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Distribution and Derivation of Mallard Band Recoveries from the Upper Mississippi River, 1961-1989

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ABSTRACT

The Upper Mississippi River is an important habitat for migrating Mallards. However, siltation and development threaten the value of this habitat. We used banding data at a regional scale to determine the derivation and distribution of Mallard recoveries in the Upper Mississippi to study whether changes in habitat occurring during 1961-1989 were reflected in Mallard migration.

The Upper Mississippi has attracted a constant proportion of recoveries from SW Saskatchewan, SE Saskatchewan, SW Manitoba and the Missouri River Basin during 1965-1989. We found no changes in Mallard recovery rates during 1965-1989 for any sex/age class banded in these breeding areas ($P > 0.05$), except a slight decrease for adult males banded in SW Saskatchewan ($P = 0.026$).

The derivation of Mallard recoveries has not been stable during 1961-1989. The percent of Upper Mississippi recoveries from Missouri River Basin and Great Lakes declined, while SW Saskatchewan, SE Saskatchewan, and SW Manitoba increased. We found an unequal distribution of recoveries among Upper Mississippi navigation pools, which is probably due to differences in hunter pressure or an uneven distribution of quality habitat. Pools 1, 7, 12, 16, 22, 24, and 25, and the area below pool 26 all contributed over 500 total recoveries during 1961-1989.

Our analyses of band recoveries found no evidence of decreased Mallard use of the Upper Mississippi. Whereas Upper Mississippi habitat may be above a critical threshold level, continued degradation of backwater habitats, caused by siltation, could ultimately affect waterfowl use. Biologists should continue to use regional analyses of Mallard banding recoveries as one means of monitoring changes in waterfowl and habitat quality on the Upper Mississippi.

INTRODUCTION

The Upper Mississippi River (Upper Mississippi) is used as a migratory pathway by millions of birds. Bellrose (1968) estimated that 751,000 to 3,000,000 dabbling ducks used the Upper Mississippi each year. The Mississippi's north-south orientation leading from the northern prairies to the Gulf of Mexico provides a geographically well-defined corridor that concentrates the migratory movement into the greatest density of dabbling ducks in any flyway east of the Rocky Mountains (Bellrose 1968). Because of its importance as migratory habitat for waterfowl and other bird species, the Upper Mississippi is one of 34 areas of major concern as identified by the North American Waterfowl Management Plan (NAWMP) (NAWMP Committee, 1986).

The Upper Mississippi meanders 1200 km (744 miles) from St. Paul, MN, to Cairo, IL, through a flood plain with numerous backwater sloughs and oxbows (Emlen et al. 1986). Three national wildlife refuges collectively occupy over two-thirds of the Upper Mississippi's length: the Upper Mississippi River National Wildlife and Fish Refuge (UMRNWFR), Mark Twain National Wildlife Refuge, and Trempealeau National Wildlife Refuge.

The width of the Upper Mississippi varies from 300-2000 meters, while its flood plain's span averages 2-4 km near St. Paul, MN, 5-10 km at the mid-point, and 10-20 km near Cairo, IL. Every 15-40 km, the river is interrupted by navigation dams, built in the 1930s, which create long artificial lakes, or "pools" with relatively stable levels of water and vegetation (Emlen et al. 1986).

Although Upper Mississippi wetlands are relatively stable on a year-to-year basis when compared to the prairie pothole wetlands, long term changes have occurred because of sedimentation of back-water areas, increased barge traffic, and recreational use (Sparks 1995). For example, Pool 5 had a 56% decrease in submergent plants and a 54% decrease in emergent vegetation from 1940 to 1975 (North Central Region 1987).

Waterfowl managers are concerned about the effect of habitat degradation on migrating waterfowl. In order to manage effectively the Upper Mississippi, managers must first determine the relative importance of the Upper Mississippi to waterfowl populations using the Mississippi flyway. The Upper Mississippi is especially important to Mallards, which comprised 40.3% of the total duck harvest during 1946-1960 on the UMRNWFR (Green 1963) and 27.2% of the UMRNWFR's harvest during 1975-1984 (North Central Region 1987). Changes in the magnitude and distribution of use of the Upper Mississippi by Mallards may reflect long-term changes in the quality and quantity of habitat existing on the Upper Mississippi. Similar recovery analysis among the Upper Mississippi pools may help refuge managers prioritize management efforts. Although population counts of waterfowl would be a more direct measure of Upper Mississippi waterfowl use, population survey data have not been collected consistently. However, Mallard band-recovery data exist which cover the last 30 years.

