SOCIALITY, AGONISTIC INTERACTION, AND THE PULSE PHENOMENON IN THE FLIGHT BEHAVIOR OF FALCONIFORMES ALONG THE MAINE COAST

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Introduction

During the months of September, October, and the first week of November there is a significant migration of Falconiformes along the Maine coast. We have been studying these migrations since 1965, with the exception of 1971.

Our observation site is in Casco Bay, toward the end of one of the peninsulas. Though we have not been able to man the station full time, we are there regularly each weekend and frequently a Monday or Friday as well. However, when we believe that a major movement of birds is going to take place because of weather patterns, we make an effort to be on the station. As a result, the station is manned anywhere from approximately one-third to one-half of the time.[1]

In other presentations and papers I have described the size of this movement and the influence of weather conditions on it. I have also speculated on the source of the hawk flights, as there has yet been no systematic observations farther north of us (Apell 1970, 1975, 1977). Therefore, in this article I shall describe certain behavioral observations we have made and discuss their implications.

However, let me briefly indicate the size of the migrations; since 1967 the average number of individuals observed was 2,533. In 1967 we had our lowest count (637) and 1975 we had our largest (7,310)--see Table 1. Our counts have been increasing, which is not reflected in these averages, but I shall discuss this topic shortly.

The rank order of species counted, indicating the usage of the coastal migration route, is shown in Table 2.

In Figure 1 (see also Table 3), I have plotted the seasonal pattern of the migration. Along the horizontal axis are rough weekly divisions throughout the months of September and October (some "weeks" include eight days in order to fit into the monthly division). On the vertical axis are plotted the average count for each species over a 10-year period.

Note that the Broad-winged Hawks peak early and then drop off rapidly, although we do get a few stragglers through in late October and even early November. Osprey also peaks early, but drops off more slowly. The Sharp-shinned Hawks have a rather symmetrical pattern, with the peak of their movements during the first week in October.

The most interesting pattern is that of the American Kestrel. While they pass through in greatest numbers during the first week in October, there is a second peak during the second week in September, about three weeks earlier. We do not know whether this earlier peak represents a distinct

population from somewhere farther north or whether it represents different migration patterns for juveniles and adults.

TABLE 1

TEN-YEAR AVERAGES OF FALCONIFORMES COUNTS,

CASCO BAY (AUTUMN 1967-1977)*

	Average	Maximum	Minimum	S.D.
Goshawk	2.4	9 ('76)	0 ('68,'69,'72)	2.9
Sharp-shinned Hawk	1157.3	3544 ('75)	137 ('67)	1020.2
Cooper's Hawk	13.4	33 ('67)	4 ('68,'70)	9.1
Unidentified Accipiter	6.9			
Red-tailed Hawk	26.8	76 ('67)	5 ('68)	22.6
Red-shouldered Hawk	3.1	10 ('74)	1 ('72,'77)	2.7
Broad-winged Hawk	466.6	1701 ('75)	61 ('67)	524.1
Unidentified Buteo	4.8			
Marsh Hawk	58.4	129 ('75)	7 ('67)	36.0
Osprey	97.5	223 ('73)	23 ('69)	64.6
Peregrine Falcon	4.8	14 ('76)	0 ('72,'74)	5.2
Merlin	52.7	129 ('75)	8 ('68)	40.3
American Kestrel	578.6	1481 ('75)	147 ('67)	381.2
Unidentified Falcon	42.3			
Unidentified Hawk	16.8			
Totals	2533.5	7310 ('75)	637 ('67)	1881.2

* In 1971 the station was not manned.

Average per cent of days on station during migration period: 49%

In Figure 2 (see also Table 3) we have plotted the less frequently occurring species, using a different vertical scale. Note that the Red-tailed Hawk is highly erratic. The Merlin peaks on the same week as the Sharp-shinned Hawk. Both the Cooper's Hawk and the Peregrine seem to increase more slowly but then the peak lasts a week or two longer.

In Figures 3 and 4 (see also Table 4) the trends in our hawk counts are plotted. A linear regression analysis shows that for all hawks, except the Sharp-shinned, our counts are increasing at the rate of 89 individuals per year. This may represent a growth in the population of Falconiformes, or it may indicate developing skills in predicting when to be on station to catch a movement. I suspect the latter.

TABLE 2

RANK ORDER OF SPECIES COUNTS FOR COASTAL MIGRATION ROUTE (1967-1977)*

Sharp-shinned Hawk	44.5%
American Kestrel	25.5%
Broad-winged Hawk	18.8%
Osprey	4.0%
Marsh Hawk	2.4%
Merlin	2.2%
Red-tailed Hawk	1.3%
Cooper's Hawk	.6%
Red-shouldered Hawk	.2%
Peregrine Falcon	.2%
Goshawk	.1%
Rough-legged Hawk	.1%

* Station not manned in 1971.

As for the Sharp-shinned Hawk, there is clearly a trend upward in counts. The slope of this line represents an increase of 193 individuals per year. If we factor out on a proportion basis the increase in counts due to increasing ability to predict flights, which may be causing our counts to increase, we can reach the conclusion that the Sharp-shinned Hawk populations that migrate along the Maine coast have been increasing over the past 10 years at an average rate of roughly 10 percent, or 120 individuals per year.

