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Evaluation of Effectiveness of Pheasant Flushing Bars in Iowa Hayfields[1]

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Abstract. A three year study on 394 acres of hayfields revealed an overall reduction in hen mortality of 38 percent through the use of flushing bars. This was significant at the .01 probability level. For the individual years, only 1954 showed a significant reduction in hayfield mortality, the observed 54 percent decrease being significant at the .05 probability level. The bars were most effective in flushing hens that were in the hay but not sitting on the nest at the instant before the mower passed. A large proportion of hens on the nest was saved if incubation had not been started. Flushing bars were more effective in the afternoon than the forenoon hours. Effectiveness was well correlated with the condition of the hay crop; as the density and height of the hay increased, the effectiveness of the bar decreased rapidly. A possible "security threshold" factor related to the density of the cover, which may influence the likelihood a hen will flush, is suggested. It is not known if the use of the flushing bar actually resulted in additional pheasants in the fall populations; there was no noticeable increase attributable to their use. The principle of "carrying capacity" may act to cancel any initial gain resulting from the use of flushing bars.

A major problem in the management of the ringneck pheasant, *Phasianus colchicus*, in Iowa, as well as other states, is the heavy loss inflicted on the hens and their nests during hay mowing (Figure 1). In Iowa's pheasant range the preferred nesting sites of large numbers of hens are in hayfields composed primarily of alfalfa or red clover, or various mixtures with these two legumes predominating. The mowing of the first hay crop usually occurs when pheasant nesting is at its peak. Most hens are incubating, though several are still laying. Very few hayfield nests have hatched before mowing in the primary northern Iowa pheasant range. The few chicks hatched previous to haying operations are still too small to readily escape the mower and consequently suffer heavy mortality.

A desire to reduce this destruction of nests and birds has resulted in the development and use of various types of devices for flushing the birds from the standing hay ahead of the mower bar. Although the nest is still destroyed, since the tractor speed makes it nearly impossible to stop in time to save it, it is possible that the uninjured hen will be able to renest successfully elsewhere. The idea of using

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Figure 1. Most pheasant nests in hayfields and many of the hens are destroyed during the mowing of the first hay crop.

flushing bars to save pheasants is not a new one. However, the earlier flushing bars were designed for use on horse-drawn mowers (English, 1934) and were not adaptable to present-day high speed tractor mowers. A need for a suitable "scaring" device led to the development of the Ohio Flushing Bar (Warvel, 1949, 1950), and the bars used in recent years have been patterned, in general, after this design. Certain types of auditory stimuli for flushing pheasants were found ineffective in tests by Stewart and Dustman (1955) and Zorb (1957).

Results obtained with these flushing bars have been quite variable, however. Warvel (1949, 1950) found a 45 percent reduction in adult hen mortality and a 70 percent saving of juvenile pheasants in his Ohio studies. Bue and Ledin (1954) in Minnesota reported a 45 percent decrease in hen mortality during a 1941 flushing bar study and a 60 percent reduction in hen losses in one county in a 1953 investigation. Robbins (1953, 1954) indicated a saving of about 35 percent with the use of the Ohio Flushing Bar in northern Iowa, while Klonglan (1955a) found a 75 percent reduction in hen mortality on the same area with the same bar during the succeeding year. Klonglan also found during the same study that a different type of flushing bar resulted in a decrease of 31 percent in the loss of hens. Others, including Bell (1954) in Wisconsin, Swagler (1951) and Webb (1952) in Ohio, Fischer (1954) in North Dakota and Kemptar (1953) in Nebraska, have indicated that a significant reduction in pheasant losses in hayfields can be achieved with flushing bars.

However, tests by Zorb (1957) in Michigan failed to show that the "Ohio" bar reduced hayfield mortalities. Nelson (1955) mentions that, while one Minnesota test indicated a reduction of 60 percent, another test showed that very little benefit was derived from the use of flushing bars. Ridley (1955), in a continuation of the earlier northern Iowa studies, found the differences in mortality with and without a flushing bar were insignificant.

In view of the widespread differences in results reported, one might wonder what actual value flushing bars have. Flushing bar studies were conducted on the same northern Iowa area during a 3-year period from 1953 to 1955, and very different results were obtained each year. Hence, an evaluation of the data from these 3 years might give some evidence explaining the reasons for these differences. Throughout the remainder of this discussion, all 1953 data referred to are from Robbins (1953), all 1954 data from Klonglan (1955a), and all 1955 data from Ridley (1955).

