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U.S. Fish and Wildlife Service



Model Applications to Lessard – Sams Outdoor Heritage Council Parcels to Simulate Restoration Affects to Estimate Breeding Duck Pair Numbers Prior to Restoration and After Restoration.

Introduction

The U.S. Fish and Wildlife Service Habitat and Population Evaluation Team (HAPET) often receives requests from our partners for information on habitat restoration and protection projects and the impact of these projects on species of importance to our partners. Recently HAPET was approached by the Lessard – Sams Outdoor Heritage Council (LSOHC) to model predicted breeding duck response to tracts purchased and restored with LSOHC funding.

Objectives

Our overall objective was to estimate the net benefit of LSOHC Investments to breeding waterfowl within the Prairie Pothole Region (PPR) of MN. This was accomplished in three steps:

- 1) First we Applied duck pair/wetland basin regression models to existing wetland basins and provide estimates on LSOHC parcels of duck numbers by county prior to habitat restoration.
- 2) Next, we applied duck pair/wetland basin regression models to existing wetland basins and restorable wetlands basin data to provide estimates on LSOHC parcels of duck numbers by county after habitat restoration.
- 3) Last, we determined the difference between pre and post restoration to predict the net benefits to breeding waterfowl.

Procedural Background

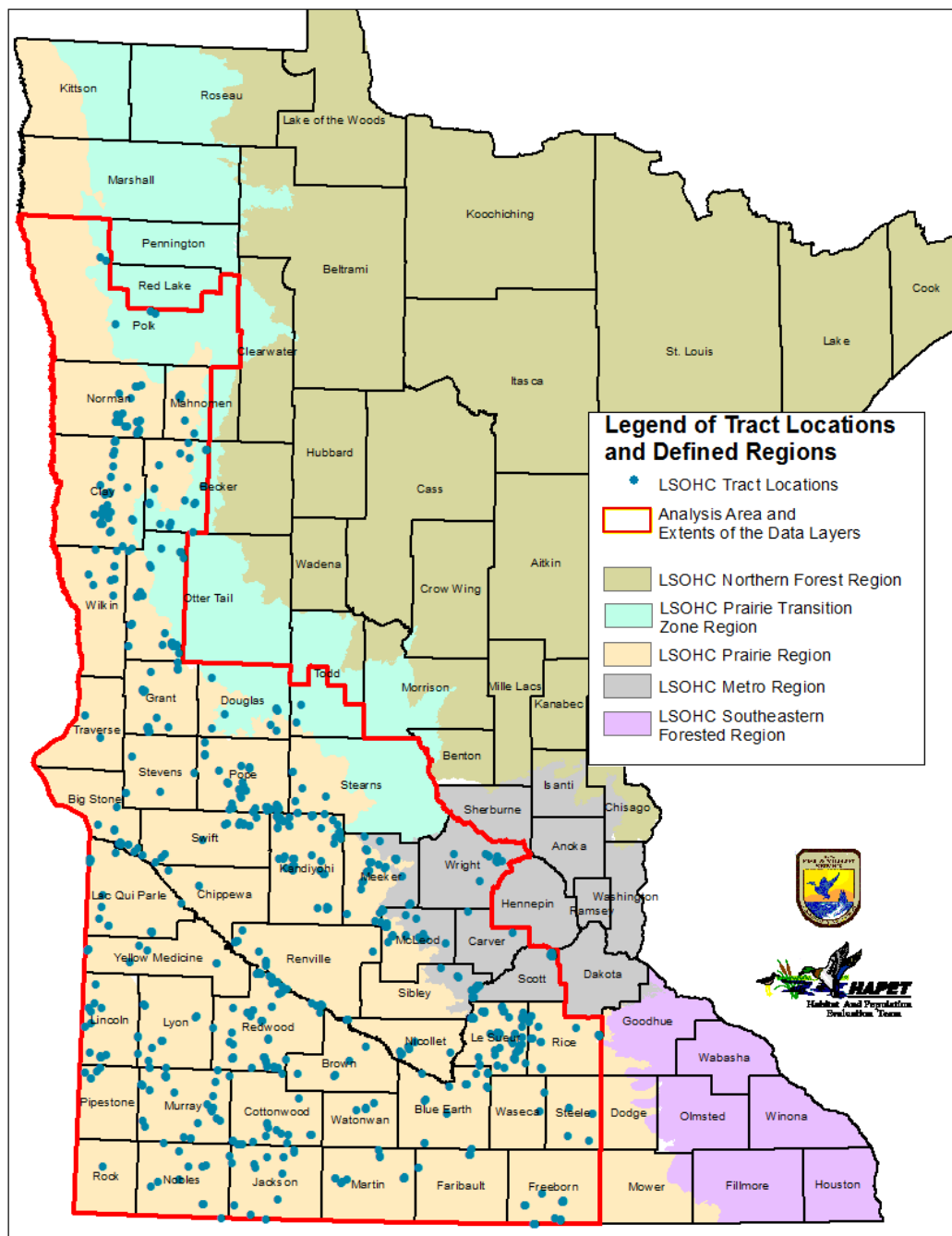
The USFWS Four Square Mile Survey (FSMS) has been conducted annually in the U.S. PPR by the USFWS Regions 3 and 6 National Wildlife Refuge System since 1987. The resulting long-term dataset was compiled to evaluate breeding duck pairs and provide estimates of breeding duck populations on lands managed by the USFWS National Wildlife Refuge System in the Prairie Pothole Region. With intentions to identify priority landscapes for conservation, this long-term dataset was used to develop breeding duck pair/wetland basin regression models to provide predictions of waterfowl pair numbers for individual wetland basins. These breeding duck pair/wetland basin regression models have been a baseline for the development of several popular and well accepted decision support tools in making habitat conservation restoration and protection decisions.

