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Waterfowl Populations and the Conservation Reserve Program in the Prairie Pothole Region of North and South Dakota

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Abstract

Newly proposed rules governing future CRP enrollments are causing concern among groups interested in using CRP to maintain and enhance waterfowl habitat in the region. A collaborative effort between economists at the Center for Agricultural and Rural Development at Iowa State University and wildlife biologists working for the U.S. Fish and Wildlife Service in Bismarck, North Dakota, demonstrates the feasibility of incorporating an objective measure of wildlife habitat into rules that can be used for CRP targeting.

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Executive Summary

One of the important environmental benefits of CRP land in the prairie pothole region of North and South Dakota is the enhancement of waterfowl habitat. This benefit was achieved even though the primary purpose of CRP was control of soil erosion and commodity supply. Since 1990, CRP enrollment rules have de-emphasized supply control while focusing on water quality. This change has resulted in relatively fewer newly enrolled acres in the Great Plains region (particularly North and South Dakota) and relatively more acreage in the Eastern Corn Belt.

The newly proposed rules governing future CRP enrollments continue the focus on enhancing water quality and reducing soil erosion. Groups interested in using CRP to maintain and enhance waterfowl habitat in the prairie pothole region fear that this focus on soil erosion and water quality may not result in adequate land being enrolled in the region. However, the proposed rules allow land to be enrolled if it offers significant wildlife benefits. But the problem with targeting wildlife benefits is that quantification of a land parcel's wildlife benefits is difficult. This report contains the results of a collaborative research effort between economists working in the Center for Agricultural and Rural Development at Iowa State University, and wildlife biologists working for the U. S. Fish and Wildlife Service in Bismarck, North Dakota. The objective of the collaborative effort was to demonstrate the feasibility of incorporating an objective measure of wildlife habitat into rules that can be used for CRP targeting.

The four questions addressed in this report are: (1) How well did old CRP targeting rules do at obtaining good waterfowl habitat? (2) What kind of habitat improvements could we expect if we retargeted land within Wetland Management Districts (WMDs)? (3) What improvements could we expect if we retargeted land both within and between WMDs? And, (4) What would be the likely consequences on waterfowl habitat if soil erosion reductions were the main enrollment criterion?

To answer these questions we used potential waterfowl densities estimated from models developed by the U.S. Fish and Wildlife Service and the U.S. Geological Survey. These estimated densities are reported in maps showing the potential number of breeding pairs attracted to 40-acre units in the 15 WMDs. We obtained estimates of the distribution of CRP land from a random sample of 4-square-mile plots in North and South Dakota.

We first estimated the wildlife benefits from the current distribution of CRP by locating the coordinates of each 4-square-mile plot and overlaying it on the waterfowl density maps. We found that the density of waterfowl breeding pairs under the current distribution of CRP land is only 12.5% greater than what would have been obtained had land been randomly enrolled. This suggests that the old enrollment rules did a relatively poor job of targeting good waterfowl habitat.

We then estimated the improvements in habitat under the assumption that CRP land within WMDs can be retargeted to the best waterfowl habitat. Such a retargeting would about double the density of breeding pairs obtained under the current distribution of CRP land. The magnitude of this increase varies widely across WMDs depending on the spatial variability of waterfowl habitat within each WMD.

Further improvements in breeding pairs could be obtained if CRP land were allowed to also move between WMDs because different WMDs offer different average qualities of waterfowl habitat. We estimate that allowing movement of CRP between WMDs would only increase the number of breeding pairs by about 8% over the level achieved by retargeting within WMDs.

We also find some evidence that enrolling land based on soil erosion levels would not, in general, be good at obtaining land with high waterfowl densities. Too much of the highly erodible land in many of the productive WMDs is simply not good waterfowl habitat.

Conclusions that can be drawn from this research are as follows. First, using the estimated waterfowl breeding pair distributions from this report is a feasible method for targeting wildlife benefits on CRP land. Second, the old CRP targeting rules and rules that target only soil erosion will provide some habitat, but not nearly the level that could be achieved if habitat is targeted directly. And third, it is more important to focus targeting efforts within multiple county regions rather than between regions. This conclusion is consistent with CRP rules that do not allow more than 25% of cropland in a county to be enrolled. The conclusion also enhances the value of the waterfowl breeding pair distributions as an indicator of broader wildlife benefits.

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Introduction

What to do with the Conservation Reserve Program (CRP) is a question that has been in the policy forefront since 1995. The original intent of the program was to retire cropland from production to reduce commodity supplies and soil erosion. Beginning in 1986, these objectives were accomplished by removing about 36.4 million acres of land from production, at a annual cost of about $1.9 billion. In addition, just under $1.3 billion worth of cost sharing agreements encouraged CRP participants to establish permanent grass and legume cover, and to plant trees on just over 32 million acres of contracted land. The objectives of the CRP evolved beginning with the post-1990 sign-ups, when the program began to enroll land based on the ratio of environmental quality to per-acre cost with an objective of improving the environmental performance of the program (Osborn, 1993; Thurman, 1995). Environmental objectives were expanded to include wetlands protection, scour erosion reduction, conservation in priority areas, water quality enhancement and well head protection. Osborn (1993) reports that this change in enrollment criteria did indeed increase the environmental benefit to cost ratio of the land enrolled in these later sign-ups. However, less than five% of total CRP acreage was enrolled based on these secondary criteria.[1]

The new USDA rules (Federal Register, vol. 61, No. 185, September, 23, 1996) propose to maintain the CRP as an environmental program. The new rules effectively prohibit the extension of existing CRP contracts when they expire. All new CRP contract bids will be accepted on the basis of an environmental benefits to cost ratio. The proposed rules for future CRP contracts clearly indicate a desire of the present administration to target cropland based on a set of environmental objectives: "The Administration's policy is simply this: we establish enrollment criteria based on sound environmental considerations and accept acreage as it meets [these criteria]. ...we are making every effort to enroll land with the highest environmental

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[1] See Osborn, Llacuna and Linsenbigler, The Conservation Reserve Program: Enrollment Statistics for Signup Periods 1-12 and Fiscal Years 1986-93, United States Department of Agriculture, Economic Research Service, Statistical Bulletin Number 925.

benefits at the least cost to the taxpayers.[2]" Increased emphasis on targeting along with continued concerns about the federal budget deficit strengthen the need for carefully developed targeting criteria. Since it is currently not feasible to target all facets of environmental quality, it is important to choose feasible targets that are indicative of significant environmental concerns.

This report selects one such target, waterfowl, and demonstrates how important biological and spatial information can be integrated to measure the environmental impact of the current CRP on wetland and upland wildlife habitat. Upland nesting waterfowl represent a good indicator group for wetland and upland habitat because they require both to be successful. Wetlands provide food and protection for breeding pairs and broods, and upland cover is needed for nesting. Without both high quality wetland and upland habitats, waterfowl and their offspring are increasingly susceptible to predation. Therefore, the quality of habitat provided for many other upland and wetland species should be highly correlated to quality waterfowl habitat. Specifically, our indicator of the quality of habitat is the potential density of waterfowl breeding pairs attracted to a specific geographic location. For this exercise, we confine our analysis to fifteen wetland management districts (WMDs) in the prairie pothole region of North and South Dakota. To analyze the differences in wetland habitat, we develop Lorenz curves that measure spatial heterogeneity within a WMD. These Lorenz curves are one indicator of where poor targeting can be the most problematic and proper targeting can be the most beneficial. We then calculate the average potential density of waterfowl breeding pairs given the current distribution of CRP land. We also calculate the average potential density of waterfowl breeding pairs if CRP land was randomly selected, and if CRP land could be optimally targeted.

Three conclusions can be drawn from this analysis. First, the potential for improved targeting varies widely across WMDs. Second, under the previous CRP rules the potential density of waterfowl breeding pairs is only slightly higher than if the program had randomly enrolled land without concern for waterfowl habitat. Third, additional gains in waterfowl populations can be achieved by retargeting land between WMDs. However, the marginal gains from retargeting optimally between WMDs are not as large as the marginal gains from optimally targeting within WMDs. This implies that the benefits to other bird species and local economies

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[2] Remarks prepared for Secretary of Agriculture Dan Glickman, CRP rule announcement, Washington, D.C., September 18, 1996.

derived from a broad geographical distribution of CRP can be maintained while still achieving most of the potential gains from optimal targeting of waterfowl habitat.

Methods

Assessing the impact of CRP on waterfowl populations requires two pieces of spatial information. First, wetland habitat that attracts waterfowl must be identified. Second, the spatial distribution of CRP land must be identified. These two pieces of information can be overlaid to determine whether or not the spatial distribution of CRP land coincides with the distribution of attractive waterfowl habitat.

The potential waterfowl density for five species of ducks[3] was determined by applying biological models developed by the U.S. Fish and Wildlife Service (USFWS) Habitat and Population Evaluation Team (HAPET), and the U.S. Geological Survey, Biological Resource Division, Jamestown, ND, to digital wetland data derived from the USFWS National Wetlands Inventory (NWI) database for North and South Dakota. First, NWI wetland data was reclassified to a system similar to that described by Stewart and Kantrud (1971). Duck pair counts from a sample of each class were used to develop regression models. These regression models were used to calculate the number of waterfowl breeding pairs attracted to and potentially supported by each wetland within the fifteen WMDs of North and South Dakota. Next, each WMD was partitioned into 40-acre units, and the number of estimated waterfowl breeding pairs for each wetland was combined with breeding hen home range data to calculate the potential density of waterfowl breeding pairs proximate to each 40-acre unit. The results were displayed as a map representing all 40-acre units grouped into seven categories of waterfowl breeding pair densities (pairs/mi^2). Each category was determined by partitioning the land into seven nonuniform quantiles based on these rankings: 0 to 20, 20 to 40, 40 to 60, 60 to 80, 80 to 95, 95 to 99.5, and 99.5 to 100% of the all land.[4]

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[3] The five species of ducks used to determine potential waterfowl habitat included the blue winged teal (Anas discors), gadwall (A. strepera), mallard (A. platyrhynchos), northern pintail (A. acuta), and the northern shoveler (A. clypeata).

