textcolor{red}{Bewick's Wren}	
\textcolor{red}{Black-billed Cuckoo}	
\textcolor{red}{Black-billed Magpie}	
\textcolor{red}{Black-capped Chickadee}	
\textcolor{red}{Blue Jay}	
\textcolor{red}{Brewer's Blackbird}	
\textcolor{red}{Brewer's Sparrow}	
\textcolor{red}{Brown Thrasher}	
\textcolor{red}{Bullock's Oriole}	
\textcolor{red}{Carolina Chickadee}	
\textcolor{red}{Chimney Swift}	
\textcolor{red}{Clay-colored Sparrow}	
\textcolor{red}{Common Grackle}	
\textcolor{red}{Common Tern}	
\textcolor{red}{Common Yellowthroat}	
\textcolor{red}{Curve-billed Thrasher}	
\textcolor{red}{Downy Woodpecker}	
\textcolor{red}{Eastern Kingbird}	
\textcolor{red}{European Starling}	
\textcolor{red}{Gray Partridge}	
\textcolor{red}{Great Crested Flycatcher}	
\textcolor{red}{Greater Prairie-Chicken}	
\textcolor{red}{House Sparrow}	
\textcolor{red}{Kentucky Warbler}	
\textcolor{red}{Killdeer}	
\textcolor{red}{King Rail}	
\textcolor{red}{Loggerhead Shrike}	
\textcolor{red}{Marbled Godwit}	
\textcolor{red}{Mourning Dove}	
\textcolor{red}{Northern Bobwhite}	
\textcolor{red}{Northern Harrier}	
\textcolor{red}{Northern Mockingbird}	
\textcolor{red}{Orchard Oriole}	
\textcolor{red}{Ovenbird}	
\textcolor{red}{Prothonotary Warbler}	
\textcolor{red}{Purple Martin}	
\textcolor{red}{Red-bellied Woodpecker}	
\textcolor{red}{Red-headed Woodpecker}	
\textcolor{red}{Red-winged Blackbird}	
\textcolor{red}{Rock Pigeon}	
\textcolor{red}{Rock Wren}	
\textcolor{red}{Scissor-tailed Flycatcher}	
\textcolor{red}{Song Sparrow}	
\textcolor{red}{Western Kingbird}	
\textcolor{red}{Willet}	
\textcolor{red}{Wood Thrush}	11
\textcolor{red}{Yellow-bellied Sapsucker}	
\textcolor{red}{Yellow-billed Cuckoo}	
\textcolor{red}{Baird's Sparrow}	

Table 2: Summary statistics for annual species richness and annual turnover in all NABBS routes in study area.