Techniques of Investigation

The Winnebago Pheasant Research Area in north-central Iowa (Baskett, 1947) was selected for this investigation since it is located in Iowa's primary pheasant range and the cooperation of local farmers has been well established through previous studies. This area is intensively farmed, with 90 to 95 percent of the land put to direct agricultural use each year (Klonglan, 1955b). The flushing bar

Figure 2. The "Ohio" type flushing bar was used in studies to find ways to reduce destruction of pheasant hens in hayfields.

Figure 3. A flushing bar with heavy belting was one of the types tested for effectiveness in scaring pheasant hens ahead of the mower.

studies were conducted on a total of 394 acres of hayfields during the 3 years.

During 1953 the standard all-metal Ohio Flushing Bar (Figure 2) was used on 10 hayfields totaling 110 acres. The bar was used on half of each field and the other half used as a control. In 1954 flushing bars were used on 16 hayfields totaling 126 acres. The "Ohio" bar was used on half of each field, and a bar with strips of heavy belting in place of the cables and weights (Kemptar, 1953) was used on the other half (Figure 3). As a control, no bar was used on six fields totaling 50 acres. In 1955 tests were made on nine fields totaling 108 acres. Also, in 1955 four modifications of the "Ohio" bar were tried as follows:

1. A standard bar with eight weights and cables spaced at the usual 10 inches, but with 4.5-pound weights of 1¼-inch solid steel shaft instead of the regular 2.9-pound 1-inch lead-filled steel pipe.
2. A standard bar with 2.9-pound weights but with cables set on 6½-inch centers. This allowed 12 trailing weights rather than eight in front of the mower blade.
3. The same as No. 2, with the exception that 4.5-pound weights were substituted for the lighter ones.
4. An extended flushing bar with the distal weight trailing about 63 inches beyond that of the standard bar. Cables were set on 6½-inch centers, with a total of 21 trailing 2.9-pound weights. This allowed 10 cables to trail in the hay beyond the cutter bar and to pass over the hen twice—one swath

ahead of the mower and again just before the arrival of the cutter bar. By having the weight pass over the hen when there was no mower blade following, it might be determined if the hens were trying to flush but were being hit before they could clear the mower. This bar was braced with a truss and cable with turnbuckle. The additional weight did not affect the handling of the tractor and mower according to the operators. This was also true with the other flushing bars described.

Since the farmers mowed around a hayfield in a "circular" manner, the first half of the field cut consisted of a strip around the outer edges and the second half of a solid block in the center. The selection of the half of the field in which a particular bar was to be used was made before mowing by means of a restricted random sample, the restriction being that each bar be used on an equal number of outer and inner halves. Also prior to mowing, each field was examined for density of stand, height of stand and species composition.

The tests were made each year only during the mowing of the first crop of hay. The inclusive dates were June 15 to June 30 in 1953, June 14 to July 15 in 1954 and May 25 to June 24 in 1955. No attempt was made to use the flushing bar during the second cutting of hay. Klonglan (1955b) found no nests in the second alfalfa cutting and only one nest in second-cutting red clover. Very few birds were flushed near the mower and none were hit. Baskett (1947) found no nests in the second cutting of alfalfa during his 3 years of study.

In 1953, the mower operator made observations from the tractor, while the investigator followed on foot at two-swath intervals to check for further sign of nests and birds. In 1954, the investigator rode on the tractor with the operator during the mowing operations on all but 20 acres. When a hen flushed, a search was made for a nest and any signs of injury to the hen, if not previously apparent. The fields were walked in search of additional sign immediately after mowing and again after the hay was raked into windrows. On the 20 acres in which the observer was unable to be present during mowing (two farmers mowing at the same time), the tractor operator reported his observations and the fields were then walked before and after raking in search of other sign. The same techniques were used in 1955 as in 1954, with the investigator riding the tractor whenever possible.

Only those pheasants flushed within the immediate vicinity of the machine were counted. The habit some pheasant hens have of running a few feet from the nest before flushing was taken into consideration, so that, in general, any bird flushed without visible signs of harm and less than 15 feet from the mower was included in the "escaped" category. Hens that had lost one or both legs and/or wings or had sustained severe bodily injury, as evidenced by considerable loss of feathers, flesh and blood, were considered lost to the future breeding population and were placed in the "killed" category with those birds killed outright by the mower. In 7 years of intensive nesting studies, the authors found only four hens that had recovered from leg amputations or other severe injuries and nested during the following year. Another five hens that had lost a leg and recovered were seen, but it was not known if they ever nested after being injured. Thus, any error introduced by including all severely injured hens in the "killed" category probably is slight.