[4] A more detailed account of the methods used to construct potential waterfowl habitat maps can be found in Reynolds, Cohan and Johnson (1996).

The distribution of CRP land within the prairie pothole region of North and South Dakota was determined for 335 randomly selected 4-square-mile plots. The sample, derived from Cowardin, et. al. (1988) was stratified based on three landownership classes: USFWS owned, USFWS easement and all other. Of the 335 plots that fell within the prairie pothole region of North and South Dakota, 195 plots contained more than 10 acres of CRP land. The distribution of CRP within each of these 195 plots was mapped into 10-acre units using spatial land use data. Each 10-acre unit was then assigned an expansion factor according to Cowardin et. al.'s (1988) original stratification. The estimated acreage of CRP in the fifteen WMDs given the random sample of plots and the expansion factor is 3.69 million acres. The same figure obtained from the National Resource Inventory database is 3.62 million acres.

The distribution of CRP acreage within the seven quantiles of waterfowl breeding pair densities was determined by identifying the location of each 4-square-mile plot and overlaying it on the waterfowl density maps. For each WMD, the proportion of CRP acreage in each of the seven quantiles was calculated by taking the weighted average of the distribution of CRP acreage in the randomly selected plots. Weights were calculated based on the proportion of the total CRP acreage in each random plot and the expansion factor.

Results

Three important questions can be addressed with these data. First, a measure of spatial heterogeneity can be calculated. This measure indicates which WMDs would benefit the most from targeting. If the distribution of wetlands throughout a WMD is uniform such that the number of breeding pairs varies only slightly across the landscape, then targeting mistakes will generally not be too costly. However, if the distribution of wetlands in a WMD varies such that some areas will support large numbers of breeding pairs while others support few breeding pairs, then targeting mistakes can have serious consequences. Second, the efficacy of the current distribution of CRP land can be assessed in terms of the potential density of waterfowl breeding pairs. If the current CRP is well targeted based on the measures of erodibility used to enroll most of the current CRP land, this would suggest that quality waterfowl habitat is highly correlated with erodible cropland and that there may be no need to explicitly target this habitat on its own merit. However, if the current CRP land tends to be poorly correlated with quality waterfowl habitat, then the previous enrollment criteria does not provide the best targeting mechanism to benefit waterfowl. Third, the gains to retargeting the current CRP land between WMDs can be evaluated. Current rules limit the amount of CRP land enrolled in any county to no more than 25% of the county's total cropland acreage. These enrollment limitations were designed to limit the impact of the CRP on local economies. However, if there are large benefits to concentrating CRP land within a county or WMD, then there may be sufficient rational for eliminating these restrictions in future CRP sign-ups.

Figure 1 shows the location of each WMD in the prairie pothole region of North and South Dakota. Table 1 reports CRP acreage, total acreage, and the proportion of total acreage in CRP for each WMD, for all WMDs within North and South Dakota, and for all WMDs combined. Table 2 reports the distribution of CRP as well as the distribution of total acreage between WMDs. The proportion of total acreage in CRP ranges from a high of 11.3% in Chase

Table 1: CRP acreage, total acreage and the proportion of CRP acreage for each wetland management district in North and South Dakota.[a]

	Wetlands Management District[b]	CRP Acreage[c]	Total Acreage[c]	Proportion of Total Acreage in CRP
North Dakota		2470.8	32751.6	7.5%
	Arrowwood	84.6	824.9	10.3%
	Audubon	262.9	3448.8	7.6%
	Chase Lake	259.6	2297.4	11.3%
	Crosby-Lostwood	328.6	4172.0	7.9%
	Devils Lake	371.8	6500.4	5.7%
	J.Clark Salyer	376.4	4176.9	9.0%
	Kulm	253.3	2750.2	9.2%
	Long Lake	273.2	2979.5	9.2%
	Tewaukon	137.4	2032.2	6.8%
	Valley City	123.0	3569.2	3.4%
South Dakota		1147.1	21432.6	5.4%
	Huron	204.8	4497.1	4.6%
	Lake Andes	86.6	5133.4	1.7%
	Madison	137.7	3779.9	3.6%
	Sand Lake	429.6	4514.2	9.5%
	Waubay	288.4	3507.9	8.2%
	Total	3617.9	54184.2	6.7%

[a] CRP acreage and total acreage obtained from the National Resource Inventory data.

[b] Crosby-Lostwood includes Crosby and Lostwood WMDs, and Arrowwood WMD has been split into Arrowwood and Chase Lake.

[c] Thousands of acres.

Lake to a low of 1.7% in Huron. On average, 6.7% of total acreage is in CRP. CRP acreage is more concentrated in the WMDs of North Dakota which contain 68.3% of the CRP acreage even though they account for only 60.4% of the total land.

Spatial heterogeneity

Spatial heterogeneity is measured using a Lorenz curve and its associated Gini coefficient. Lorenz curves are calculated by ranking quantiles based on waterfowl breeding pair densities, and by taking the cumulative distribution of land starting with the highest waterfowl breeding pair densities. Figure 2 presents the Lorenz curve for the entire prairie pothole region. The vertical axis in Figure 2 is the cumulative proportion of potential waterfowl breeding pairs, while the horizontal axis is the cumulative proportion of land ranked from the highest breeding pair density to the lowest. For example, Figure 2 implies that the best 20% of waterfowl habitat in the prairie pothole region of North and South Dakota attracts 40% of the potential waterfowl breeding pairs. The forty-five degree line represents a homogeneous landscape. If all the land within the prairie pothole region was equally attractive waterfowl habitat, the Lorenz curve

Table 2: Distribution of CRP and total acreage by wetland management district in North and South Dakota.

	Wetlands Management District	Proportion of CRP Acreage	Proportion of Total Acreage
North Dakota		68.3%	60.4%
	Arrowwood	2.3%	1.5%
	Audubon	7.3%	6.4%
	Chase Lake	7.2%	4.2%
	Crosby-Lostwood	9.1%	7.7%
	Devils Lake	10.3%	12.0%
	J.Clark Salyer	10.4%	7.7%
	Kulm	7.0%	5.1%
	Long Lake	7.6%	5.5%
	Tewaukon	3.8%	3.8%
	Valley City	3.4%	6.6%
South Dakota		31.7%	39.6%
	Huron	5.7%	8.3%
	Lake Andes	2.4%	9.5%
	Madison	3.8%	7.0%
	Sand Lake	11.9%	8.3%
	Waubay	8.0%	6.5%

would fall on this forty-five degree line. The bow or concavity of the Lorenz curve indicates spatial heterogeneity. The more bowed the Lorenz curve, the more variable the landscape in terms of potential waterfowl breeding pair densities. If all the attractive waterfowl habitat fell within a single unit of land, then the Lorenz curve would lie on the left hand-side and top of the unit box.

A measure of the bow or concavity of a Lorenz curve is the area between the 45-degree line and the Lorenz curve. This area can be normalized by dividing this area by the total area above the 45-degree line. This normalization is referred to as the Gini coefficient. When the Gini coefficient is equal to zero, the Lorenz curve falls on the 45-degree line signifying a perfectly homogeneous landscape. As the concavity of the Lorenz curve increases more area falls between the Lorenz curve and the 45-degree line, and the Gini coefficient increases. If all attractive waterfowl wetland habitat fell within a single unit of land, the Gini coefficient would equal one. Note that the Gini coefficient for the entire prairie pothole region is 0.341 which provides a benchmark for comparison.

Figures 3 and 4 present Lorenz curves and report Gini coefficients North Dakota (figure 3) and South Dakota (figure 4) prairie pothole regions. First, notice that the Lorenz curve for North Dakota is more concave. This is also seen by comparing Gini coefficients. North Dakota's Gini coefficient is 0.348 as compared to 0.329 for South Dakota. This implies that targeting can have the greatest relative impact in the northern WMDs, although the difference is not great.

Figures 5 through 19 present Lorenz curves and report Gini coefficients for each of the WMDs. Arrowwood, Audubon, Chase Lake, Huron, J. Clark Salyer, Kulm, Madison, Sand Lake, and Waubay have generally less variable landscapes on average, while Crosby-Lostwood, Devils Lake, Lake Andes, Long Lake, Tewaukon and Valley City have more variable landscapes on average. The most variable landscape falls in Valley City which has a relatively high Gini coefficient of 0.517. Devils Lake and Tewaukon also have relatively high Gini coefficients of 0.438 and 0.435. The least variable landscape falls in Arrowwood, while J. Clark Salyer, Chase Lake and Kulm also have relatively homogeneous landscapes.

While the Gini coefficients are indicative of areas where targeting can be most effective, they can not be used without additional consideration of the magnitude of potential waterfowl populations. For example, just because Valley City has a very heterogeneous landscape it will become clear below that much of the landscape within Valley City is not very attractive waterfowl habitat. Therefore, while relative gains may be large, absolute gains may not. Conversely, Audubon is less heterogeneous on average, but its landscape as a whole supports more waterfowl breeding pairs than Valley City. Small relative changes within Audubon represent large absolute changes in potential waterfowl breeding pair densities.

Targeting Within WMDs

Gini coefficients illustrate the potential for beneficial targeting within a WMD. However, further insight is gained by comparing the average potential density of waterfowl breeding pairs for an optimal, actual, and random distribution of CRP land. These averages can also be used to construct a CRP targeting index that shows how well the current CRP land is distributed within a particular WMD.

The average potential density of waterfowl breeding pairs associated with a random distribution of CRP was calculated by taking a weighted average of the seven nonuniform quantiles. If CRP land was randomly selected across the landscape without regard for waterfowl habitat, the proportion of CRP that falls into any one quantile will on average be equal to the proportion of the total land represented by that quantile. Therefore, the weights used to obtain the average for all quantiles are equal to the percentage of land represented by each quantile.

The average potential density of waterfowl breeding pairs associated with the actual distribution of CRP was calculated by using the proportions obtained from the stratified random sample. Recall that these proportions were calculated by weighting the distribution of CRP in each randomly selected plot by the proportion of total CRP acreage in that plot and the expansion factor. After estimating the actual distribution of CRP across the seven quantiles, the weighted average was calculated using this distribution.