Year	Annual Richness			Annual Turnover		
	$\bar{x}$	$\sigma$	N	$\bar{x}$	$\sigma$	N
1967	39.37037	8.143653	27	-0.0740741	8.133151	27
1968	41.43243	8.108776	37	1.6216216	10.245192	37
1969	39.87234	7.444336	47	0.6382979	10.119773	47
1970	41.25581	7.733948	43	0.9069767	9.743897	43
1971	39.44444	7.496454	36	0.6944444	10.617558	36
1972	41.00000	9.804541	32	-1.1562500	12.941829	32
1973	40.06061	8.328938	33	-2.1212121	10.415606	33
1974	38.77778	7.672796	27	-2.2222222	10.529568	27
1975	38.34375	7.368676	32	-1.4062500	9.574359	32
1976	41.17778	7.529605	45	0.6000000	10.307544	45
1977	39.48837	8.475095	43	-1.6976744	9.694217	43
1978	39.45238	8.876393	42	-1.8809524	10.087912	42
1979	39.72093	8.060266	43	-1.6744186	10.027868	43
1980	40.40541	7.181997	37	-1.0810811	10.160868	37
1981	41.20513	8.763499	39	-1.1794872	9.264737	39
1982	42.31250	6.649945	32	-1.5937500	8.280795	32
1983	41.30303	8.472326	33	-1.9393939	8.909052	33
1984	41.68182	7.852124	22	-4.0909091	6.117182	22
1985	40.76471	8.538891	34	-1.0882353	11.298613	34
1986	42.15625	9.172573	32	-2.6562500	10.415898	32
1987	43.42105	8.943159	38	-1.2631579	9.816380	38
1988	41.72973	9.350130	37	-1.4324324	12.191847	37
1989	42.30000	8.668244	40	-1.7500000	9.981393	40
1990	42.26316	9.471677	38	-1.6315789	9.690957	38
1991	43.30000	9.692336	30	-2.1000000	10.144984	30
1992	44.61290	7.517435	31	-0.8387097	9.605890	31
1993	42.73171	9.351536	41	-0.9756098	12.869514	41
1994	43.42105	9.761013	38	0.3684211	12.495234	38
1995	42.17949	9.983860	39	-0.7692308	12.751598	39
1996	44.13889	7.437944	36	1.0277778	10.681054	36
1997	44.58974	9.449918	39	1.0256410	12.652204	39
1998	43.84375	8.998600	32	-1.9062500	12.245761	32
1999	45.89286	9.523224	28	-1.7857143	11.663038	28
2000	45.80357	9.303801	56	0.4821429	11.855173	56
2001	46.54348	8.508052	46	0.6521739	11.948440	46
2002	46.80000	8.939707	50	0.4800000	13.908212	50
2003	48.12281	9.836285	57	-0.1929825	13.105940	57
2004	45.79592	10.879988	49	0.0612245	13.973797	49
2005	46.30769	9.129866	52	-0.5961538	11.202695	52
2006	46.23077	10.461161	52	-0.4807692	11.941837	52
2007	46.70175	9.587874	57	0.3157895	11.288676	57
2008	48.19149	11.001261	47	1.0425532	14.841126	47
2009	47.75000	9.923801	56	-0.3750000	12.109444	56
2010	47.37778	9.620737	45	-0.9111111	11.927474	45
2011	47.00000	10.531526	47	-1.0425532	14.609344	47
2012	47.73913	10.328891	46	0.6521739	13.463064	46
2013	46.96491	10.026687	57	1.0526316	13.500557	57
2014	47.76271	9.353847	59	-0.1525424	11.223150	59
2015	48.46939	9.325373	49	0.3877551	10.793162	49
2016	50.84091	9.383169	44	1.9545455	12.727839	44
2017	47.57778	9.838442	45	0.1777778	11.826555	45

Table 3: Number of NABBS in each regime (South, North) per year.

Year	North	South	testing
1967	38	11	NA
1968	43	12	NA
1969	53	11	NA
1970	45	17	NA
1971	43	13	NA
1972	38	17	NA
1973	39	15	NA
1974	29	17	NA
1975	41	16	NA
1976	46	18	NA
1977	47	16	NA
1978	45	18	NA
1979	46	17	NA
1980	43	16	NA
1981	40	18	NA
1982	38	16	NA
1983	37	16	NA
1984	30	14	NA
1985	30	24	NA
1986	31	21	NA
1987	36	21	NA
1988	34	24	NA
1989	33	25	NA
1990	40	21	NA
1991	31	22	NA
1992	33	23	NA
1993	39	23	NA
1994	37	23	NA
1995	37	22	NA
1996	39	22	NA
1997	36	24	NA
1998	34	21	NA
1999	32	23	NA
2000	NA	NA	74
2001	NA	NA	65
2002	NA	NA	68
2003	NA	NA	74
2004	NA	NA	70
2005	NA	NA	74
2006	NA	NA	74
2007	NA	NA	75
2008	NA	NA	69
2009	NA	NA	76
2010	NA	NA	67
2011	NA	NA	71
2012	NA	NA	68
2013	NA	NA	76
2014	NA	NA	80
2015	36	33	NA
2016	37	30	NA
2017	35	32	NA