Crop and Weather Conditions

Since such different results were obtained with the flushing bars during the 3 years, some factor or combination of factors involving the hay, the flushing bar, or the birds themselves must have been operating. Therefore, an examination of the data on crop development and weather conditions was made to see if there were any significant differences in the hay crops of the 3 years. Climatological data were obtained from the U. S. Weather Bureau Station located at Forest City, Iowa, which is about 15 air miles southeast from the center of the Winnebago Research Area. Temperature and precipitation data for April, May, and June for the 3 years of study are summarized in Table 1.

April, 1953, was cooler and wetter than normal, retarding crop planting and development slightly. However, all of the oat crop had been planted at the month's end. May was about normal in temperature and, as in April, the precipitation was closer to normal than May of 1954 or 1955. The growth of hay, pasture, and oats was good, and all farm field activities were completed at the normal dates. June was a warm month, the second warmest in 18 years, and had the normal amount of precipitation. Growth of all crops, including hay, was very favorable during June, and mowing of the first crop of hay occurred during the usual interval of June 15 to June 30. Yields were average, indicating that with respect to the hay crop 1953 was a normal year.

In 1954, April was very favorable and farm field work proceeded well ahead of the normal schedule, with all of the oats planted by the end of the third week. However, the winter kill of new seedlings of alfalfa and red clover was considerable, with a loss of about 20 percent. Then, in the first week of May, an abrupt weather change occurred. New low temperature records were set as the mercury averaged 12 degrees below normal during the first week. Below

Table 1
Mean Temperature and Total Precipitation at Forest City, Iowa, for April, May and June, 1953-1955

	Mean Temperature			Total Precipitation		
Year	April	May	June	April	May	June
1953	40.9°	59.5°	71.2°	3.32″	3.27″	4.56″
1954	49.5°	53.9°	71.0°	4.71″	2.84″	8.85″
1955	54.4°	62.9°	67.1°	3.50″	1.69″	6.04″
Normal	46.7°	58.9°	68.6°	2.18″	4.13″	4.52″

freezing minimum temperatures were recorded on six mornings, with 26 degrees the lowest. Noticeable frost damage occurred on the 5th, 6th and 7th. This resulted in a considerable setback to the new oat crop and hurt the red clover crop to a lesser degree. Alfalfa was affected to a minor extent. The rest of May was also cool. Though the first week of June was cool, the rest of the month was much warmer than average and was ideal for crop development. Thus, the major portion of the first hay mowing took place as usual between June 14 and June 30. However, the combination of winter kill and late frost resulted in a significant decrease in the height and density of the hay crop, and the yields were poorer than average. One 30-acre red clover field that suffered the worst winter kill and some frost damage was not mowed until July 10. A 16-acre alfalfa field that had been grazed lightly was not cut till July 6, and the small acreage of native hay, which was usually cut during the last week of June, was not mowed until the first week of July. Some of the delay in 1954 was also due to very heavy rains during the usual peak mowing period, with 7.7 inches falling between June 14 and June 22—5.6 inches on the 18th and 19th alone.

April, 1955, was the third warmest on record and the early development of hay and pasture was excellent. Oat seeding was finished by the middle of the month and the stands at the end of the month were excellent. May was also sunny and warm, with the temperature surpassing 80 degrees on 13 days. Only one temperature minimum below 43 degrees was reported during the month—a 30 degree reading on the 8th. Thus, May was ideal for crop development, and all crops were in excellent condition. The first cutting of alfalfa began on May 25, nearly 3 weeks earlier than in 1953 or 1954. Most fields were ready for mowing at the end of the month, but 3.6 inches of rain during the first week of June delayed the cutting considerably. As a result, both alfalfa and red clover became very dense and the subsequent yields were above average. The last field, native hay, was cut on June 24.