Munro and Kimball (1982) provided estimates, on a continental scale, for each state's historical waterfowl derivations, or origins. During 1961-1975, Mallards from the Missouri River Basin and SW Manitoba banding areas averaged 21.8% and 20.2%, respectively, of the recoveries in the five states surrounding the Upper Mississippi.

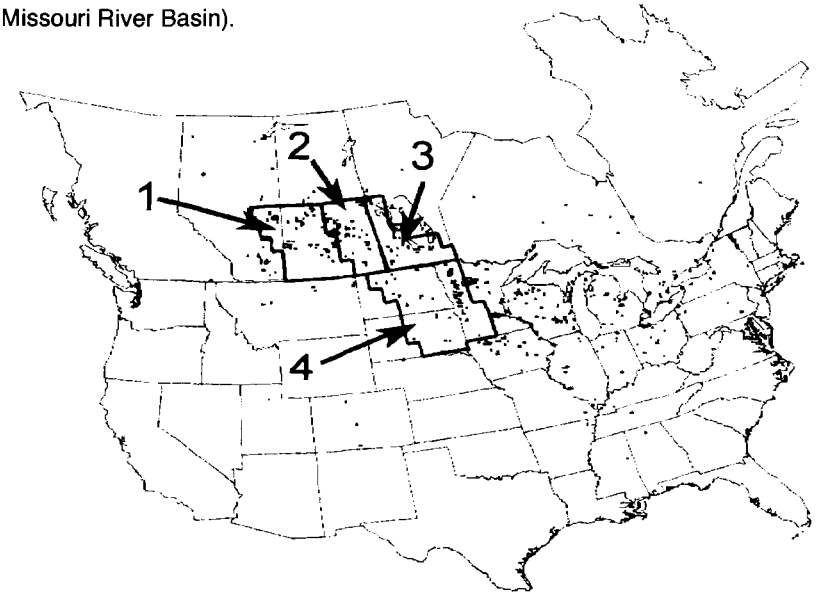
OBJECTIVES

We analyzed band-recovery data from Mallards banded during 1961-1989 and recovered on the Upper Mississippi. Our first objective was to study the importance of the Upper Mississippi to Mallards migrating from the SW Saskatchewan, SE Saskatchewan, SW Manitoba and Missouri River Basin banding areas, which lie along a geographical gradient away from the Upper Mississippi. We compared the proportion of banded waterfowl from the 4 banding areas using the Upper Mississippi in five time blocks during 1965-1989, and we also performed linear regressions on recovery rates during 1965-1989 to detect changes in hunter effort on the Upper Mississippi. Our second objective was to use banding data on a small-scale, regional level to determine the derivation of the harvest. We attempted to detect change in the sample derivation during 1965-1989, and compared the Upper Mississippi figures to Munro and Kimball's (1982) continental derivations. Our last objective was to use variation in the distribution of recoveries among the pools of the Upper Mississippi to detect contrasts and long-term changes in habitat quality and quantity.

METHODS

We identified the Upper Mississippi recovery area as the set of 10' latitude/longitude blocks through which the Mississippi River flows and those directly adjacent to a block which included the River from St. Paul, MN, to Cairo, IL. We did not include the entire width of the Mississippi Flyway, because we were strictly interested in the effects of the Upper Mississippi. We obtained Mallard band recovery records for the Upper Mississippi recovery area from the US Fish and Wildlife Service Banding Laboratory in Laurel, MD. We used records of normal, wild Mallards banded during July-September, 1961-1989, and shot or found dead between banding periods. After finding the derivations of all Upper Mississippi recoveries during 1961-1989, we chose the banding reference areas that contributed at least 5% of the recoveries (Fig. 1). We used these banding areas to follow temporal trends in Upper Mississippi recovery derivation.

Figure 1. Banding locations (*) of Mallards recovered in the Upper Mississippi River recovery area, 1965-1989, and banding areas (Anderson and Henny 1972) used in geographical gradient (1 = SW Saskatchewan, 2 = SE Saskatchewan, 3 = SW Manitoba, and 4 = Missouri River Basin).



To study the effect of banding area proximity on Upper Mississippi recoveries, we selected four banding areas that lie along a geographical gradient extending westward over the prairie pothole region from the Upper Mississippi; these regions are identified in this paper as SW Saskatchewan, SE Saskatchewan, SW Manitoba, and Missouri River Basin (Anderson and Henny 1972; see Fig. 1). The prairie pothole region is crucial to Mallard productivity, as 34-54% of the North American Mallard population breeds in this region (Anderson and Henny 1972). Also, approximately two-thirds of Mallards recovered by hunters on the wintering grounds (e.g., LA: 66.7%, AR: 66.8%, Eastern TX: 60.6%) were banded in the prairie pothole region (Munro and Kimball 1982).