The average potential density of waterfowl breeding pairs associated with an optimal distribution of CRP was determined by calculating the proportion of CRP land that would fall in each of the seven quantiles under an optimal distribution. First, the total available land in each quantile was calculated.[5] Then, as much CRP land as possible was assigned to the most

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[5] The total available acreage in each quantile was based on the total land mass of the WMD. This method will bias the calculated average upward because in most instances the total land mass in each quantile will not be eligible for

productive quantiles first until there was no more CRP acreage left to assign. A weighted average was then calculated based on the proportion of the total CRP land that fell in each quantile under this optimal distribution.

Weighted averages are also calculated for the subset of WMDs in North Dakota, the subset in South Dakota, and for all WMDs combined. These weighted averages are calculated by weighting each WMD average by the proportion of the total land it encompasses.

The CRP targeting index is the ratio of the difference between the actual and random averages, and the difference between the optimal and random averages: CRP targeting index $= \frac{W_A - W_R}{W_O - W_R}$ where W_A is the average density of waterfowl breeding pairs associated with the actual distribution of CRP land, W_R is the average density of waterfowl breeding pairs associated with the random distribution of CRP land, and W_O is the density of waterfowl breeding pairs associated with the optimal distribution of CRP land. A value of one indicates that the land was optimally targeted. Values between one and zero indicate that the actual distribution of CRP was targeted better than if the CRP land had been randomly selected. Larger numbers indicate better targeting. A value equal to zero implies that the land was essentially randomly targeted without regard for waterfowl habitat. Values below zero indicate that random targeting would have improved potential waterfowl densities relative to the actual distribution of CRP.

Table 3 reports the weighted averages and the CRP targeting index for each WMD, WMDs in North and South Dakota, and all WMDs combined. The average density of waterfowl breeding pairs per square mile is 73.2. If CRP was randomly distributed, the average density of waterfowl breeding pairs would be 32.8. With the actual distribution of CRP, the average density of waterfowl breeding pairs is estimated to be 36.9. The targeting index of 0.100 indicates that the actual distribution of CRP was better than random, but only slightly.

The density of waterfowl breeding pairs varies greatly within the individual WMDs of North Dakota. The range of averages for the optimal distribution is 94.8 to 49.9, while these

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the CRP program. In general, only privately owned cropland is eligible for the CRP, and only 25% of the cropland in any given county is eligible. Therefore, placing all of the most attractive waterfowl habitat into the CRP program may not be feasible. Unfortunately, the data needed to calculate the feasible optimum are not yet available same ranges for the actual and random distributions are 61.0 to 19.6 and 45.7 to 13.7. Even more indicative of the differences between North Dakota WMDs is the targeting index which ranged from a high of 0.436 in Tewaukon to a low of -0.126 in Kulm. In fact, for three of the ten WMDs in the north including Devils Lake, J. Clark Salyer and Kulm, average densities of waterfowl breeding pairs could have been higher if targeting would have been random. However, three of the ten WMDs had CRP targeting indexes above 0.200.

Variation in the South Dakota WMDs was less pronounced. Average waterfowl breeding pair densities for the optimal, average, and random distributions are 72.9 to 60.8, 38.0 to 22.1 and 31.4 to 21.8. The CRP targeting index ranges from 0.338 in Lake Andes to -0.086 in Madison. Only one out of the five South Dakota WMDs could have been better targeted randomly, but only one had a CRP targeting index above 0.200.

Table 3: Average potential waterfowl pairs (per mile^2) associated with CRP land in the prairie pothole region of North and South Dakota.

Wetlands Management District		Optimal Distribution[a]	Actual Distribution	Random Distribution	CRP Targeting Index
North Dakota		77.5	39.5	34.9	0.107
	Arrowwood	55.7	36.3	31.8	0.191
	Audubon	94.6	61.0	45.7	0.312
	Chase Lake	76.0	43.6	41.7	0.056
	Crosby-Lostwood	94.8	54.0	37.1	0.292
	Devils Lake	72.7	22.2	26.4	-0.090
	J.Clark Salyer	79.8	36.4	41.0	-0.118
	Kulm	73.2	34.5	38.8	-0.126
	Long Lake	62.6	30.7	26.5	0.118
	Tewaukon	88.0	56.7	32.6	0.436
	Valley City	49.9	19.6	13.7	0.165
South Dakota		63.9	31.3	28.4	0.081
	Huron	72.9	38.0	31.4	0.159
	Lake Andes	64.5	36.2	21.8	0.338
	Madison	62.9	22.1	25.3	-0.086
	Sand Lake	60.8	31.9	29.6	0.071
	Waubay	62.6	28.6	28.0	0.018
	Average[b]	73.2	36.9	32.8	0.100

[a] Assumes that the top 20% of potential waterfowl habitat is eligible for CRP.

[b] Weighted average based on CRP acreage in each wetlands management district.

The North Dakota WMDs have higher average waterfowl pair densities than the South Dakota WMDs. The North Dakota WMDs are also targeted better on average. Almost a third of the WMDs in North Dakota were poorly targeted and about another third were relatively well targeted. In the South Dakota only one of the five WMDs is poorly targeted, but again only one of the five is relatively well targeted. Two of the five South Dakota WMDs are not targeted much better than random. The remaining South Dakota WMD is targeted better than average, but not nearly as well as the best WMDs in the combined area.

Recall that the Gini coefficients indicate that the potential for targeting is greater in North Dakota than in the South Dakota. The estimated potential density of waterfowl breeding pairs and the CRP targeting index indicates that the North Dakota WMDs are targeted better. Overall, there appears to be sufficient potential to improve targeting within WMDs. Only three of the WMDs had targeting indexes above 0.300. This implies that for only three of the fifteen WMDs the actual distribution of CRP captured about 30% of the optimal potential density of waterfowl breeding pairs relative to random targeting. Admittedly, the upward bias in the estimates for the optimal density of waterfowl breeding pairs deflates the CRP targeting index. However, while this bias implies that positive CRP targeting indexes are actually larger, it also implies that negative CRP targeting indexes are larger.

Redistribution Between WMDs

The previous results were obtained by maintaining the current distribution of CRP land among WMDs. While this only partially accounts for the constraints placed on the percentage of cropland acreage eligible within a given county, it is the best that can be done given current availability of data. The resulting estimates of potential waterfowl pair densities clearly indicate that some WMDs have higher densities than others. Therefore, waterfowl densities could be improved if CRP land was redistributed between WMDs. By comparing the optimal distribution of CRP land between WMDs to the optimal distribution to CRP land within WMDs, we can derive a rough estimate of the reduction in the density of waterfowl breeding pairs attributable to county acreage restrictions.

The optimal distribution of CRP land between WMDs was constructed by determining the total amount of acreage in each of the quantiles for each of the WMDs. This yielded 105 possible areas of land where CRP could be located. The areas were then ranked according to the potential density of waterfowl breeding pairs per square mile. The total acreage of CRP land for all fifteen WMDs was then distributed into the most productive quantiles first until no more CRP acreage remained. A weighted average over the 105 areas was then taken where the weights were determined by the proportion of the total amount of CRP distributed to each of the 105 areas. This process was identical to the method used to calculate the average density of waterfowl breeding pairs for the optimal distribution within WMDs except we allowed land to be redistributed between WMDs.

Table 4 reports the estimated optimal distribution of CRP land between WMDs, the estimated actual distribution of CRP land between WMDs, and the distribution of all land between WMDs. The weighted average for the optimal and actual distributions of CRP land are also reported. Recall that North Dakota had a greater proportion of its land enrolled in CRP than did South Dakota, 7.5% as opposed to 5.4%. In the optimal distribution, even more CRP land would be allocated to North Dakota. Comparing the distributions by WMD, the proportion of

Table 4: Optimal and actual distribution of CRP land based on the potential density of waterfowl breeding pairs, the optimal distribution of CRP land based on the erodibility index, and the distribution of land.

Wetlands Management District		Optimal Distribution[1]	Actual Distribution	Optimal EI Distribution	Distribution of Land
North Dakota		81.5%	68.3%	86.7%	60.4%
	Arrowwood	0.1%	2.3%	1.5%	1.5%
	Audubon	19.1%	7.3%	7.0%	6.4%
	Chase Lake	4.8%	7.2%	4.7%	4.2%
	Crosby-Lostwood	23.1%	9.1%	22.8%	7.7%
	Devils Lake	9.0%	10.3%	10.7%	12.0%
	J.Clark Salyer	5.8%	10.4%	16.0%	7.7%
	Kulm	3.8%	7.0%	4.5%	5.1%
	Long Lake	4.1%	7.6%	14.1%	5.5%
	Tewaukon	11.2%	3.8%	2.8%	3.8%
	Valley City	0.5%	3.4%	2.6%	6.6%
South Dakota		18.5%	31.7%	13.3%	39.6%
	Huron	6.2%	5.7%	0.8%	8.3%
	Lake Andes	0.7%	2.4%	3.3%	9.5%
	Madison	0.5%	3.8%	4.8%	7.0%
	Sand Lake	6.2%	11.9%	3.2%	8.3%
	Waubay	4.8%	8.0%	1.2%	6.5%
	Average	79.1	36.9		

[1] Assumes that the top 20% of potential waterfowl habitat is eligible for CRP.

CRP land in Audubon, Crosby-Lostwood and Tewaukon is greater than their proportion of total land, yet under the optimal distribution these WMDs are even more disproportionately represented. The proportion of CRP in Huron is lower than its proportion of total land. In the optimal distribution Huron is also under represented, but not by as much. The proportion of CRP in Arrowwood, Chase Lake, J. Clark Salyer, Kulm, Long Lake, Sand Lake and Waubay is greater than their proportion of total land. However, in the optimal distribution, the proportion of CRP in each of these WMDs should be less than their proportion of total land. Finally, Devil's Lake, Valley City, Lake Andes and Madison are all under represented in the CRP relative to their proportion of total land, but not to the extent indicated by the optimal distribution. The average potential density of waterfowl breeding pairs associated with an optimal distribution between WMDs is 79.1 which is only about 8% higher than if land was only optimally redistributed within WMDs.