Our Process

Our analysis was based upon the application of duck pair and wetland basin relationships to modified National Wetlands Inventory (NWI) data (Cowardin et.al. 1979) and Restorable Wetlands Inventory (RWI) data. The NWI data exists for the whole state, but the RWI data only covers a portion of the western part of the state. Other data and model limitations to the application of this process limited the extents of the analysis. The breeding duck pair/wetland basin regression models were developed from

FSMS data based in the PPR. The extents of application of these models were limited to the PPR. Therefore, only parcels that are within the boundaries of these baseline data layers could be used in the analysis. The extents of the data layers and the locations of the LSOHC tracts used in the analysis are shown in Figure 1. There were roughly 670 LSOHC tracts that were within the extents of the data limitations and were used in this analysis. The LSOHC tract boundaries were cleaned up, assigned unique tract names, assigned to a county that they occurred within, and limited to include tracts within the areas within the extents of the data layers.

Figure 1. LSOHC Tracts and the Analysis Area.



A wetland basin data layer was created from NWI polygon data that were mapped according to the classification and definitions in Cowardin et al. (1979) and simplified by collapsing wetlands with multiple polygon wetland basins to a singular wetland basin polygon (basin) with the characteristics of the deepest water regime of the basin (Johnson et. al. 1997, Cowardin, L.M, 1982) . For example, a lake with shallower wetland portions such as shallow bays or weedy vegetated areas within the lake basin were collapsed into one singular wetland basin polygon classified as a lake. This collapsed NWI basin data was used to simulate existing wetland conditions. The duck pair/wetland basin regression models were applied to the NWI basin data to provide estimates of duck pairs per wetland basin.

The Restorable Wetlands Inventory (RWI) is a complement to the National Wetlands Inventory (NWI) completed in late-1980s by the U.S. Fish & Wildlife Service. The RWI project identifies the completely-drained depressional wetlands that were not mapped by the NWI. Restorable wetlands mapping is based upon protocols established for NWI allowing seamless integration of the two datasets. Since the RWI data layer has no attributes indicating the basin depth or the length of time that the basin is inundated with water, RWI basins were assigned the class of Seasonal wetlands and processed as basins that are seasonally inundated with water. The RWI data layer was combined with the collapsed NWI basin data layer to simulate restored conditions. Restorable wetlands inventory data that were delineated on LSOHC tracts were assumed to be restored wetland habitats in the analysis. The duck pair/wetland basin regression models were applied to the combined RWI/NWI basin data layer to provide estimates of duck pairs per wetland basin.

Results

The resulting data estimates for each LSOHC tract were compiled and summarized by county. The number of wetland basins on LSOHC tracts increased by approximately 2,509 basins and 4,257 acres (Appendix 1). The estimated number of dabbling duck pairs on LSOHC tracts increased from approximately 3,143 prior to restoration to approximately 5,082 duck pairs for an increase of approximately 1,939 pairs (Appendix 2). The estimated number of diving duck pairs on LSOHC tracts increased by approximately 60 pairs (Appendix 3). The number of wetland basins on LSOHC tracts before and after restoration is listed by county in Appendix 4. The estimated number of dabbling duck pairs on LSOHC tracts before and after restoration by county is listed in Appendix 5. The estimated number of diving duck pairs on LSOHC tracts before and after restoration by county is listed in Appendix 6.

Summary

Analysis of habitat projects on roughly 700 plus tracts of interest to the LSOHC involved approximately 3,022 wetland basins. After potential restoration of wetland habitats on these tracts, 2,509 additional wetlands would be restored. The estimated results of restoration would add an additional 4,257 acres of wetland habitats resulting in an 80% increase in basin numbers and a 44% increase in wetland basin acres. Restoration of wetland habitats would result in an increase of dabbling duck pairs from 3,143 to 5,082 or an increase of 62%. Estimated diving duck response to restoration would be an increase from 150 breeding pairs to 209 breeding pairs, or an increase of 39%.