We plotted the Upper Mississippi recoveries from the prairie pothole banding areas, SW Saskatchewan, SE Saskatchewan, SW Manitoba, and the Missouri River Basin, as percentages of the total Mallard recoveries from each banding area. We also described the relative contribution of each banding area to the total Upper Mississippi recovery bag. Although the same proportion of birds from a given banding area may use the Upper Mississippi each year, it is possible for the proportion of banded ducks in the Upper Mississippi total hunter bag from that banding area to increase or decrease if changes occur in migration from other banding areas or if banding efforts are not constant across all banding areas. Because of irregular yearly banding efforts during 1965-1989, we used five-year time intervals to monitor long-term trends in the Upper Mississippi recoveries and banding in the four banding areas. We used a linear regression (PROC REG, SAS Instit. 1987) to detect increases or decreases in the proportions in the five-year time intervals during 1965-1989.

Recoveries were sorted according to the latitudes of the recoveries and the approximate latitudinal boundaries of the Upper Mississippi pools. Because Upper Mississippi pools are not the same size, an index of recoveries/number of 10' blocks in the pool was used to show the relative importance of the pool to migrating Mallards.

Upper Mississippi recovery rates (probability of a Mallard being recovered by a hunter in the Upper Mississippi) were estimated using the post-release stratification methods of Schwarz et al. (1988). Recovery rates were estimated for each age and sex class from the SW Saskatchewan, SE Saskatchewan, SW Manitoba and Missouri River Basin banding areas (Powell et al. 1995). We used a linear regression (SAS Instit. 1987) to detect increases or decreases in recovery rate as a function of time from 1965-1989.

RESULTS

Recovery Proportions

The importance of the Upper Mississippi to prairie pothole populations. —Fifteen banding reference areas were represented in the Upper Mississippi sample. The banding areas which contributed over 5% of Upper Mississippi recoveries during 1961-1989 were SW Saskatchewan (8.05%), SE Saskatchewan (5.11%), SW Manitoba (15.60%), Missouri River Basin (26.28%), and Great Lakes (34.00%) (Table 1, Fig. 1). Mallard recovery sample sizes for age and sex classes are given in Table 2.

There were no trends during 1965-1989 in the proportion of Mallards from each banding area recovered on the Upper Mississippi (SW Saskatchewan, P=0.200; SE Saskatchewan, P=0.700; SW Manitoba, P=0.667; Missouri River Basin, P=0.458). In five-year time blocks during 1965-1989, a mean of 3.27% of SW Saskatchewan-banded Mallards, 5.31% of SE Saskatchewan-banded Mallards, 6.96% of SW Manitoba-banded Mallards, and 8.00% of Missouri River Basin-banded Mallards were recovered on the Upper Mississippi (Fig. 2).

Table 1. Comparison of the proportion of the total Upper Mississippi River hunter recovery bag coming from all banding reference areas during six time intervals, 1961-1989.

	Percent of total recoveries during time interval						Total %	N
Banding Area[a]	1961-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1961-1989	1961-1989
N Pacific	0.00	0.07	0.00	0.00	0.00	0.00	**0.01**	1
N Alberta/Mackenzie	0.00	2.11	1.48	0.75	0.45	0.17	**0.88**	71
SW Alberta	0.36	0.22	0.56	0.54	0.28	0.52	**0.41**	33
SW Saskatchewan	5.11	6.62	7.34	8.15	8.13	12.45	**8.05**	647
SE Saskatchewan	4.28	3.20	2.40	6.32	7.11	6.70	**5.11**	411
SW Manitoba	3.80	4.87	13.13	21.26	25.47	17.60	**15.60**	1254
N SK/N MB/W ON	2.62	2.55	2.05	3.94	0.90	0.52	**2.06**	166
E Ontario/W Quebec	0.48	2.11	4.02	5.77	3.27	3.43	**3.40**	273
Intermountain	0.00	0.07	0.00	0.00	0.00	0.09	**0.02**	2
High Plains	0.24	1.24	0.64	0.27	0.23	1.46	**0.66**	53
Missouri River Basin	29.85	33.24	28.93	22.21	19.71	27.33	**26.28**	2113
Great Lakes	44.95	39.42	35.99	28.74	31.11	28.33	**34.00**	2734
Mid-Atlantic	0.83	1.53	2.19	1.09	2.71	0.94	**1.67**	134
NE United States	0.12	0.65	0.49	0.82	0.34	0.17	**0.46**	37
Other	7.37	2.11	0.78	0.14	0.28	0.26	**1.39**	112
Total recovered	**841**	**1375**	**1417**	**1472**	**1771**	**1165**		**8041**

[a] After Anderson and Henny (1972).