These results suggest that while there are gains in waterfowl densities from redistributing CRP land between and within WMDs, most of the gains can be captured by redistributing within WMDs. With the optimal distribution of CRP between WMDs, the average potential density of waterfowl pairs is 79.1 which is 114.4% of the average potential density of pairs given the current distribution of CRP. If CRP is optimally redistributed within WMDs, the average is 73.2 which is 98.3% of the actual distribution's average. Therefore, by redistributing within WMDs 86.0% of the total gains to redistribution can be captured.

Highly Erodible Land and Waterfowl Habitat

If highly erodible land is strongly associated with potential waterfowl habitat, explicit targeting on this habitat may be unnecessary in order to maintain waterfowl populations. Under the old CRP rules, our analysis suggests that there is very little correlation between the potential density of waterfowl breeding pairs and highly erodible land. The CRP targeting index for the prairie pothole region as a whole indicates that the old rules may have only increased the potential density of waterfowl breeding pairs by about 10% above that which could have been achieved by randomly selecting land into the program. Under the proposed rules for new CRP contracts, land with an erodibility index (EI) of at least 8 is automatically eligible. While the EI was not used to determine eligibility in the first three sign-up periods, it was one measure used for the remaining nine sign-ups. Therefore, it is not clear whether future targeting based on the EI will successfully enroll those lands which hold the most potential for waterfowl nesting habitat.

Table 5 reports the distribution of land by EI index for the fifteen WMDs in the prairie pothole, for WMDs in North and South Dakota, and for all WMDs combined. Notice that the distribution is bimodal. Nearly 40% of all land does not meet the erodibility criteria of at least 8. However, of those lands that do meet the erodibility criteria, most have EIs of at least 48. On average, North Dakota WMDs have higher EIs, 38.0 as compared to 22.1 for South Dakota. Devil's Lake and Valley City have the highest average EIs, while Huron and Waubay have the lowest.

Using techniques similar to those used to calculate the optimal distribution of the current CRP lands between WMDs based on the potential density of waterfowl breeding pairs, we can also calculated the optimal distribution based on the EI. This distribution is reported in Table 4 as the optimal EI distribution. Notice that while over 80% of the CRP land should be targeted to North Dakota regardless of whether the density of waterfowl breeding pairs or the EI is used, the distribution between WMDs is different. Most notable is the fact that Audubon should have substantially less CRP if the EI is targeted instead of waterfowl breeding pairs, while Devil's Lake, J. Clark Salyer, Long Lake, and Valley City should have more. Crosby-Lostwood should contain just under 25% regardless of whether waterfowl or erodibility is targeted. In South Dakota, Huron, Sand Lake and Waubay should have less CRP if the EI is used instead of waterfowl breeding pairs, while Madison and Lake Andes should have more.

Just as the optimal distribution of CRP within the prairie pothole depends on which targeting criteria is used, the optimal distribution of CRP within WMDs will depend on whether we consider the EI or the density of waterfowl breeding pairs. Comparing maps with the average EIs to the waterfowl habitat maps suggests that the areas of highest waterfowl productivity generally fall in the areas with average EIs of 16 to 40. Two notable exceptions are Devil's Lake and Valley City. These two WMDs comprise the far northeast corner of North Dakota and have the highest average EIs of all WMDs. But further analysis suggests that the most highly erodible land in these two WMDs fall within the three lowest quantiles of potential waterfowl breeding pair densities. For the optimal distribution of CRP among WMDs, based on waterfowl breeding pairs, very little land should be targeted in Valley City and only 9.6% of the CRP land should be targeted in Devil's Lake. If CRP land is targeted in these WMDs based on erodibility, too much of the wrong land is targeted in terms of potential waterfowl densities. Slightly under 25% of the total CRP land should be targeted in Crosby-Lostwood regardless of whether we target based on erodibility or waterfowl habitat. However, which land should be selected within Crosby-Lostwood depends crucially on the targeting criteria. The most productive waterfowl habitat in Crosby-Lostwood tends to fall on some of that WMD's least erodible land. Also, it is important to realize that some areas with high waterfowl density are dominated by grasslands instead of cropland. Grassland is generally not accepted for CRP contracts.

At a highly aggregate level, it does not seem to matter too much whether we choose the EI index or the potential density of waterfowl breeding pairs in order to target future CRP contracts. Both lead to similar allocations of land between the North Dakota and South Dakota portions of the prairie pothole. However, a closer look at spatial information indicates that much of the highly erodible land between and within WMDs is not associated with high potential waterfowl breeding pair densities. Therefore, tradeoffs between waterfowl production and reduced soil erosion will exist such that the preservation of waterfowl populations will require explicit targeting based on its own merit.

Summary and Conclusions

This report combines spatial information on potential waterfowl habitat and the current distribution of CRP land within the fifteen wetland management districts (WMDs) of the prairie pothole regions of North and South Dakota to evaluate the efficacy of the current CRP enrollment in providing potential waterfowl nesting habitat. The analysis supports three conclusions.

First, Lorenz curves and Gini coefficients indicate which WMDs may hold the most relative potential for targeting decisions. These Lorenz curves and Gini coefficients provide a measure of the spatial heterogeneity of potential waterfowl densities within specific WMDs. WMDs with highly variable densities are at greater risk of negatively impacting waterfowl populations if poor targeting decision are made. These WMDs may also hold the greatest relative potential for proper targeting decisions. However, while these Lorenz curves and Gini coefficients are indicative of where costly CRP resources can be devoted to improving waterfowl production, they should not be the sole guide for policy because the magnitudes of possible gains or losses are masked.

Second, the evaluation of potential waterfowl breeeding pair densities given the current distribution of CRP land, the optimal distribution of CRP land, and a random distribution of CRP land within WMDs suggests that better targeting could have large positive impacts on the potential density of waterfowl breeding pairs within the prairie pothole region. Currently, the distribution of CRP land is better for waterfowl than if the land had been randomly enrolled. However, the distribution is not that much better than random, and optimal targeting could nearly double the potential density of waterfowl breeding pairs on CRP land. Therefore, there is sufficient evidence to suggest that improved targeting with the new CRP contracts can have significant positive impacts on these waterfowl populations.

Third, while there are additional gains from redistributing new contracts between WMDs, most of the gains from redistribution can be captured by carefully targeting within WMDs. Over 85% of the total possible gains to retargeting CRP can be accomplished by retargeting within WMDs. Only about 15% of the total possible gains are attributable to optimally redistributing CRP land between WMDs.

The analysis in this report suffers from two weaknesses. First, the actual distribution of CRP land was estimated using a random sample of plots within the fifteen WMDs of the prairie pothole region. Furthermore, while this random sample seems to be representative of the distribution of CRP in North and South Dakota, it is not nearly as representative in individual WMDs. Any errors in the distribution of CRP within a WMD will influence the estimates of the potential density of waterfowl breeding pairs. Second, the habitat data in its current form does not allow us to fully incorporate constraints on what and how much land is eligible for the CRP in each of the seven nonuniform quantiles. Nor does it consider the desire of the landowners to participate in the program. Therefore, the estimates of the optimal program suffers from an upward bias that will exaggerate the gains to redistributing CRP land. Fortunately, both weakness can be corrected once the appropriate data become available.

As the current administration refocuses the goal of the CRP on protecting environmentally sensitive land, it becomes increasingly important to be able to identify such land for targeting. The spatial waterfowl breeding pair density data used in this report could easily be combined with erosion data, water quality data, priority area data, additional wildlife habitat data and land use data to develop an aggregate targeting index that will allow policy makers to identify environmentally sensitive land. Our brief consideration of the distribution of highly erodible land suggest that tradeoffs will exist between alternative objectives. Therefore, the importance of each objective must also be determined in order to optimally target between erosion, water quality and wildlife habitat. Studies demonstrate that CRP cover is beneficial to nesting waterfowl (Reynolds, et. al., 1994). Also, the United States has entered into treaties with several other countries to provide protection for migratory birds and their habitats. This is justification enough to include waterfowl benefits as a criteria in targeting conservation programs. Once these objectives are ranked in terms of importance, new CRP contracts can be evaluated based on the farmer's CRP bid, and an index of alternative environmental objectives.