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**Cited References:**

Cowardin, L. M., and D. H. Johnson. 1979. Mathematics and mallard management. *Journal of Wildlife Management* 43:18-35.

Johnson, R. R., and K. F. Higgins. 1997. *Wetland resources of Eastern South Dakota*. Brookings: South Dakota State University. 102 pp.

Cowardin, L. M. 1982. Some conceptual and semantic problems in wetland classification and inventory. *Wildlife Society Bulletin* 10:57-60.

Appendices:

Appendix 1.

Wetland Basins on LSOHC Tracts Before and After Restoration by County**Wetland Basins**

Before Restoration			After Restoration			Difference after Restoration		
All Counties in Analysis	Count of Basins	Sum of Acres	All Counties in Analysis	Count of Basins	Sum of Acres	All Counties in Analysis	Count of Basins	Sum of Acres
Total	3122	9,653	Total	5631	13,909	Total	2509	4,257

Appendix 2.

Dabbling Duck Pair Estimates on Lessard-Sams OHC Tracts.

Before Restoration							
All Counties in Analysis	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Total	1153	1033	45	27	39	846	3143

After Restoration							
All Counties in Analysis	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Total	1970	1677	62	39	58	1276	5082

Difference Between Before and After Restoration							
All Counties in Analysis	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Total	817	644	17	12	19	430	1939

Appendix 3.

Diving Duck Pair Estimates on Lessard-Sams OHC Tracts.

Before Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Total	24	59	7	26	34	150

After Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Total	34	78	9	34	55	209

Difference Between Before and After Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Total	10	19	2	8	21	60

Appendix 4.

Wetland Basins on LSOHC Tracts Before and After Restoration by County**Wetland Basins**

Before Restoration		
County	Count of Basins	Sum of Acres
Becker	79	185.90
Big Stone	51	94.60
Blue Earth	34	107.78
Brown	13	15.09
Carver	14	56.40
Chippewa	10	26.59
Clay	178	819.64
Cottonwood	71	29.26
Douglas	45	120.82
Faribault	5	22.34
Freeborn	22	138.29
Grant	48	189.75
Jackson	58	101.52
Kandiyohi	262	736.19
Lac qui Parle	41	99.13
Le Sueur	195	672.83
Lincoln	56	119.74
Lyon	67	123.22
Mahnomen	117	160.40
Martin	35	153.63
McLeod	36	68.96
Meeker	143	236.17
Murray	130	298.69
Nicollet	19	90.01
Nobles	87	223.57
Norman	200	611.57
Otter Tail	156	446.39
Pipestone	24	28.27
Polk	33	141.91
Pope	100	448.54

After Restoration		
County	Count of Basins	Sum of Acres
Becker	120	234.44
Big Stone	103	122.56
Blue Earth	59	155.59
Brown	35	121.68
Carver	54	91.81
Chippewa	18	47.20
Clay	604	1456.83
Cottonwood	80	127.90
Douglas	87	164.00
Faribault	26	72.86
Freeborn	47	211.61
Grant	88	222.30
Jackson	146	306.08
Kandiyohi	468	1038.86
Lac qui Parle	85	159.26
Le Sueur	271	914.29
Lincoln	93	205.37
Lyon	106	188.75
Mahnomen	222	316.35
Martin	71	173.50
McLeod	73	123.39
Meeker	197	284.17
Murray	150	391.82
Nicollet	63	114.86
Nobles	173	373.97
Norman	308	891.97
Otter Tail	279	664.61
Pipestone	24	28.27
Polk	44	145.35
Pope	174	490.41

Difference after Restoration		
County	Change in Count of Basins	Change in Sum of Acres
Becker	41	48.54
Big Stone	52	27.96
Blue Earth	25	47.81
Brown	22	106.59
Carver	40	35.41
Chippewa	8	20.60
Clay	426	637.18
Cottonwood	9	98.65
Douglas	42	43.18
Faribault	21	50.52
Freeborn	25	73.33
Grant	40	32.54
Jackson	88	204.56
Kandiyohi	206	302.68
Lac qui Parle	44	60.13
Le Sueur	76	241.46
Lincoln	37	85.63
Lyon	39	65.52
Mahnomen	105	155.95
Martin	36	19.87
McLeod	37	54.43
Meeker	54	48.00
Murray	20	93.13
Nicollet	44	24.84
Nobles	86	150.40
Norman	108	280.40
Otter Tail	123	218.21
Pipestone	0	0.00
Polk	11	3.44
Pope	74	41.88

Red Lake	16	47.45
Redwood	177	313.62
Renville	31	88.27
Rice	34	266.18
Scott	81	698.36
Sibley	13	53.46
Stearns	77	556.38
Steele	14	19.27
Stevens	4	1.44
Swift	123	420.34
Todd	20	43.88
Traverse	21	15.14
Waseca	2	9.76
Watonwan	32	60.73
Wilkin	55	276.87
Wright	62	158.85
Yellow Medicine	31	55.45
Total	3122	9,652.63