Table 2. Number of bandings and subsequent recoveries of normal, wild Mallards, by age and sex, banded in SW Saskatchewan, SE Saskatchewan, SW Manitoba, and the Missouri River Basin (minor reference areas 131, 132, 133, Anderson and Henny 1972), 1965-1989.

Age	Sex	Banding Area[a]	N Banded	N Recovered
Juvenile	M	SW Saskatchewan	126,077	5,222
		SE Saskatchewan	12,940	1,822
		SW Manitoba	26,162	4,265
		Missouri River Basin	40,521	7,233
Juvenile	F	SW Saskatchewan	25,361	2,325
		SE Saskatchewan	9,655	872
		SW Manitoba	19,172	1,986
		Missouri River Basin	38,274	4,189
Adult	M	SW Saskatchewan	90,783	10,341
		SE Saskatchewan	31,455	3,959
		SW Manitoba	61,976	9,016
		Missouri River Basin	53,382	7,979
Adult	F	SW Saskatchewan	24,737	1,409
		SE Saskatchewan	11,543	713
		SW Manitoba	28,031	2,057
		Missouri River Basin	41,072	3,351

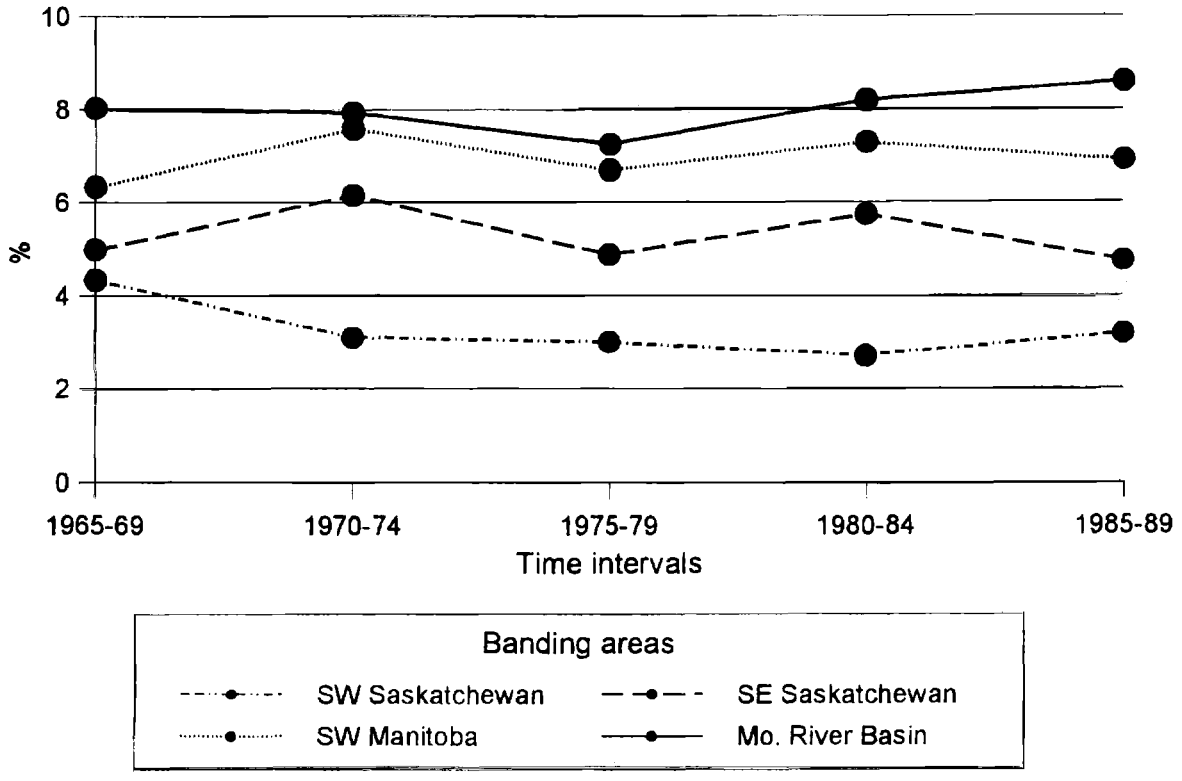
[a] After Anderson and Henny (1972).