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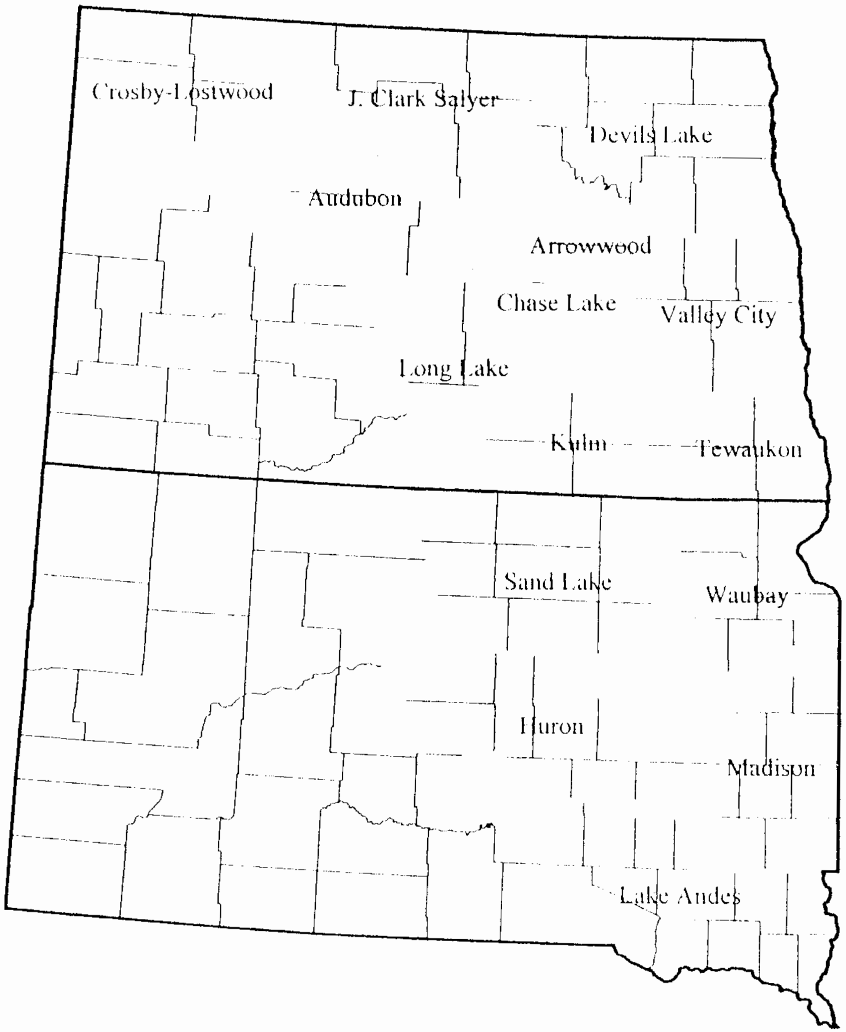
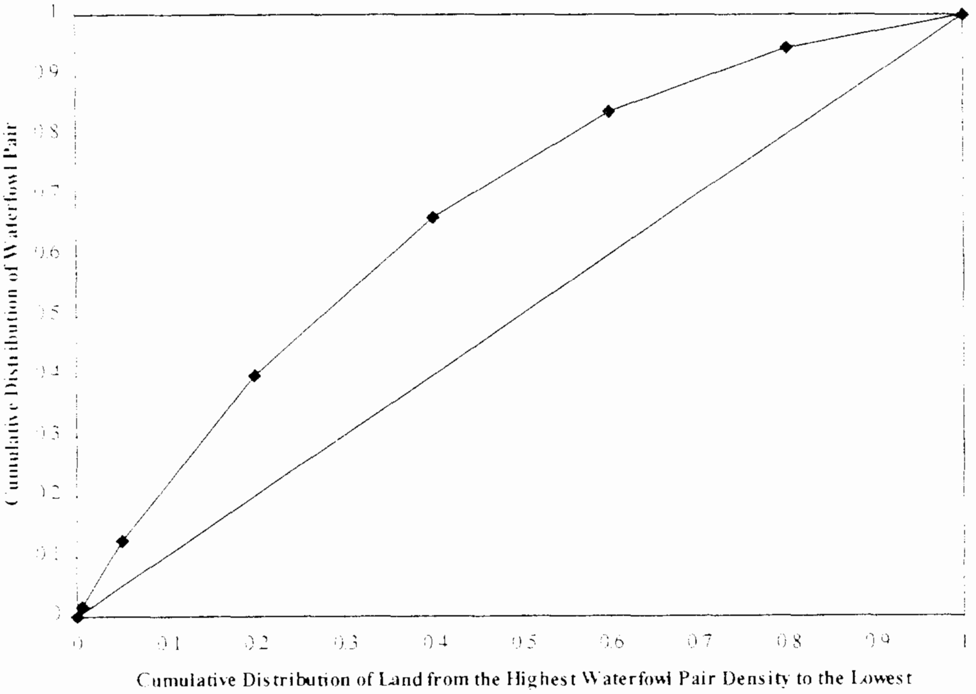
Figure 1. Wetland Management Districts in North and South Dakota



Source: CARD, Iowa State University

Figure 2.



Lorenz Curve for Potential Waterfowl Pair Density in Prairie Pothole Region of North and South Dakota (Gini=0.341)

Figure 3.

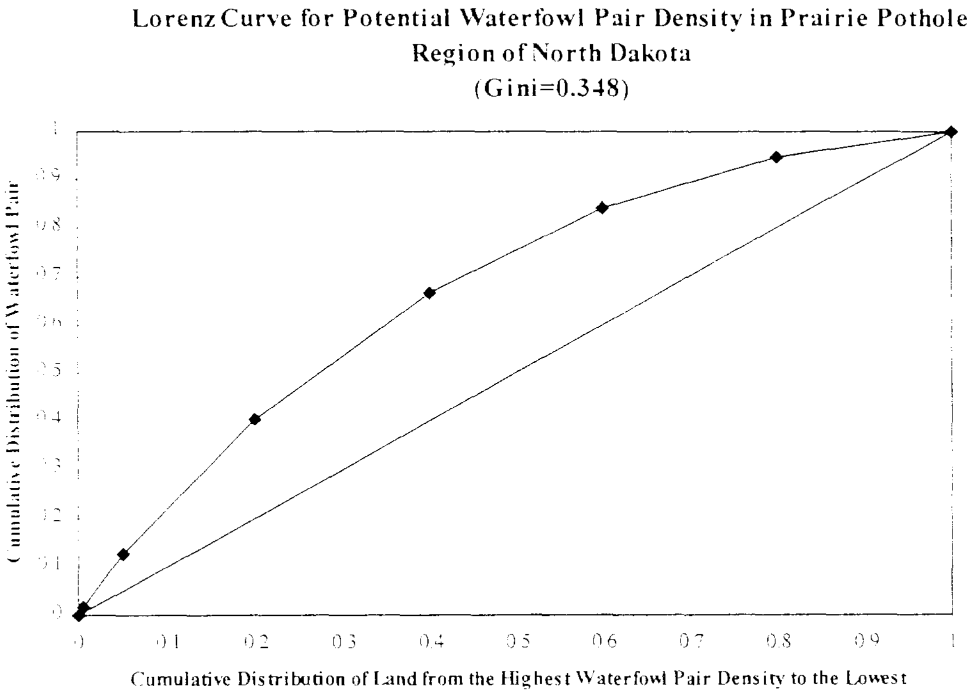

Lorenz Curve for Potential Waterfowl Pair Density in Prairie Pothole Region of North Dakota (Gini=0.348)

Figure 4.

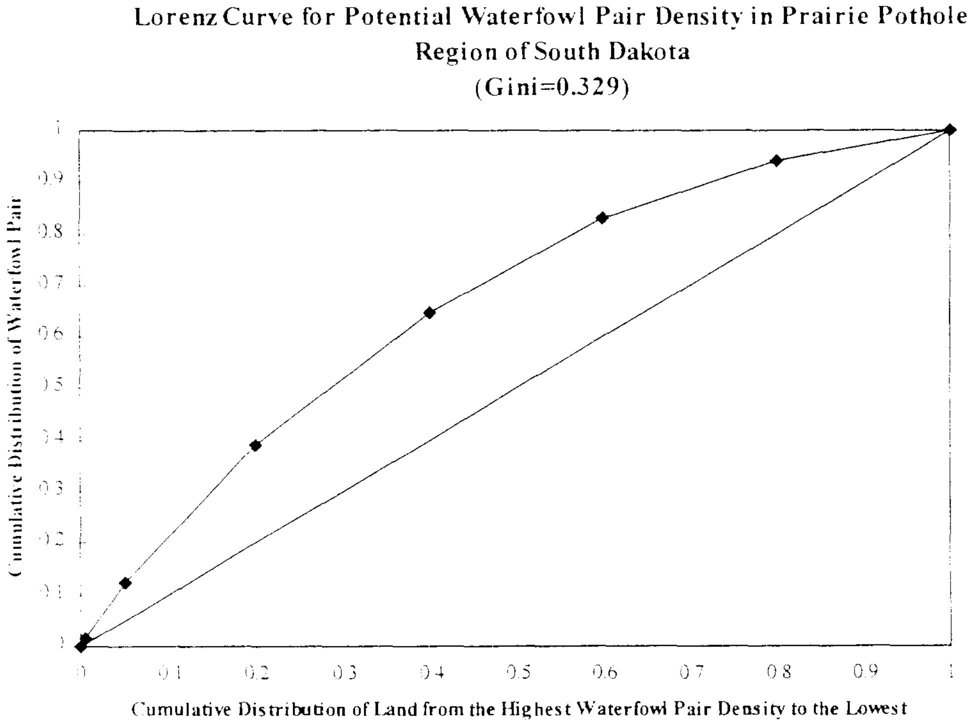

Lorenz Curve for Potential Waterfowl Pair Density in Prairie Pothole Region of South Dakota (Gini=0.329)

Figure 5.

Lorenz Curve for Potential Waterfowl Pair Density in Arrowwood Wetland Management District
(Gini=0.222)

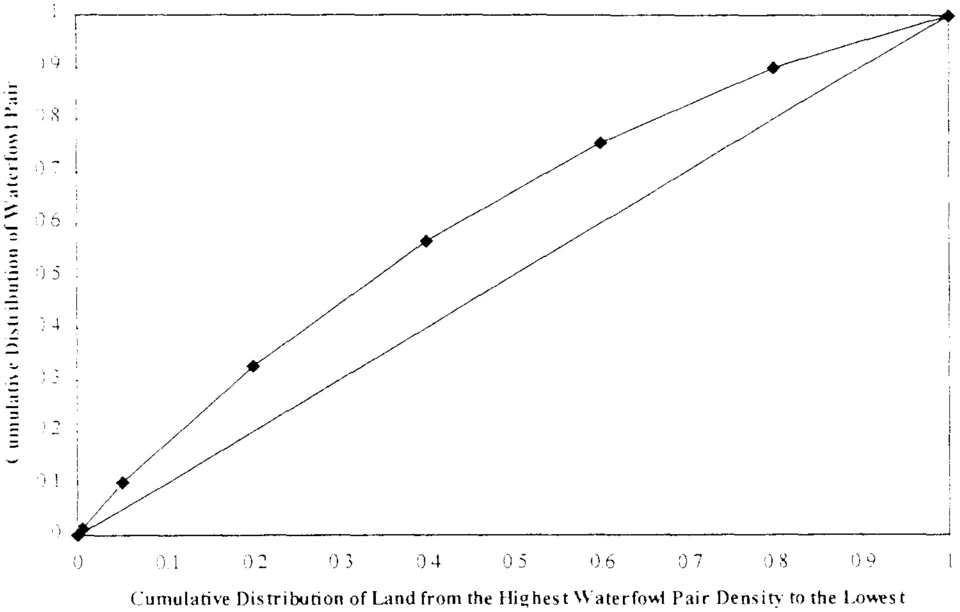


Figure 6.