Results of Investigation

A comparison of the overall results of the flushing bar studies conducted during the 3 years (Table 2) shows marked differences between the years involved. The data from the different types of bars used in 1954 and 1955 were combined in the overall analysis. In 1954, there was a significant difference between the 75 percent reduction in mortality experienced with the "Ohio" bar and the 31 percent reduction found with the flushing bar made of heavy belting. However, farmers have been observed using different types of "home-made" bars incorporating some principles from both of the above types, so the data from the two were combined to give a better overall picture. Though four modifications of the bar with cables and weights were used in 1955, the sample size of hens flushed with each was too small to permit comparisons between them, and all results were combined.

During the 3 years of study, a total of 175 pheasant hens was flushed from 394 acres of hay, or one hen per 2¼ acres. On the 278 acres on which flushing bars were used, 125 hens were flushed and 37 percent of them were killed or severely injured. On the 116 acres on which no bar was used, 50 hens were flushed and 60 percent of them were killed. This reduction in the rate of mortality from 60 to 37 percent meant a saving in hens of 38 percent when flushing bars were used. This decrease in mortality was statistically significant at the .01 probability level. It was assumed that the

Table 2

Effectiveness of Pheasant Flushing Bars During a 3-Year Study in North-Central Iowa

	With flushing bar		Without flushing bar	
	Number	Percent	Number	Percent
		1953		
Hens killed	15	39	17	59
Hens escaped	23	61	12	41
	—		—	
Total hens	38		29	
59% killed without bar, 39% with bar = 34% decrease in kill*				
		1954		
Hens killed	18	27	10	59
Hens escaped	48	73	7	41
	—		—	
Total hens	66		17	
59% killed without bar, 27% with bar = 54% decrease in kill**				
		1955		
Hens killed	13	62	3	75
Hens escaped	8	38	1	25
	—		—	
Total hens	21		4	
75% killed without bar, 62% with bar = 17% decrease in kill*				
		3-year Totals		
Hens killed	46	37	30	60
Hens escaped	79	63	20	40
	—		—	
Total hens	125		50	
60% killed without bar, 37% with bar = 38% decrease in kill***				

*Not significant, adj. chi-square = 1.71 for 1953 and 0.005 for 1955, .05 level = 3.84.
**Significant, adj. chi-square = 4.70, .05 level = 3.84.
***Significant, adj. chi-square = 7.78, .01 level = 6.64.

distribution of hens in the various fields was essentially homogeneous, and this was apparently true, since one hen was seen per 2.2 acres when the bar was used and one per 2.3 acres when it was not.

Though the overall reduction in hayfield mortality with the use of flushing bars during the 3 years was significant, this was not true for each year. As shown in Table 2, only the 54 percent reduction in 1954 was significant. The 34 percent decrease in 1953 appears large, but the sample size was not large enough to verify a true difference. The difficulty of small sample size was even more apparent in 1955, since fewer hens were observed in the hayfields than in previous years. In 1953, 67 hens were flushed from 110 acres, or one hen per 1.6 acres; in 1954, 83 hens from 176 acres, or one per 2.1 acres; but in 1955 only 25 from 108 acres, or one per 4.3 acres. This small sample made it impossible to compare the results from the various modifications of the "Ohio" bar and weakened the possible comparisons with the other years. Examination of the weather and crop records may explain why there were fewer hens in the hayfields. The growth of oats was well underway by the end of April, much earlier than usual, due to the favorable weather. The stands were quite dense and began furnishing suitable nesting cover as soon as did the alfalfa and red clover fields. Further growth of oats was quite rapid, reaching a height of 5 feet in many fields by the end of June. Since the acreage of oats on the study area was about triple that of hay, a large number of hens that would have nested in hayfields in a normal year began nesting in oatfields instead. Since the fall population in 1955 was considerably higher than the preceding 2 years and the hens were not nesting at the usual rate in hayfields, they had to be elsewhere, and the oatfields were the primary nesting areas available.