We found that recovery rates, which are used as a rough index to hunting pressure, have not changed during 1965-1989 for any sex/age class banded in the prairie pothole banding areas, except for SW Saskatchewan-banded, adult male recovery rates, which decreased slightly (P=0.026).

Derivations of Upper Mississippi recoveries.— Although the proportion of Mallards from the prairie pothole banding areas using the Upper Mississippi has remained constant (Fig. 2), the derivation of Upper Mississippi Mallard recoveries has changed during 1961-1989. While the Missouri River Basin (P=0.174) and Great Lakes (P=0.007) contribution to the total Upper Mississippi recovery bag declined during 1961-1989, the percentage of recoveries contributed by SW Saskatchewan (P=0.012), SE Saskatchewan (P=0.087), and SW Manitoba (P=0.034) increased (Table 1). Banding totals for SW Saskatchewan (P=0.002), SE Saskatchewan (P=0.126), SW Manitoba (P=0.179), and the Missouri River Basin (P=0.716) showed markedly similar trends during the same period (Fig. 3). Banding information for the Great Lakes recovery area was not requested.

We compared our Upper Mississippi recovery derivation data during 1961-1989 to recovery derivations for the five surrounding states during 1961-1975 provided by Munro and Kimball (1982) (Table 3). Because increased proximity to a banding area which contributed the most recoveries to each

Figure 2. Percentage of total Mallard recoveries from the SW Saskatchewan, SE Saskatchewan, SW Manitoba, and Missouri River Basin banding areas, recovered on the Upper Mississippi River during six time intervals, 1961-1989.



state varied depending on the geographical position of the state. The proportions from the Upper Mississippi, during 1961-1989, sometimes deviated drastically, from the derivations of the individual states, and the five states' mean derivation. For example, Northern Alberta/Mackenzie and Northern Saskatchewan/Northern Manitoba/Western Ontario both provided a large percentage of recoveries for most states, while only 0.9% and 2.1% of the Upper Mississippi recoveries were derived from those locations. Also, the five state mean for the Great Lakes banding area is 15.5%, while 34% of Upper Mississippi recoveries are derived from the Great Lakes area.

Recovery Distribution by Pool

The number of recoveries and the index of recoveries per 10' latitude block for each Upper Mississippi pool is shown in Fig. 4. Pools 16 and 25 had the highest indices, while pools 1, 7, 12, 16, 22, 24, and 25, and the area below pool 26 all contributed over 500 recoveries during 1961-1989. The length of the pools did not have any effect on the number of recoveries/pool (P = 0.147).

DISCUSSION

Recovery Proportions

The importance of the Upper Mississippi to prairie pothole populations. — The importance of the Upper Mississippi as a migratory route for Mallards banded in the four prairie pothole banding areas (SW Saskatchewan, SE Saskatchewan, SW Manitoba, and the Missouri River Basin) is primarily a function of the distance from the banding areas to the Upper Mississippi. Other migratory routes, including the Pacific, Mountain, and Central Flyways, attract more Mallards from Saskatchewan and Manitoba. SW Saskatchewan is the farthest of the four banding areas from the Upper Mississippi, and it had the lowest proportion of its banded sample of Mallards recovered on the Upper Mississippi. The Missouri River Basin is nearest, and had more of its banded sample recovered in the Upper Mississippi in each time block. Because the proportion of Mallards from each of four banding areas using the Upper Mississippi has not changed over 30 years, we might assume that habitat degradations on the Upper

Figure 3. Number of Mallards banded in SW Saskatchewan, SE Saskatchewan, SW Manitoba, and the Missouri River Basin in six time intervals during 1961-1989.