Lorenz Curve for Potential Waterfowl Pair Density in Audobon Wetland Management District
(Gini=0.328)

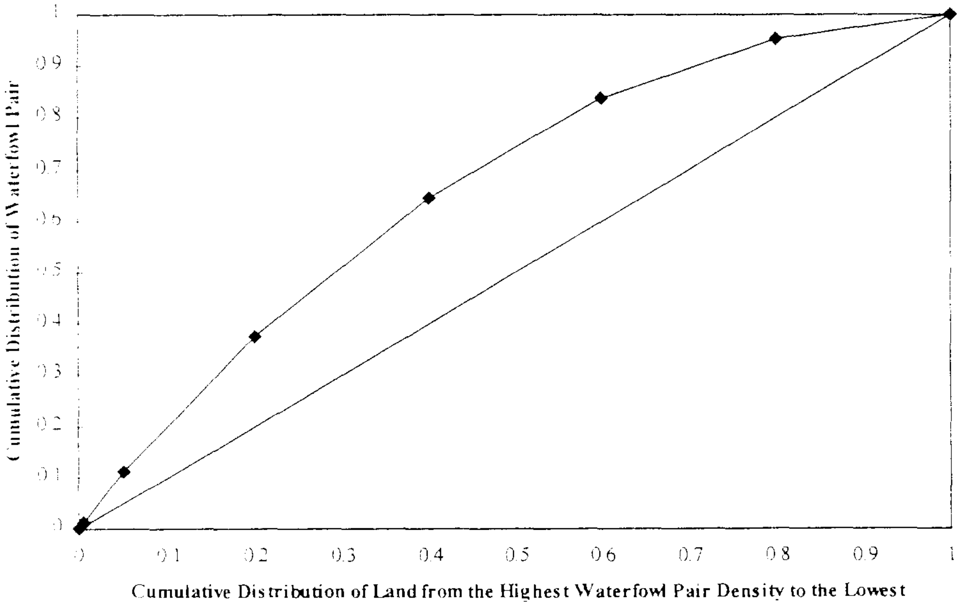


Figure 7.

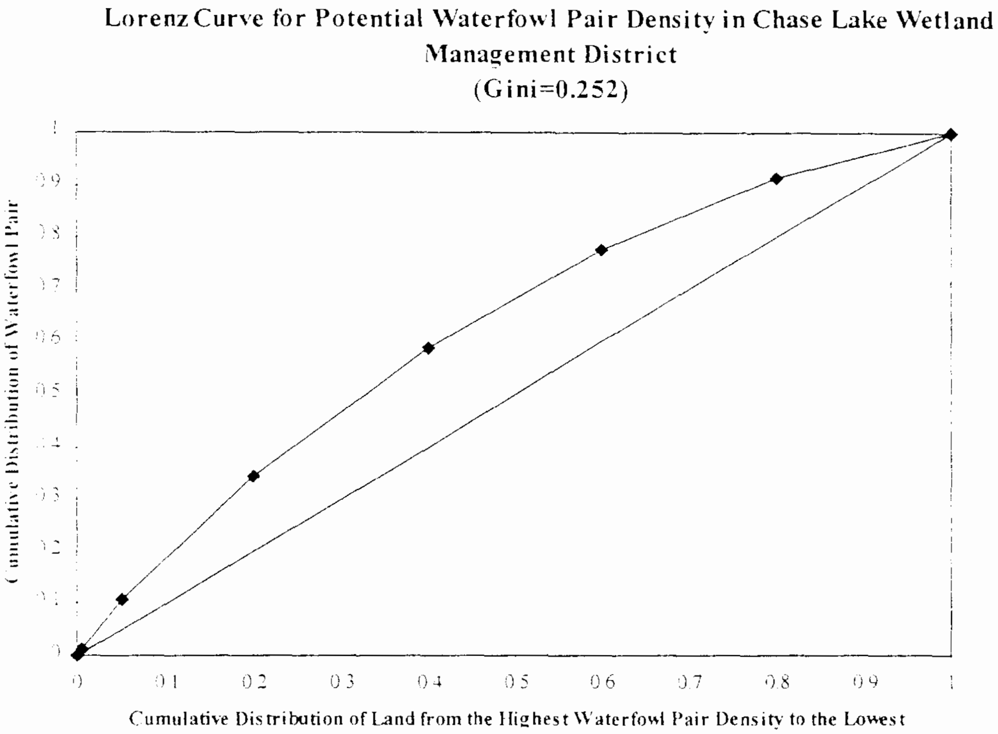


Figure 8.

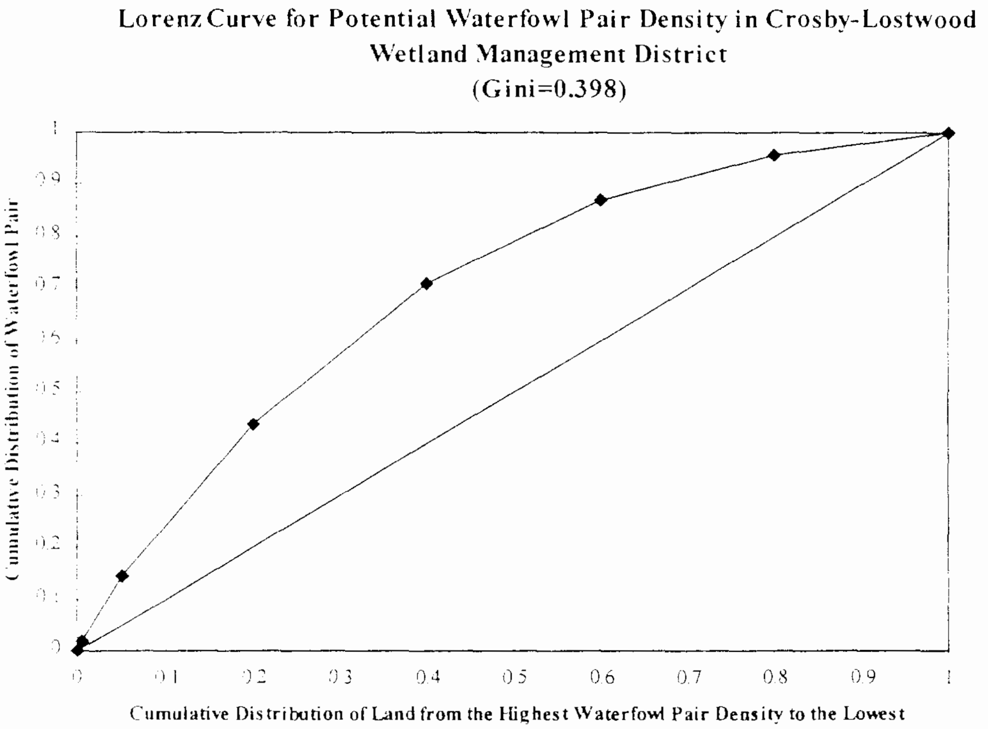


Figure 9.

Lorenz Curve for Potential Waterfowl Pair Density in Devils Lake Wetland Management District (Gini=0.438)

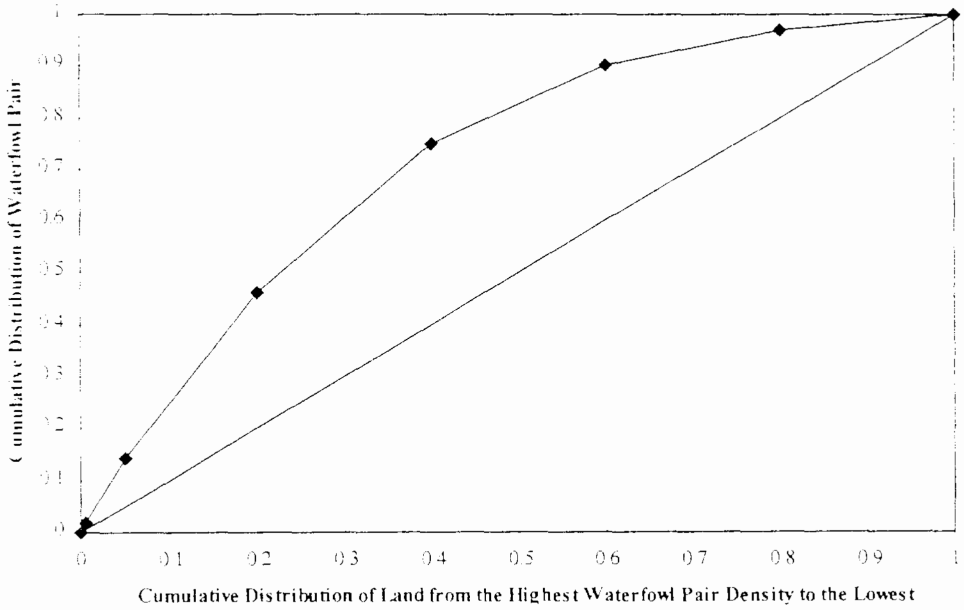


Figure 10.