A distinct difference was found in the effectiveness of the flushing bar on hens that were sitting on their nests at the instant before the mower passed as opposed to those that were in the hay but not sitting on the nest (Table 3). To determine the category in which a hen belonged, a thorough search for a nest was made where the hen flushed. If a nest was not found within 15 feet of the spot where the hen flushed, it was assumed she was not on a nest when the mower passed. If the flushing location was not known definitely, this information was not recorded. When the flushing bar was in use, the mortality suffered by hens not on a nest was a highly significant 77 percent less (11 percent killed vs. 47 percent) than for those on their nests (Adj. chi-square = 13.02, .001 level = 10.83). When no flushing bar was in use, the difference (39 percent killed vs. 75 percent) was a significant 48 percent (Adj. chi-square = 4.59, .05 level = 3.84). Thus, as might be expected, the flushing bars were most effective in flushing hens not immediately associated with a nest. It should be remembered that the "Hens not on nest" category included only those flushed within 15 feet or less of the flushing bar and did not include the many that ran or flew out of the field at some distance from the tractor as mowing progressed. Thus, it should not be concluded that 39 percent of all hens originally in the field and not on a nest were killed when no flushing bar was used. The same would also be true, though to a lesser degree, for the hens on their nests, since some active nests from which no hen was flushed were found. Of course, in such instances it was not known if the mowing operations provided the incentive to leave the nest or if it was a "normal" absence.

Though it might be thought that hens in the later stages of incubation would tend to leave their nests more reluctantly and thus

Table 3

Effectiveness of Flushing Bars Upon Hen Pheasants Sitting on Nests and Not Sitting on Nests When Mower Blade Passed, North-Central Iowa, 1953-1955

	Hens on nest		Hens not on nest	
	With bar	Without bar	With bar	Without bar
Hens killed	28	21	5	7
Hens escaped	32	7	39	11
Total hens	60	28	44	18
Percent killed	47	75	11	39
Saved by bar	37%*		72%*	

*Statistically significant at .05 probability level (adj. chi-square = 5.12 and 4.28, respectively; .05 level = 3.84).

suffer a higher rate of mortality, no significant trend in this direction was found in this study (Table 4). The correlation between the stage of incubation and the proportion of hens killed was not significant ($r = 0.531$, .05 level = 0.707). One group, however, differed considerably from the rest, and no doubt accounted for most of the preceding "r" value. Only 8 percent of those hens with nests still in the laying stage were killed, so apparently the chances of saving a hen are greater if incubation has not begun. The average stage of incubation of 59 nests encountered when flushing bars were in use was 7.5 days, while the 27 nests for which stage of incubation data were available when no bar was in use averaged 8.3 days. Thus, there would be no significant variation introduced into the several comparisons from this source.

An analysis of the relationship between the number of hens killed and the time of day at which the mowing occurred was made (Table 5). It was found that 23 of 60 hens, or 38 percent, were killed during the forenoon hours when the flushing bar was in use, while during the forenoon hours when the bar was not in use 13 of 26 hens, or 50 percent, were killed. Thus, the flushing bar resulted in a reduction in mortality in the forenoon of only 24 percent, which was not significant (adj. chi-square = 0.60, .05 level = 3.84). In the afternoon, only 10 of 44 hens, or 23 percent, were killed when the bar was in action, while 14 of 20, or 70 percent were killed when it was not. This 67 percent reduction in hen mortality in the afternoon with the use of flushing bars was highly significant (adj. chi-square = 11.17, .001 level = 10.83).

The reasons for this apparent difference between forenoon and afternoon, with 64 percent more birds saved during the latter period, are not known. However, if this is a true difference, a possible clue may have been provided by studies on the nesting behavior of the pheasant hen conducted on the Winnebago Area (Ridley, 1957). It was found that 14 of 17 incubating hens were away from their nests most often between 1 and 6 p.m., with the 4 to 5 p.m. hour being most prominent. Perhaps many hens are more "restless" in

Table 4

Relationship Between the Stage of Incubation of Nests and the Number of Hens Killed or Escaped During Hay Mowing With or Without Use of Flushing Bar, North-Central Iowa, 1953-1955

Stage of	With bar		Without bar		Totals		
incubation in days	Hens killed	Hens escaped	Hens killed	Hens escaped	Hens killed	Hens escaped	Percent killed
0	1	10	0	1	1	11	8
1-3	4	4	2	4	6	8	43
4-6	6	5	6	0	12	5	71
7-9	4	3	5	1	9	4	69
10-12	5	3	1	0	6	3	67
13-15	4	3	1	2	5	5	50
16-18	1	3	1	0	2	3	40
19-23	2	1	3	0	5	1	83

Table 5

Relationship Between the Number of Hens Killed or Escaped During Hay Mowing With or Without Flushing Bar and the Time of Day Flushing Occurred, North-Central Iowa, 1953-1955