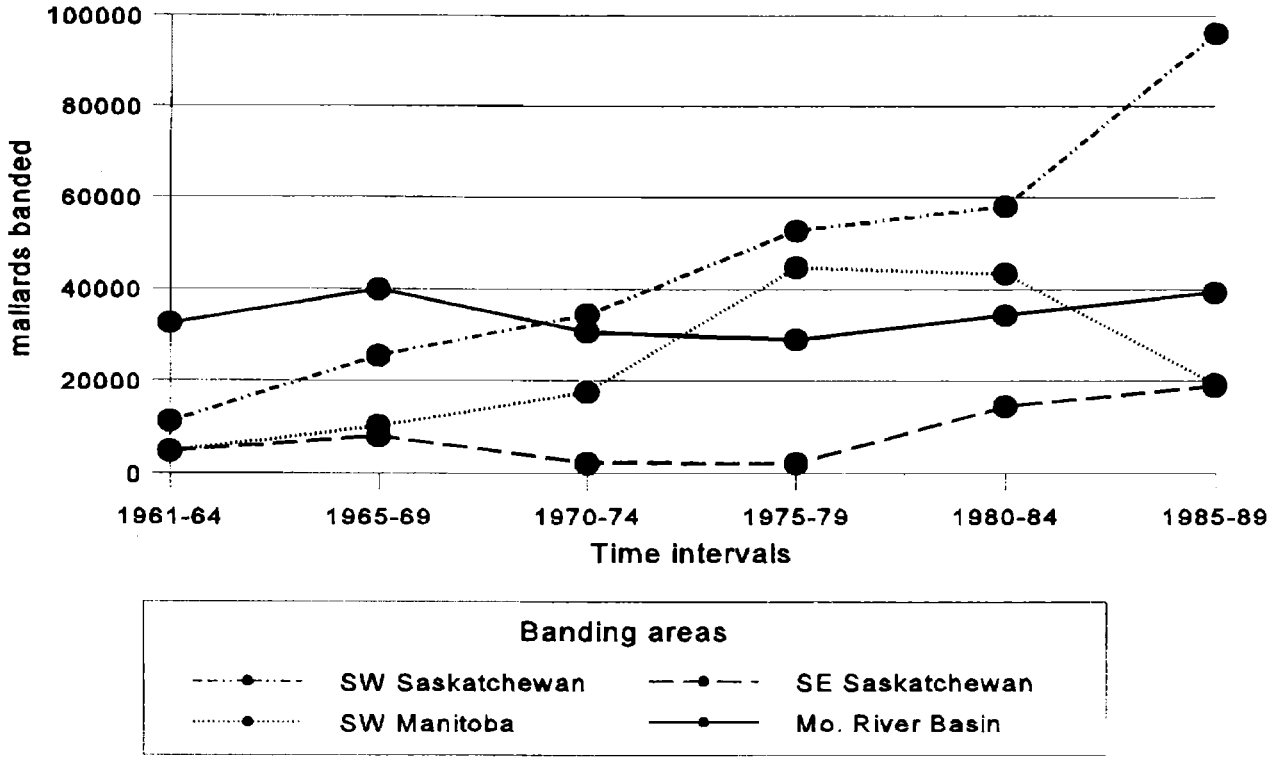


Figure 4. Distribution of Mallards among the pools on the Upper Mississippi River during 1961-1989. Recoveries are shown both as absolute numbers per navigation pool, and as an index of recoveries per 10' latitude block for each navigation pool which accounts for the size of the pools.