Lorenz Curve for Potential Waterfowl Pair Density in J. Clark Salyer Wetland Management District (Gini=0.248)

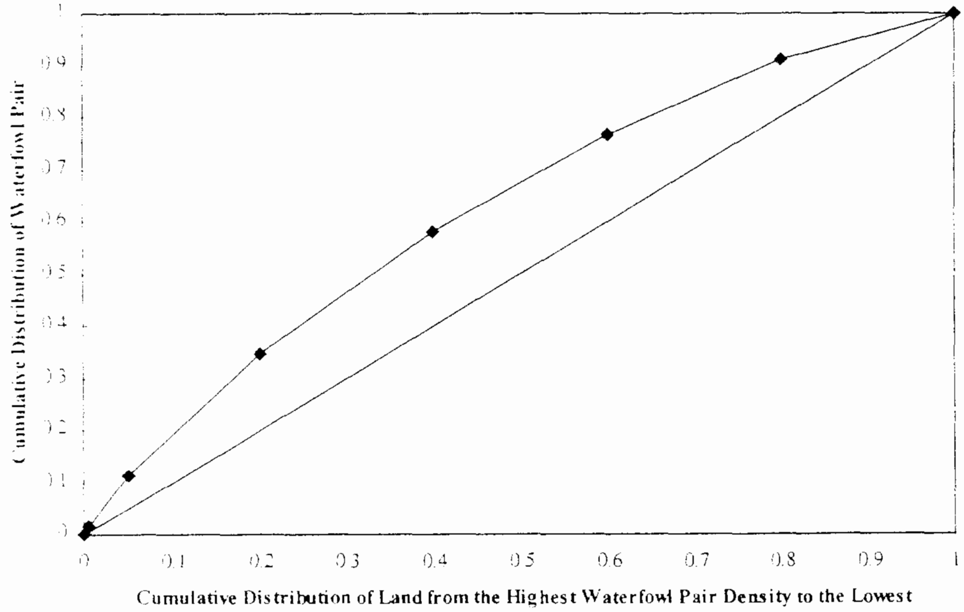
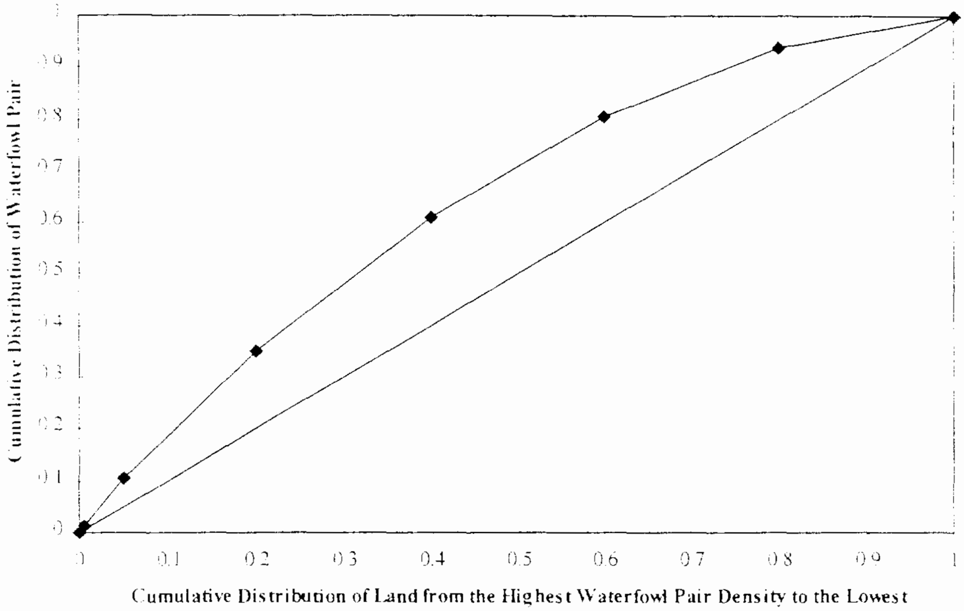
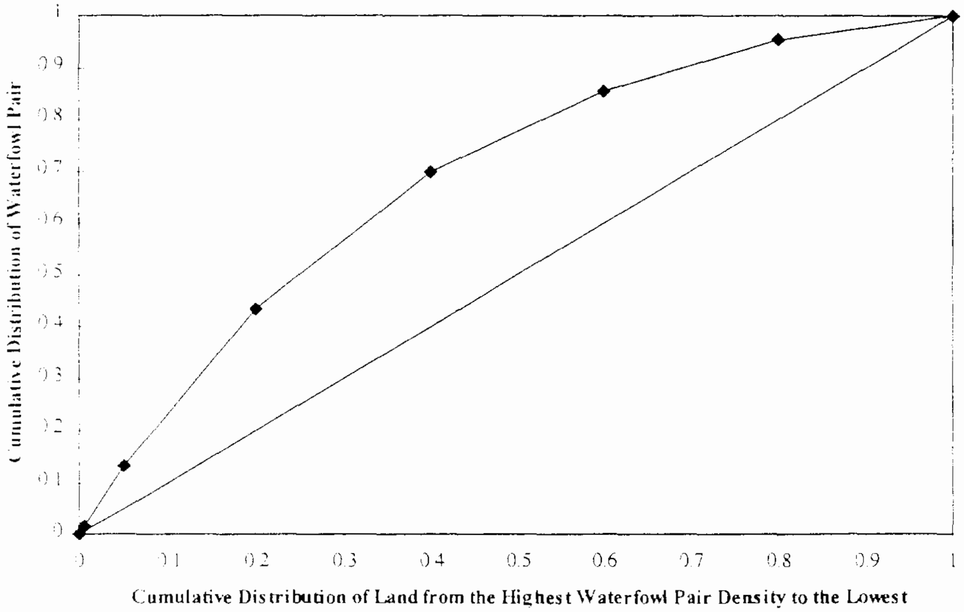


Figure 11.



Lorenz Curve for Potential Waterfowl Pair Density in Kulm Wetland Management District (Gini=0.284)

Figure 12.



Lorenz Curve for Potential Waterfowl Pair Density in Long Lake Wetland Management District (Gini=0.382)

Figure 13.

Lorenz Curve for Potential Waterfowl Pair Density in Tewaukon Wetland Management District (Gini=0.435)

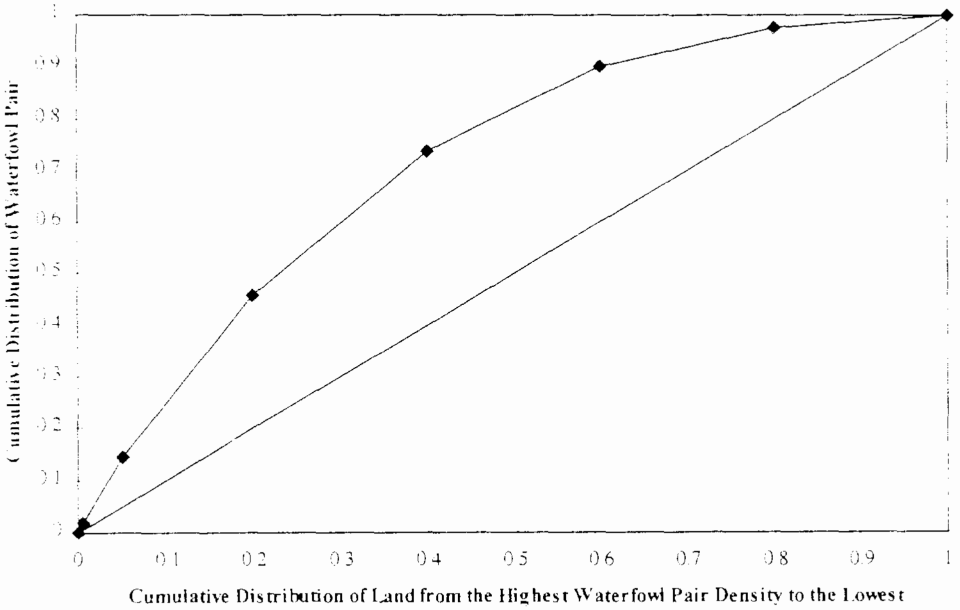


Figure 14.

Lorenz Curve for Potential Waterfowl Pair Density in Valley City Wetland Management District (Gini=0.517)

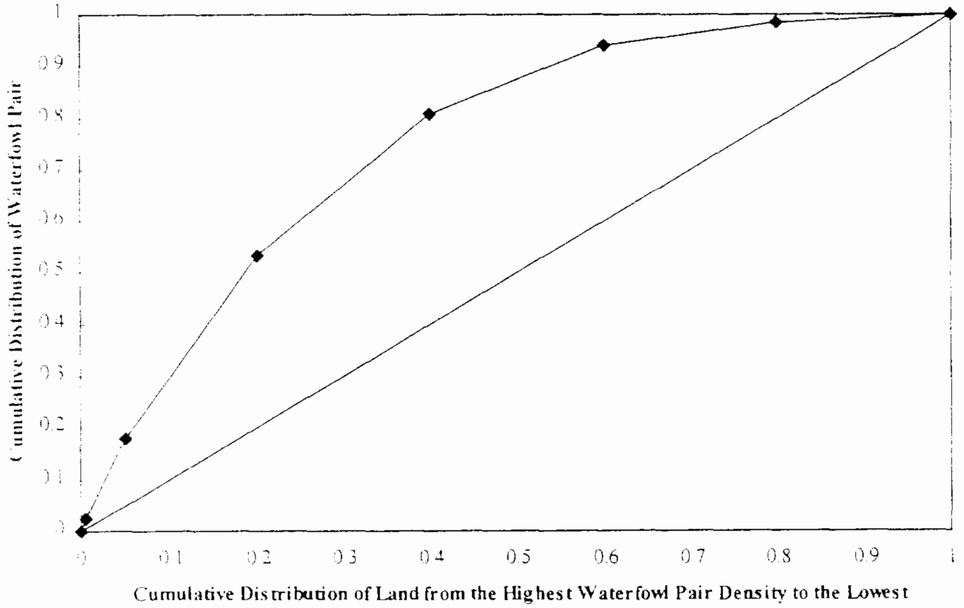
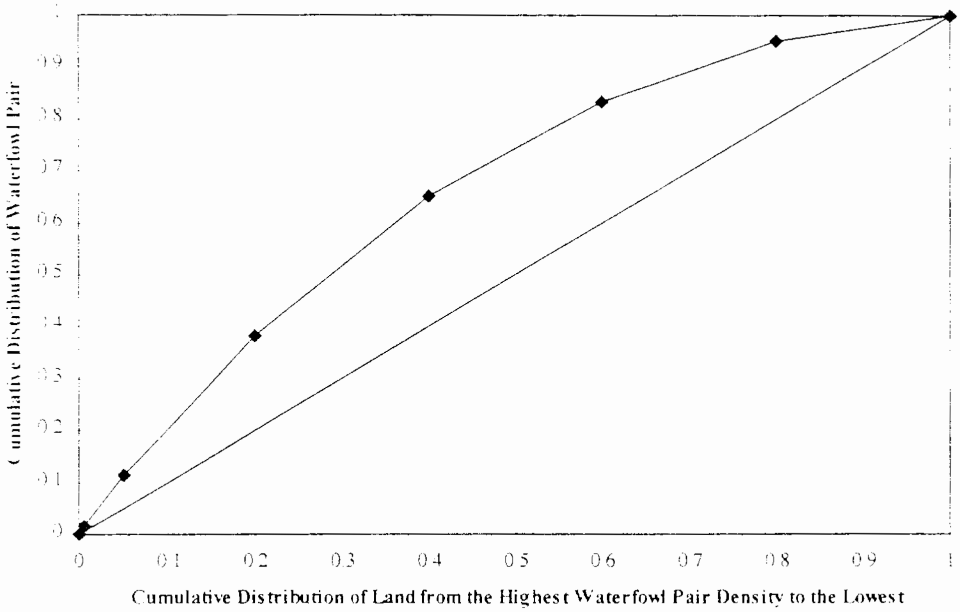
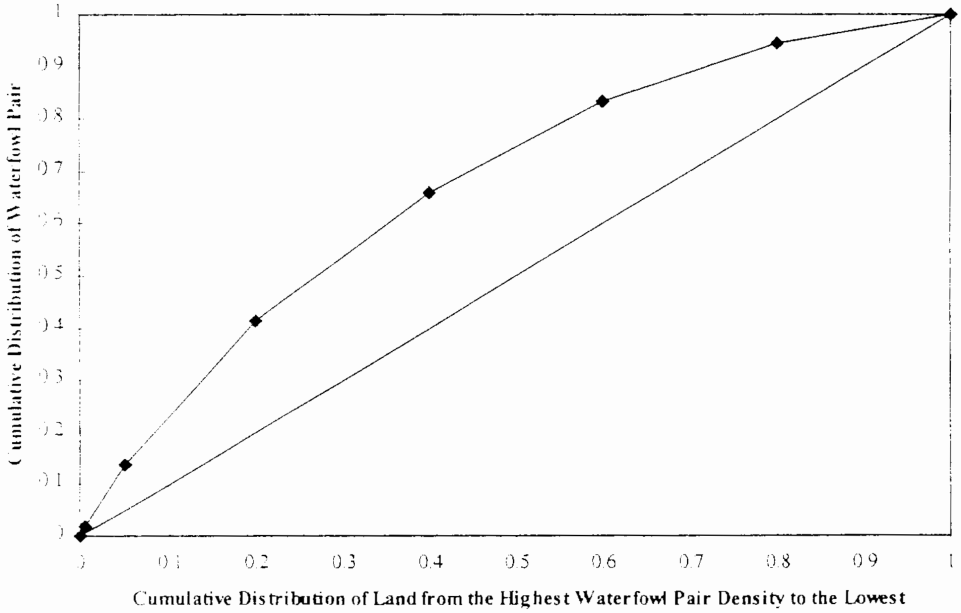