Red Lake	17	49.44
Redwood	273	606.93
Renville	38	102.23
Rice	44	284.28
Scott	85	701.69
Sibley	31	67.38
Stearns	125	602.75
Steele	71	89.15
Stevens	61	72.00
Swift	290	721.54
Todd	28	53.96
Traverse	37	25.90
Waseca	2	9.96
Watonwan	36	65.43
Wilkin	73	284.13
Wright	99	236.70
Yellow Medicine	53	95.68
Total	5631	13,909.20

Red Lake	1	2.00
Redwood	96	293.32
Renville	7	13.96
Rice	10	18.10
Scott	4	3.33
Sibley	18	13.91
Stearns	48	46.37
Steele	57	69.88
Stevens	57	70.55
Swift	167	301.20
Todd	8	10.07
Traverse	16	10.77
Waseca	0	0.21
Watonwan	4	4.70
Wilkin	18	7.27
Wright	37	77.85
Yellow Medicine	22	40.23
Total	2509	4,256.57

Appendix 5.

Dabbling Duck Pair Estimates on LSOHC Tracts by County

Before Restoration							
County	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Becker	33.0	25.4	0.2	0.4	0.6	18.7	78.3
Big Stone	9.9	11.3	0.5	0.2	0.3	3.4	25.7
Blue Earth	12.2	10.3	0.4	0.2	0.5	12.1	35.7
Brown	3.3	3.5	0.0	0.0	0.2	2.1	9.1
Carver	6.6	5.0	0.2	0.1	0.3	4.5	16.7
Chippewa	4.1	4.3	0.2	0.1	0.1	2.6	11.4
Clay	80.4	61.0	1.4	1.3	1.6	42.3	188.0
Cottonwood	6.5	6.9	0.5	0.4	0.2	7.2	21.6
Douglas	20.2	17.1	0.8	0.2	0.6	13.7	52.5
Faribault	2.0	1.6	0.1	0.1	0.1	2.1	5.9
Freeborn	14.2	11.2	0.9	0.6	0.5	12.9	40.2
Grant	28.4	25.7	6.9	0.8	3.9	14.6	80.2
Jackson	19.4	21.5	1.1	0.8	0.6	17.4	60.7
Kandiyohi	95.1	83.3	1.8	1.3	3.8	83.5	268.8
Lac qui Parle	19.4	21.7	1.4	0.4	0.6	7.4	50.9
Le Sueur	54.8	42.8	3.1	2.0	2.7	49.4	154.8
Lincoln	21.2	27.1	1.0	0.7	0.6	14.3	65.0
Lyon	26.2	30.2	1.1	0.9	0.8	15.9	75.0
Mahnomen	34.7	25.7	0.3	0.5	0.7	10.0	71.8
Martin	17.9	17.0	0.5	0.3	0.7	12.3	48.7
McLeod	10.0	7.6	0.3	0.1	0.4	6.4	24.8
Meeker	43.3	35.7	1.2	0.7	1.7	28.9	111.5
Murray	43.3	47.8	2.7	1.9	0.9	60.2	156.9
Nicollet	13.4	12.6	0.2	0.1	0.5	10.6	37.4
Nobles	36.6	39.9	1.7	1.1	1.0	29.5	109.7
Norman	55.3	41.0	0.7	1.1	1.5	23.2	122.9
Otter Tail	79.3	69.4	0.7	0.6	1.3	84.4	235.8
Pipestone	6.5	8.1	0.8	0.7	0.2	8.4	24.7
Polk	7.1	5.0	0.2	0.2	0.2	4.4	17.2
Pope	50.3	46.0	0.9	0.3	1.3	27.9	126.7
Red Lake	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Redwood	39.8	42.1	2.3	1.8	1.3	38.1	125.5
Renville	13.6	13.6	0.5	0.4	0.5	9.4	37.9

Rice	18.2	14.5	0.6	0.3	0.8	13.6	48.0
Scott	40.3	32.5	3.8	2.6	2.1	46.6	128.0
Sibley	7.2	5.8	0.2	0.1	0.3	4.6	18.1
Stearns	47.5	39.3	1.0	1.2	1.3	19.9	110.1
Steele	3.4	2.0	0.2	0.1	0.1	3.1	9.0
Stevens	0.8	0.9	0.2	0.1	0.1	0.2	2.3
Swift	63.3	62.0	1.0	0.7	1.6	32.6	161.1
Todd	6.4	5.1	0.1	0.1	0.2	4.0	15.9
Traverse	3.4	4.1	0.7	0.2	0.2	1.4	9.9
Waseca	1.2	1.0	0.0	0.0	0.1	1.5	3.8
Watonwan	10.7	9.7	0.4	0.3	0.3	9.4	30.9
Wilkin	15.2	11.6	0.2	0.1	0.3	5.9	33.3
Wright	18.3	11.6	0.6	0.3	0.9	14.2	46.0
Yellow Medicine	9.4	11.2	1.4	0.9	0.3	11.2	34.5
Total	1153.1	1032.7	45.0	27.4	38.8	846.0	3143.0