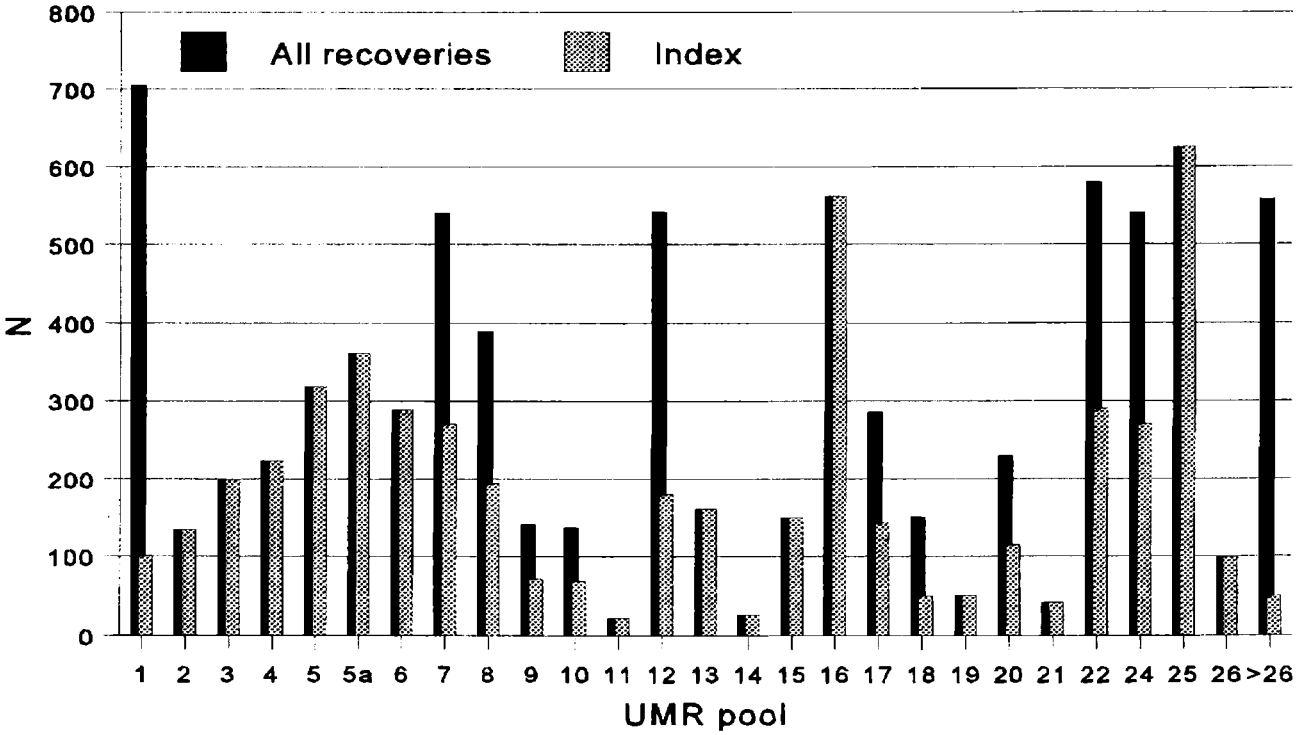


Table 3. Derivation rates (%) from 14 banding areas in five Upper Mississippi River states as presented by Munro and Kimball (1982) during 1961-1975 compared to Upper Mississippi River recovery area derivation rates (%), 1961-1989.

Banding Area[b]	State Recovery Area[a]					5-State Mean[c]	Upper Miss.
	IA	IL	WI	MN	MO		
N Pacific	0.7	1.5	0.0	0.0	0.9	0.6	<0.1
N Alberta/Mackenzie	12.7	9.7	2.0	3.8	15.5	8.7	0.9
SW Alberta	2.8	0.8	0.1	0.3	5.1	1.8	0.4
SW Saskatchewan	20.5	18.2	2.7	6.5	27.2	15.0	8.1
SE Saskatchewan	11.5	12.0	3.7	5.6	13.3	9.2	5.1
SW Manitoba	5.1	7.7	3.2	4.0	6.1	5.2	15.6
N SK/N MB/W ON	20.6	23.1	19.3	21.2	16.7	20.2	2.1
E Ontario/W Quebec	0.5	1.1	1.6	0.8	0.3	0.9	3.4
Intermountain	0.0	0.0	0.1	0.1	0.1	0.1	<0.1
High Plains	1.0	0.6	0.2	0.9	1.6	0.9	0.7
Missouri River Basin	20.6	16.4	11.5	48.5	11.8	21.8	26.3
Great Lakes	4.1	8.7	55.1	8.1	1.4	15.5	34.0
Mid-Atlantic	0.1	0.2	0.3	0.2	0.0	0.2	1.7
NE United States	0.0	0.0	0.1	0.0	0.0	<0.1	0.5

[a] Estimates from Munro and Kimball (1982).
[b] After Anderson and Henny (1972).
[c] Average of five states in Upper Mississippi area (Munro and Kimball 1982).

Mississippi have not been sufficient to affect waterfowl use.

Conversely, the banding areas' importance to the Upper Mississippi recovery sample seems to be a combined function of (1) distance from the banding area to the Upper Mississippi and (2) the proportionate number of Mallards banded in each banding area. The proportion of the Upper Mississippi sample derived from each banding area decreases along a geographical gradient extending westward from the Upper Mississippi, with the exceptions of SW Saskatchewan and SE Saskatchewan. Although SW Saskatchewan is farther from the Upper Mississippi than SE Saskatchewan, more birds are banded in SW Saskatchewan (Powell et al. 1995).

Derivations of Upper Mississippi recoveries.— The differences between Munro and Kimball's (1982) derivation estimates and our regional estimates are probably caused by scale. Upper Mississippi waterfowl managers could easily make incorrect conclusions about the derivation of Upper Mississippi recoveries if they use Munro and Kimball's (1982) large scale data. Because of the importance of the Upper Mississippi to waterfowl, small-scale band analyses of the Upper Mississippi are necessary to our understanding of the region and are more useful for refuge managers. Similar studies might be valuable in other geographic regions, where large-scale trends have traditionally been used in the management of a small-scale area.