Figure 15.



Lorenz Curve for Potential Waterfowl Pair Density in Huron Wetland Management District (Gini=0.331)

Figure 16.



Lorenz Curve for Potential Waterfowl Pair Density in Lake Andes Wetland Management District (Gini=0.349)

Figure 17.

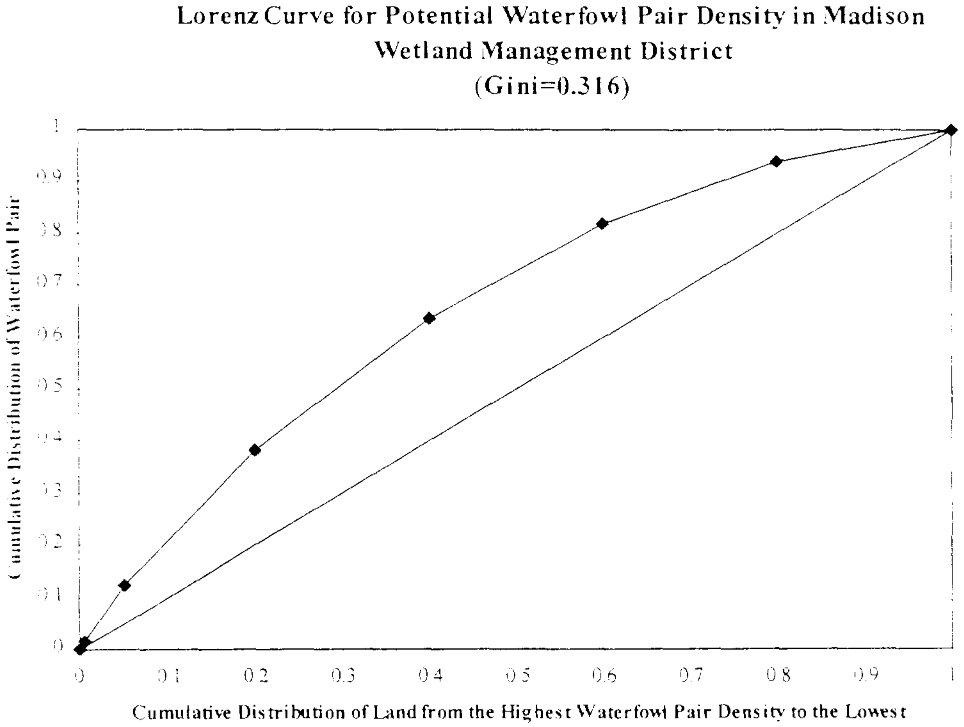

Lorenz Curve for Potential Waterfowl Pair Density in Madison Wetland Management District (Gini=0.316)

Figure 18.

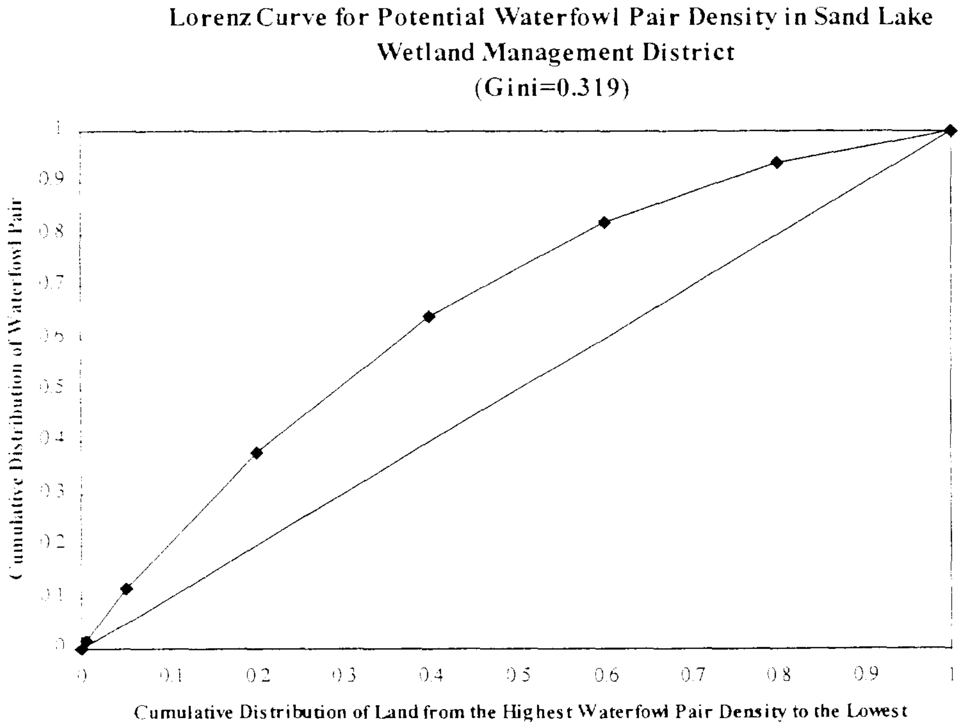
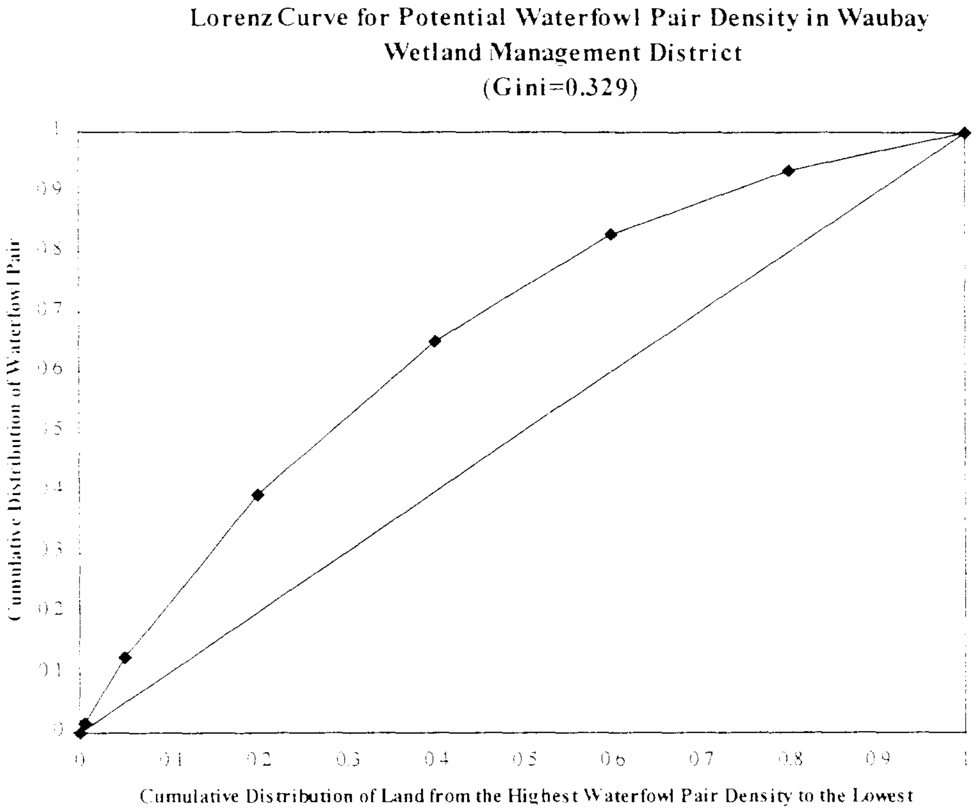

Lorenz Curve for Potential Waterfowl Pair Density in Sand Lake Wetland Management District (Gini=0.319)

Figure 19.


Lorenz Curve for Potential Waterfowl Pair Density in Waubay Wetland Management District
(Gini=0.329)
Cumulative Distribution of Waterfowl Pair
Cumulative Distribution of Land from the Highest Waterfowl Pair Density to the Lowest
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1