Time	With flushing bar				Without flushing bar			
of day	Acres cut	Hens killed	Hens escaped	Percent killed	Acres cut	Hens killed	Hens escaped	Percent killed
7-8 a.m.	4.1	0	5	0	2.7	0	0	–
8-9	18.9	4	10	29	9.9	0	3	0
9-10	24.8	6	9	40	15.5	5	3	62
10-11	25.6	8	8	50	17.9	5	6	46
11-12	16.7	5	5	50	11.7	3	1	50
12-1	2.5	0	0	–	0.0	–	–	–
1-2	22.1	2	13	13	15.1	4	4	50
2-3	29.8	7	10	41	10.7	4	0	100
3-4	16.7	1	7	12	8.2	1	0	100
4-5	15.3	0	4	0	9.3	3	1	75
5-6 p.m.	4.5	0	0	–	6.7	2	1	67
Total	181.0	33	71	32	107.7	27	19	59

Table 6

Effectiveness of Flushing Bars in Different Types of Hayfield Cover in North-Central Iowa, 1953-1955

Type of cover	With flushing bar					Without flushing bar				
	Acres cut	Acres hen	Hens killed	Hens escaped	Percent killed	Acres cut	Acres hen	Hens killed	Hens escaped	Percent killed
Alfalfa	129	1.5	31	54	36	50	1.6	17	14	55
Red clover	131	5.5	9	15	37	66	3.5	13	6	68
Sweet clover	18	1.1	6	10	37	–	–	–	–	
Total	278	2.2	46	79	37	116	2.3	30	20	60

the afternoon, either preparing to leave the nest or having recently returned from a period of absence. If this is true, these hens might be easier to flush, and thus account, at least in part, for the apparently greater effectiveness of the flushing bar during the afternoon hours. Further evidence in this direction was that fewer hens were flushed during the afternoon, even though the acreage of hay mowed was nearly identical for each period. With the flushing bar in use, one hen per 1.5 acres was flushed in the forenoon and one per 2.1 acres in the afternoon; without the bar in use, the figures were one per 2.2 acres and one per 2.5 acres, respectively.

A comparison of the results according to the predominate cover type in each hayfield showed that the flushing bar was equal in effect whether the field was alfalfa, red clover or sweet clover (Table 6). There was a considerable difference, however, in the number of hens flushed in the different types of fields. On the 179 acres of alfalfa used in the study, a total of 116 hens was flushed, one hen per 1.5 acres. Only 43 hens were flushed on the 197 acres of red clover mowed, one per 4.6 acres. In general, the alfalfa stands became suitable for nesting at an earlier date and attracted more hens. By the time of mowing, however, the heights and densities of the stands in alfalfa and red clover fields were essentially the same. The sweet clover field included in the study was the densest of all the fields used and also had the most hens in it, one per 1.1 acres.

It was not possible to ascertain the effect of flushing bars on juvenile pheasants during this study. Not a single young bird was seen during the first hay mowing in 1953 and 1954. In 1955, two broods were observed; one had just hatched and was still in the nest and the other was only 2 to 3 days old. Most of the chicks in both broods were killed. Though the flushing bar was attached at the time, chicks of such small size would hardly be expected to respond to it.

Very few rabbits were sighted during the study, which was not surprising with the low population present. Consequently, no evaluation of the effectiveness of flushing bars on rabbits could be made.

Discussion

The primary objective in the use of flushing bars is to enable the hens nesting in hayfields to escape death or injury so they can renest successfully and thus contribute to the fall population. From 1939 to 1941, a period when horse-drawn mowers were still used by most farmers, only 4 to 11 percent of the spring breeding population of hens on the Winnebago nesting study area suffered hayfield mortality (Baskett, 1947). In the 3 years of 1950 to 1952 prior to this study, the number of hens removed from further nesting by hay mowing mortality ranged from 14 to 23 percent of the estimated spring hen population. In 1954 and 1955, 19 and 20 percent of the spring hen populations were destroyed, even though flushing bars were used on 80 to 90 percent of the hay acreage on the nesting study area (which included most of the hayfields used in the flushing bar study during these two years). In 1953, 42 percent of the hen population was killed or severely injured in the hayfields, with one-third of the acreage on the nesting study area mowed with flushing bars attached. There was very little difference in the fall populations on the Winnebago Area from 1950 to 1954, and an increase in population in 1955 could not have been associated with hayfield nesting, as shown earlier. Thus, the flushing bar did not exert any noticeable effect on the fall populations of pheasants, the item of main interest to hunters.