The increases in recoveries in the Upper Mississippi sample during 1961-1989 do not mean that more birds from SW Manitoba, SW Saskatchewan and SE Saskatchewan are migrating to the Upper

Mississippi, and fewer Mallards are using the Upper Mississippi from the Missouri River Basin. Instead, we show the change in the derivation of Upper Mississippi recoveries is actually a function of the changes in the proportionate numbers of Mallards banded among banding areas.

The change in derivation of recoveries, and thus a change in the recovered sample of Mallards, may introduce bias into banding analyses. If Mallards banded in different reference areas have different annual survival, the annual survival of birds recovered in the Upper Mississippi would change according to this bias and the changing composition of the sample. For example, if SW Manitoba Mallards had unusually low survival because of intensifying breeding habitat losses, the survival of the sample recovered on the Upper Mississippi should begin to show a negative bias as more birds from SW Manitoba enter the sample in the later time blocks.

Our band analyses found no evidence of decreased Mallard use of the Upper Mississippi during 1961-1989. Fall aerial counts of the Upper Mississippi also showed stable populations during the 1960s and 1970s, but small declines during the 1980s (Reid et al. 1989). Migrating waterfowl feed on a variety of vegetation growing in backwater habitats (Reid et al. 1989, Gebauer and Weseloh 1992) that are being degraded by siltation (Sparks 1995). However, migratory patterns of Mallards are not shifting noticeably. Banding analyses may be too coarse to detect responses to the Upper Mississippi habitat, habitat may still be above any threshold level of degradation, or habitat outside the Upper Mississippi may be degrading at the same or faster rate than the Upper Mississippi's. Also, the effects of siltation on Mallard food in wetland habitats could be offset by abundant agricultural resources along the Upper Mississippi and intensive management of moist soil habitats on National Wildlife Refuges and hunt clubs along the river. We did not measure vegetation, so determining why siltation has not affected Mallard migratory use of the Upper Mississippi River is beyond the scope of our research.

Recovery distribution by pool

Contrasting waterfowl numbers in pools could be indicative of differences in habitat quality among Upper Mississippi pools, but we found that using the length of the pools as an indirect measurement of habitat quantity is not valid. Although the regression was not significant, the slope was negative, suggesting that waterfowl may prefer smaller pools, perhaps due to lower hunter pressure or a higher backwater habitat/pool area ratio. However, recovery distributions are a function of waterfowl concentrations and hunter pressure. We did not attempt to measure hunting pressure among various pools on the Upper Mississippi, but the two segments of the river with the highest indices are near large human population centers, the Quad Cities (pool 16) and St. Louis (pools 22, 24, and 25).

We were unable to show any temporal effects of changes in distribution of Mallards among Upper Mississippi pools, but continued siltation, recreational use, development, and barge traffic may have an effect on Upper Mississippi waterfowl use. In the future, small-scale band analysis studies and research designed specifically to study local and migratory waterfowl use of Upper Mississippi pools could provide critical information to refuge biologists along the Upper Mississippi.

Management Implications

The regional perspective on Upper Mississippi recovery derivations provided valuable information compared to earlier, larger scale analyses. We showed that Upper Mississippi recovery derivations have changed during 1961-1989, primarily due to contrasting changes in banding efforts among banding areas. The derivation of Upper Mississippi Mallards is unique when compared with the derivation estimates provided by Munro and Kimball (1982) for the states surrounding the Upper Mississippi. Small-scale band analyses, such as this, will provide Upper Mississippi refuge managers with the best estimates of waterfowl derivation.

Mallard recoveries were disproportionately distributed among Upper Mississippi navigation pools. This suggests a similar distribution of quality habitat or hunter pressure. Upper Mississippi habitat quantity and quality should be compared with migratory population count data, band recoveries, and hunter-day survey data before prioritizing habitat improvement projects.

We suggest continued study of the proportion of waterfowl from prairie pothole banding areas using the Upper Mississippi. Although trends in waterfowl use might indicate Upper Mississippi habitat is above a critical threshold, continued degradation of the Upper Mississippi may begin to affect waterfowl use. The Upper Mississippi is an important part of the continental migratory process. Continued analysis of Mallard banding recoveries is a crucial part of the management of waterfowl in this region. We have shown the importance of a regional perspective to banding analysis. As sample sizes permit, we recommend similar studies on the derivation and distribution of Upper Mississippi recovery data for other important waterfowl species.

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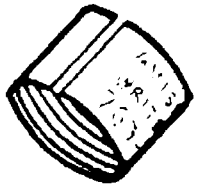

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