After Restoration							
County	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Becker	46.2	35.2	0.3	0.6	0.8	26.9	110.0
Big Stone	19.3	20.3	1.0	0.5	0.6	6.0	47.8
Blue Earth	19.1	15.3	0.5	0.3	0.7	20.2	56.1
Brown	16.9	14.6	0.2	0.2	0.7	10.1	42.6
Carver	14.0	9.0	0.3	0.2	0.5	8.4	32.4
Chippewa	8.9	8.8	0.2	0.2	0.2	5.3	23.6
Clay	227.6	175.4	3.1	4.1	4.0	93.2	507.5
Cottonwood	14.2	12.5	0.6	0.5	0.3	12.1	40.3
Douglas	30.9	24.9	1.1	0.3	0.7	22.1	80.1
Faribault	7.9	5.6	0.2	0.2	0.2	7.3	21.3
Freeborn	20.9	16.2	1.1	0.6	0.7	18.8	58.4
Grant	38.3	34.0	8.0	1.1	4.4	18.3	104.0
Jackson	50.4	50.4	1.8	1.1	1.4	37.3	142.3
Kandiyohi	155.6	128.8	2.5	1.9	5.6	136.7	431.2
Lac qui Parle	34.8	36.1	2.2	0.6	0.9	13.3	87.9
Le Sueur	82.0	60.2	3.8	2.4	3.6	70.2	222.2
Lincoln	41.3	46.1	1.3	0.9	0.9	22.8	113.4
Lyon	42.9	46.1	1.3	1.1	1.1	23.0	115.6
Mahnomen	68.6	48.3	0.5	1.0	1.2	19.3	138.8

Martin	24.0	22.1	0.5	0.4	0.8	16.0	63.8
McLeod	19.9	13.8	0.5	0.3	0.7	12.4	47.6
Meeker	55.5	44.9	1.4	0.9	2.1	35.9	140.8
Murray	57.3	59.4	2.9	2.0	1.1	68.9	191.7
Nicollet	21.8	18.7	0.3	0.2	0.7	16.6	58.3
Nobles	70.9	72.1	2.2	1.4	1.7	49.8	198.0
Norman	109.7	76.9	1.3	2.1	2.5	42.4	234.9
Otter Tail	124.6	106.4	1.2	0.9	2.0	117.8	353.0
Pipestone	6.5	8.1	0.8	0.7	0.2	8.4	24.7
Polk	9.1	6.5	0.3	0.2	0.2	5.4	21.6
Pope	62.7	55.8	1.1	0.4	1.4	33.0	154.4
Red Lake	0.6	0.4	0.0	0.0	0.0	0.3	1.3
Redwood	88.0	82.5	3.1	2.4	2.4	63.4	241.7
Renville	16.3	15.6	0.6	0.4	0.5	10.6	44.0
Rice	19.9	15.3	0.7	0.3	0.9	15.3	52.4
Scott	40.5	32.5	3.8	2.7	2.1	47.2	128.4
Sibley	9.5	7.1	0.2	0.1	0.3	6.3	23.6
Stearns	55.1	45.7	1.0	1.3	1.4	22.6	127.3
Steele	13.7	6.8	0.6	0.3	0.6	11.0	33.0
Stevens	16.6	15.0	3.0	1.0	1.7	3.6	40.9
Swift	114.9	107.3	1.7	1.3	2.7	56.1	284.0
Todd	8.2	6.3	0.2	0.1	0.3	5.0	20.1
Traverse	8.4	8.1	0.9	0.3	0.3	2.9	20.9
Waseca	1.2	1.0	0.0	0.0	0.1	1.5	3.8
Watonwan	12.0	10.8	0.4	0.3	0.4	10.2	34.0
Wilkin	18.7	14.9	0.2	0.1	0.3	7.3	41.5
Wright	29.0	16.8	0.9	0.5	1.2	20.6	69.1
Yellow Medicine	16.0	18.0	1.6	1.0	0.5	14.1	51.2
Total	1970.4	1676.6	61.7	39.3	57.6	1276.5	5081.7

Difference Between Before and After Restoration							
County	Sum of Mallard Pairs	Sum of Blue Winged Teal Pairs	Sum of Gadwall Pairs	Sum of Pintail Pairs	Sum of Shoveler Pairs	Sum of Woodduck Pairs	Sum of Dabbling Duck Pairs
Becker	13.2	9.8	0.1	0.2	0.2	8.2	31.7
Big Stone	9.4	9.1	0.5	0.3	0.3	2.5	22.1
Blue Earth	6.9	5.0	0.1	0.1	0.2	8.1	20.3
Brown	13.5	11.0	0.1	0.1	0.5	8.1	33.4
Carver	7.3	4.0	0.1	0.1	0.2	3.9	15.7