Several reasons for the apparent differences in the effectiveness of flushing bars as shown by this study can be suggested. With the relatively small number of hens sampled, random variation obviously accounted for a considerable portion of the results. However, statistical tests were made where appropriate and in most instances indicated that the differences could not be explained on this basis alone.

It is possible that differences in the techniques used were a minor contributing factor. In 1954 and 1955, the investigators rode on the tractor during nearly all of the mowing operations, while in 1953, the observer was on foot most of the time and depended on the tractor operator for a large part of his information. It was found in 1954 that 34 of 55 hens, or 62 percent, flushed without injury were not seen by the tractor operator. However, the operator did not watch his mower as closely as usual since any clogging or malfunctioning of the machine would be brought to his attention by the investigator. They undoubtedly saw a larger fraction of the flushed hens in 1953 when there was no observer on the tractor. Though the observer on foot should detect nearly all instances of death or severe injury to the hen, he could miss counting some of the non-injured hens. Also, the interpretation of nests where no hen was flushed or a hen was flushed without injury would be difficult unless the investigator was watching the mowing operation from the machine. Perhaps the percentage reduction in mortality in 1953 would have been high enough to be significant had the technique been the same as used during the following 2 years.

Variation in the flushing bar designs used could hardly be an important factor in causing the differences. The Ohio Flushing Bar was used all 3 years, with slight modifications of it tried on some fields in 1955. Though the 1954 results obtained with a bar using heavy belting in place of the cables were not as good, the exclusion of these data would only mean the differences in the 3 years would become even wider. Since some farmers have been using home-made flushing bars of canvas or heavy sack material which work on the same general principle, the results from this belt bar were included to give a broader picture.

The only factor which was well correlated with the yearly differences in flushing bar effectiveness was the condition of the hay crop at the time of mowing. This condition, as expressed by density, height, and yield, was strongly correlated with the weather picture during April, May, and June. A comparison of the weather and crop conditions during these 3 months, as given in an earlier section, and the relative effectiveness of the flushing bar gave a striking pattern. The year of 1953 could be described as "normal" from the standpoint of both weather and crops, and the use of flushing bar indicated a possible reduction in pheasant hen mortality of 34 percent. Both 1954 and 1955 were "abnormal" years from the standpoint of weather and crop conditions, but in entirely opposite directions. A combination of winter kill, a record cold May and late frosts in 1954 resulted in a marked decrease in the height, density and yield of the hay crop on the Winnebago Area. As a result, the flushing bars were able to penetrate the hay to a considerable extent. Concurrently, the mortality reduction was 54 percent in 1954, and many of the farmers were favorably inclined toward the value of flushing bars.

However, in 1955 the picture underwent a drastic reversal. The spring of 1955 was one of the warmest on record and had a sufficient supply of moisture. The hay crop was far advanced over the preceding years and was ready to cut almost 3 weeks earlier than usual. A period of wet weather at this time delayed mowing considerably and the hay became tall, dense, coarse-stemmed, and finally quite tangled. As a result, the flushing bars were unable to penetrate the dense hay and merely rode over the top of it and the nesting hens beneath. Coincidentally, a non-significant decrease in mortality of only 17 percent was observed in 1955. Even the use of the extended bar, as described earlier, to give a "double flushing incentive" did not help. In the four instances where the bar was known definitely to have passed over a hen twice, each of the hens was hit by the mower and badly injured.

Theoretically, the behavior of the pheasant hen could have been different during the 3 years. Perhaps there is a "security threshold" factor which influences the likelihood that a given hen will flush. If true, the better penetration in the hay of the flushing bar may not be the only reason the bars seem to work more effectively in sparse cover (as in 1954). With less dense cover around her, the hen's inclination to flush as the tractor approaches or as the bar passes over her may be greater than when the hay is quite dense and the hen is well hidden from the tractor and flushing bar. Since no factual information has been obtained, this security threshold concept remains in the speculative field for the present.

Many animals tend to "freeze" when they are frightened, and the pheasant hen is no exception. In the course of the pheasant nesting investigations, it was found in several instances that an incubating hen could be punched with a stick or touched by hand without causing her to flush. This same hen would sometimes then sneak away from the nest after the observer moved away. At other times it was noticed that a hen would occasionally slip off the nest if the investigator tried to "sneak up" on her, but a hen would often "sit tight" if the observer hurriedly walked by the nest without appearing to see her. This type of response by hens to the abrupt passing overhead of the flushing bar would limit the bar's effectiveness. Theoretically, it would be possible for the bar to cause a given hen to be hit when she might have otherwise escaped. This would be difficult to prove, however, since this would necessitate a knowledge of the flushing intentions of each hen.