Chippewa	4.8	4.6	0.1	0.1	0.1	2.7	12.3
Clay	147.3	114.3	1.7	2.9	2.4	50.9	319.5
Cottonwood	7.8	5.7	0.1	0.1	0.2	4.9	18.7
Douglas	10.7	7.8	0.4	0.1	0.1	8.5	27.6
Faribault	5.9	4.0	0.1	0.1	0.2	5.2	15.4
Freeborn	6.8	5.0	0.2	0.1	0.2	5.9	18.2
Grant	10.0	8.3	1.1	0.3	0.5	3.7	23.8
Jackson	31.0	28.9	0.7	0.3	0.8	20.0	81.6
Kandiyohi	60.5	45.5	0.7	0.6	1.8	53.3	162.4
Lac qui Parle	15.4	14.5	0.8	0.2	0.3	5.8	37.0
Le Sueur	27.2	17.4	0.7	0.4	0.9	20.9	67.4
Lincoln	20.1	18.9	0.4	0.2	0.3	8.5	48.5
Lyon	16.7	15.9	0.2	0.2	0.3	7.2	40.6
Mahnomen	33.9	22.6	0.2	0.5	0.5	9.3	67.0
Martin	6.1	5.1	0.1	0.1	0.1	3.6	15.1
McLeod	9.9	6.2	0.2	0.1	0.3	6.0	22.7
Meeker	12.2	9.2	0.3	0.2	0.4	7.0	29.3
Murray	14.0	11.6	0.2	0.1	0.1	8.7	34.8
Nicollet	8.4	6.1	0.1	0.1	0.2	6.0	20.9
Nobles	34.3	32.2	0.5	0.3	0.6	20.3	88.3
Norman	54.4	35.8	0.6	1.0	1.0	19.2	112.0
Otter Tail	45.2	37.0	0.5	0.3	0.8	33.4	117.2
Pipestone	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Polk	2.0	1.4	0.0	0.0	0.0	0.9	4.4
Pope	12.4	9.8	0.1	0.1	0.1	5.1	27.7
Red Lake	0.6	0.4	0.0	0.0	0.0	0.3	1.3
Redwood	48.2	40.4	0.7	0.5	1.0	25.4	116.2
Renville	2.6	2.0	0.0	0.0	0.1	1.3	6.1
Rice	1.7	0.8	0.1	0.0	0.1	1.7	4.4
Scott	0.3	0.0	0.0	0.0	0.0	0.5	0.4
Sibley	2.4	1.2	0.0	0.0	0.0	1.8	5.5
Stearns	7.7	6.4	0.0	0.1	0.1	2.7	17.1
Steele	10.3	4.9	0.3	0.2	0.4	7.9	24.1
Stevens	15.8	14.0	2.8	1.0	1.5	3.5	38.6
Swift	51.5	45.4	0.7	0.6	1.1	23.6	122.8
Todd	1.8	1.2	0.0	0.0	0.0	1.0	4.1
Traverse	5.0	4.1	0.3	0.1	0.1	1.5	11.0
Waseca	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Watonwan	1.2	1.0	0.0	0.0	0.0	0.8	3.2
Wilkin	3.5	3.2	0.0	0.0	0.0	1.4	8.2
Wright	10.7	5.2	0.3	0.2	0.4	6.5	23.2

Yellow Medicine	6.6	6.8	0.2	0.1	0.1	2.9	16.7
Total	817.3	644.0	16.7	11.9	18.8	430.4	1938.7

Appendix 6,

Diving Duck Pair Estimates on LSOHC Tracts by County

Before Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Becker	1.5	1.4	0.1	0.5	2.9	6.4
Big Stone	0.2	0.9	0.1	0.4	0.1	1.7
Blue Earth	0.0	0.1	0.0	0.0	0.0	0.2
Brown	0.0	0.2	0.0	0.0	0.0	0.3
Carver	0.0	0.0	0.0	0.0	0.2	0.2
Chippewa	0.0	0.1	0.0	0.1	0.0	0.3
Clay	3.4	4.7	0.6	1.9	3.9	14.5
Cottonwood	0.2	1.0	0.1	0.3	0.1	1.7
Douglas	0.3	0.5	0.0	0.2	0.8	1.9
Faribault	0.0	0.0	0.0	0.0	0.0	0.0
Freeborn	0.0	0.1	0.1	0.0	0.0	0.3
Grant	1.2	2.5	0.3	1.3	1.2	6.4
Jackson	0.2	1.6	0.2	0.7	0.1	2.7
Kandiyohi	0.9	2.0	0.3	0.6	2.5	6.3
Lac Qui Parle	0.5	2.6	0.2	1.3	0.3	4.8
Le Sueur	0.2	0.4	0.2	0.1	0.5	1.5
Lincoln	0.5	3.0	0.2	2.2	0.2	6.1
Lyon	0.4	2.9	0.2	1.3	0.2	5.1
Mahnomen	0.9	0.6	0.1	0.2	2.7	4.5
Martin	0.1	0.5	0.2	0.2	0.1	1.1
McLeod	0.0	0.1	0.0	0.0	0.2	0.4
Meeker	0.4	0.5	0.1	0.1	1.1	2.2
Murray	0.7	4.9	0.4	2.3	0.3	8.6
Nicollet	0.1	0.3	0.1	0.1	0.1	0.8
Nobles	0.4	3.4	0.3	1.6	0.2	5.9
Norman	2.4	2.3	0.2	0.7	3.3	9.0
Otter Tail	3.0	4.7	0.5	2.0	3.5	13.7
Pipestone	0.3	2.4	0.1	1.5	0.1	4.5
Polk	0.4	0.2	0.0	0.1	0.7	1.4

Pope	2.2	5.4	0.6	2.6	4.0	14.9
Redwood	0.5	2.2	0.2	0.8	0.4	4.1
Renville	0.2	0.6	0.1	0.2	0.2	1.3
Rice	0.0	0.1	0.1	0.0	0.2	0.4
Scott	0.1	0.2	0.1	0.1	0.3	0.7
Sibley	0.1	0.3	0.1	0.1	0.5	1.2
Stearns	0.3	0.5	0.1	0.2	0.9	2.0
Steele	0.0	0.0	0.0	0.0	0.0	0.0
Stevens	0.0	0.0	0.0	0.0	0.0	0.0
Swift	0.6	2.0	0.2	0.8	0.8	4.4
Todd	0.1	0.1	0.0	0.0	0.4	0.6
Traverse	0.1	0.3	0.0	0.1	0.0	0.6
Waseca	0.0	0.0	0.0	0.0	0.0	0.0
Watsonwan	0.0	0.2	0.0	0.0	0.1	0.3
Wilkin	0.7	1.1	0.1	0.4	0.6	2.9
Wright	0.1	0.1	0.0	0.0	0.7	0.9
Yellow Medicine	0.3	1.6	0.1	0.8	0.1	2.9
Total	23.8	58.9	6.5	25.8	34.5	149.6

After Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Becker	1.7	1.5	0.2	0.5	3.5	7.4
Big Stone	0.3	1.0	0.1	0.4	0.2	2.0
Blue Earth	0.0	0.1	0.0	0.0	0.1	0.3
Brown	0.1	0.4	0.1	0.2	0.1	0.8
Carver	0.0	0.1	0.0	0.0	0.2	0.4
Chippewa	0.1	0.3	0.0	0.1	0.1	0.6
Clay	7.4	10.9	1.3	4.7	9.9	34.1
Cottonwood	0.3	1.4	0.2	0.4	0.3	2.6
Douglas	0.4	0.6	0.1	0.2	1.1	2.3
Faribault	0.0	0.0	0.0	0.0	0.0	0.0
Freeborn	0.0	0.1	0.2	0.0	0.0	0.4
Grant	1.4	2.7	0.3	1.3	1.5	7.1
Jackson	0.3	2.6	0.3	1.3	0.2	4.7
Kandiyohi	1.3	2.6	0.3	0.8	3.7	8.7
Lac Qui Parle	0.7	3.2	0.2	1.5	0.5	6.0
Le Sueur	0.2	0.5	0.3	0.1	0.8	1.9
Lincoln	0.6	3.9	0.2	2.3	0.3	7.4
Lyon	0.5	3.2	0.2	1.5	0.4	5.8