A major obstacle in attempting to evaluate the flushing bar is that it is not known what happens to those hens that escape as a result of the impetus of the bar. How many of them are able to renest, and if they do, how many broods result? To date, no such information is available. It is, after all, the number of extra birds that appear in the fall population as a result of hens being saved by the flushing bar that tells the true value of such bars. If the late fall carrying capacity of the area in question should be such that a large number of the birds hatched during the summer will necessarily be eliminated before the hunting season, the addition of a few birds through the use of flushing bars would have no significance. The number of hens saved is apparently a very low percentage of the total population, so if only a small fraction of them are able to raise a brood, the overall increase in the fall population may be negligible, even though the population is below the carrying capacity. For example, many renests are found in oatfields adjacent to mowed hayfields. With less than a month between the first mowing of hay and oat harvest, these nests have practically no chance of succeeding. Though the hen may have been "saved" by a flushing bar, she has still added nothing to the population, and with the short life expectancy of the pheasant hen, the prospects of any contribution to the next year's population are slim indeed.

Does the flushing bar have a place in future wildlife management plans? As tractor operating speeds increase and power mowers are built for these faster speeds, whatever value the flushing bar has will decrease rapidly. There simply will not be enough interval for the hen to escape between the instant she receives the flushing impetus and the moment the cutting bar passes over her nest. With the models of tractors and mowers used in this study, the flushing bars were 12 to 16 feet ahead of the cutting bar. Thus, the escape interval, or time the hen had to get out of the hay between the flushing bar and mower blade, varied between 1.4 and 2.7 seconds. When the flushing bars were in use, a large proportion of those hens hit had only their legs severed, which might indicate that the bar had startled the hen enough to make her rise but not enough to effect her escape. With only about 2 seconds to make good her escape, any slight hesitation will prove fatal. Since mowing speeds seem more likely to increase than decrease in the future, flushing bars probably cannot contribute much toward solving the problems of the destruction of pheasants in hayfields under our present methods of farming. Though the flushing bar as presently constructed will no doubt continue to save a few hens whenever used, the time and money devoted to their promotion might better be spent in seeking a more successful way of increasing pheasant production. In fact, overemphasis on its use could make farmers, particularly those who use it in a year with results like 1955, suspicious of any recommendations by wildlife managers, and could actually have an unfavorable effect on future attempts at securing farmer cooperation in wildlife management programs.

Summary

1. A study was made of the effectiveness of pheasant flushing bars on 394 acres of hayfields on the Winnebago Pheasant Research Area in north-central Iowa from 1953 to 1955.

2. The overall reduction in pheasant hen mortality through the use of flushing bars during the 3 years was 38 percent; this was significant at the .01 probability level.

3. For the individual years, only 1954 showed a significant reduction in hayfield mortality, the observed 54 percent decrease being significant at the .05 probability level.

4. The decreases in mortality of 34 percent in 1953 and 17 percent in 1955 were not statistically significant.

5. The bars were most effective in flushing hens that were in the hay but not sitting on the nest at the instant before the mower passed. Hens that were sitting on their nests were less likely to be flushed by the bar.

6. No significant correlation was found between the stage of incubation of the nest and effectiveness of the flushing bar. A larger proportion of hens on the nest was saved if incubation had not been started.

7. There was a significant difference in flushing bar effectiveness in favor of the afternoon over the forenoon hours of mowing.

8. There was no difference in the effectiveness of the flushing bar in alfalfa, red clover and sweet clover.

9. Flushing bar effectiveness was well correlated with the condition of the hay crop at the time of mowing; as the density and height of the hay increased, the effectiveness of the bar decreased rapidly.

10. The density and yield of the hay crop were average in 1953, below average in 1954 and considerably above average in 1955, and were strongly correlated with the weather during April, May and June.

11. A possible "security threshold" factor related to the density of the cover, which may influence the likelihood a hen will flush, is suggested.

12. It is not known if the use of the flushing bar actually resulted in any additional pheasants in the fall populations, but there was no noticeable increase attributable to the use of such bars.

13. It is possible that the principle of "carrying capacity" may act to cancel any initial gain resulting from the use of flushing bars.

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