Mahnomen	1.8	1.2	0.1	0.3	5.6	9.0
Martin	0.1	0.5	0.2	0.2	0.1	1.1
McLeod	0.1	0.1	0.0	0.0	0.3	0.6
Meeker	0.4	0.6	0.1	0.1	1.2	2.5
Murray	0.8	5.5	0.4	2.4	0.5	9.6
Nicollet	0.1	0.4	0.1	0.1	0.2	0.8
Nobles	0.5	4.1	0.3	1.8	0.3	7.0
Norman	3.5	3.2	0.4	1.0	6.5	14.5
Otter Tail	3.8	6.1	0.7	2.8	4.7	18.1
Pipestone	0.3	2.4	0.1	1.5	0.1	4.5
Polk	0.4	0.2	0.0	0.1	0.8	1.6
Pope	2.5	5.9	0.7	2.7	4.7	16.4
Redwood	0.7	2.8	0.3	0.9	0.8	5.5
Renville	0.2	0.6	0.1	0.2	0.2	1.3
Rice	0.0	0.1	0.1	0.0	0.2	0.4
Scott	0.1	0.2	0.1	0.1	0.3	0.7
Sibley	0.1	0.3	0.1	0.1	0.6	1.3
Stearns	0.3	0.5	0.1	0.2	1.0	2.1
Steele	0.0	0.0	0.0	0.0	0.0	0.0
Stevens	0.2	0.5	0.0	0.2	0.2	1.2
Swift	1.1	4.1	0.4	2.1	1.5	9.2
Todd	0.1	0.1	0.0	0.0	0.4	0.7
Traverse	0.2	0.3	0.0	0.0	0.1	0.6
Waseca	0.0	0.0	0.0	0.0	0.0	0.0
Watonwan	0.0	0.2	0.0	0.0	0.1	0.3
Wilkin	0.7	1.2	0.1	0.4	0.7	3.2
Wright	0.1	0.1	0.0	0.0	1.0	1.4
Yellow Medicine	0.4	1.7	0.1	0.8	0.1	3.1
Total	33.8	78.0	8.7	33.5	55.4	209.3

Difference Between Before and After Restoration						
All Counties in Analysis	Sum of Canvasback Pairs	Sum of Redhead Pairs	Sum of Lesser Scaup Pairs	Sum of Ruddy Duck Pairs	Sum of Ringneck Duck Pairs	Sum of Diving Duck Pairs
Becker	0.2	0.1	0.0	0.0	0.6	0.9
Big Stone	0.1	0.2	0.0	0.0	0.1	0.4
Blue Earth	0.0	0.0	0.0	0.0	0.0	0.1
Brown	0.0	0.3	0.0	0.1	0.1	0.5
Carver	0.0	0.0	0.0	0.0	0.1	0.1
Chippewa	0.0	0.2	0.0	0.1	0.1	0.3
Clay	4.0	6.1	0.7	2.9	6.0	19.7

Cottonwood	0.1	0.4	0.1	0.1	0.1	0.9
Douglas	0.1	0.0	0.0	0.0	0.3	0.4
Faribault	0.0	0.0	0.0	0.0	0.0	0.0
Freeborn	0.0	0.0	0.0	0.0	0.0	0.1
Grant	0.1	0.2	0.0	0.0	0.3	0.7
Jackson	0.1	1.0	0.1	0.6	0.1	2.0
Kandiyohi	0.4	0.6	0.1	0.1	1.2	2.4
Lac Qui Parle	0.2	0.6	0.0	0.2	0.2	1.2
Le Sueur	0.0	0.1	0.0	0.0	0.2	0.4
Lincoln	0.2	0.8	0.0	0.1	0.2	1.3
Lyon	0.1	0.4	0.0	0.1	0.1	0.7
Mahnomen	0.8	0.5	0.1	0.2	3.0	4.5
Martin	0.0	0.0	0.0	0.0	0.0	0.0
McLeod	0.0	0.0	0.0	0.0	0.1	0.2
Meeker	0.0	0.1	0.0	0.0	0.2	0.3
Murray	0.1	0.6	0.0	0.1	0.1	1.0
Nicollet	0.0	0.0	0.0	0.0	0.0	0.1
Nobles	0.1	0.7	0.0	0.2	0.1	1.2
Norman	1.1	0.9	0.1	0.3	3.2	5.6
Otter Tail	0.8	1.4	0.2	0.8	1.2	4.4
Pipestone	0.0	0.0	0.0	0.0	0.0	0.0
Polk	0.0	0.0	0.0	0.0	0.1	0.2
Pope	0.2	0.4	0.0	0.2	0.7	1.5
Redwood	0.2	0.6	0.1	0.1	0.5	1.4
Renville	0.0	0.0	0.0	0.0	0.0	0.0
Rice	0.0	0.0	0.0	0.0	0.0	0.0
Scott	0.0	0.0	0.0	0.0	0.0	0.0
Sibley	0.0	0.0	0.0	0.0	0.0	0.0
Stearns	0.0	0.0	0.0	0.0	0.1	0.1
Steele	0.0	0.0	0.0	0.0	0.0	0.0
Stevens	0.2	0.5	0.0	0.2	0.2	1.2
Swift	0.5	2.1	0.2	1.2	0.7	4.7
Todd	0.0	0.0	0.0	0.0	0.1	0.1
Traverse	0.0	0.0	0.0	0.0	0.1	0.0
Waseca	0.0	0.0	0.0	0.0	0.0	0.0
Watonwan	0.0	0.0	0.0	0.0	0.0	0.0
Wilkin	0.1	0.1	0.0	0.0	0.1	0.3
Wright	0.0	0.0	0.0	0.0	0.3	0.4
Yellow Medicine	0.0	0.1	0.0	0.0	0.0	0.2
Total	9.9	19.1	2.2	7.7	20.9	59.8