I have taken the counts from Hawk Mountain, Pennsylvania, for the same period, and using linear regression, I have found that the counts of Sharp-shinned Hawks over the past 10 years have been increasing at an annual rate of 588 individuals or 11 percent. The closeness of these two figures would seem to confirm the supposition that the Sharp-shinned populations are increasing.

I want to draw attention to another interesting point that is suggested by this graph. American Kestrel populations may be characterized by short-term fluctuations with peaks and crashes about five years apart. Though it is much too early to reach any firm conclusions from such limited data, I did test the idea against data from Hawk Mountain; there is no question that there are major short-term cycles in American Kestrel populations. However, at Hawk Mountain, the periodicity of the cycle appears slightly different: the interval between population peaks varies from four to nine years. This cycle of population crashes is somewhat obscured by the steady increase in kestrel counts at Hawk Mountain.

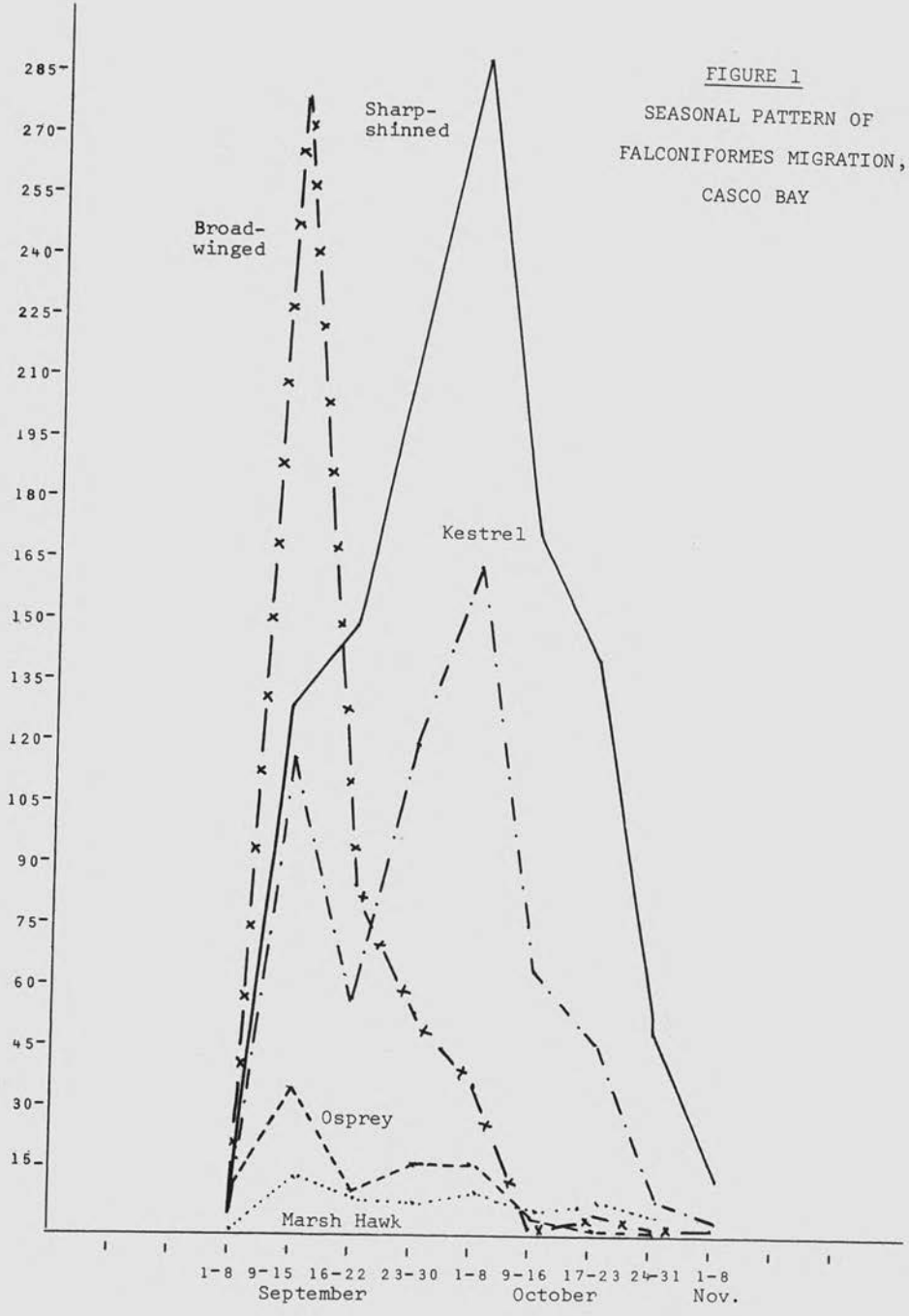

FIGURE 1

SEASONAL PATTERN OF FALCONIFORMES MIGRATION, CASCO BAY

FIGURE 2

SEASONAL PATTERN OF

FALCONIFORMES MIGRATION,

CASCO BAY

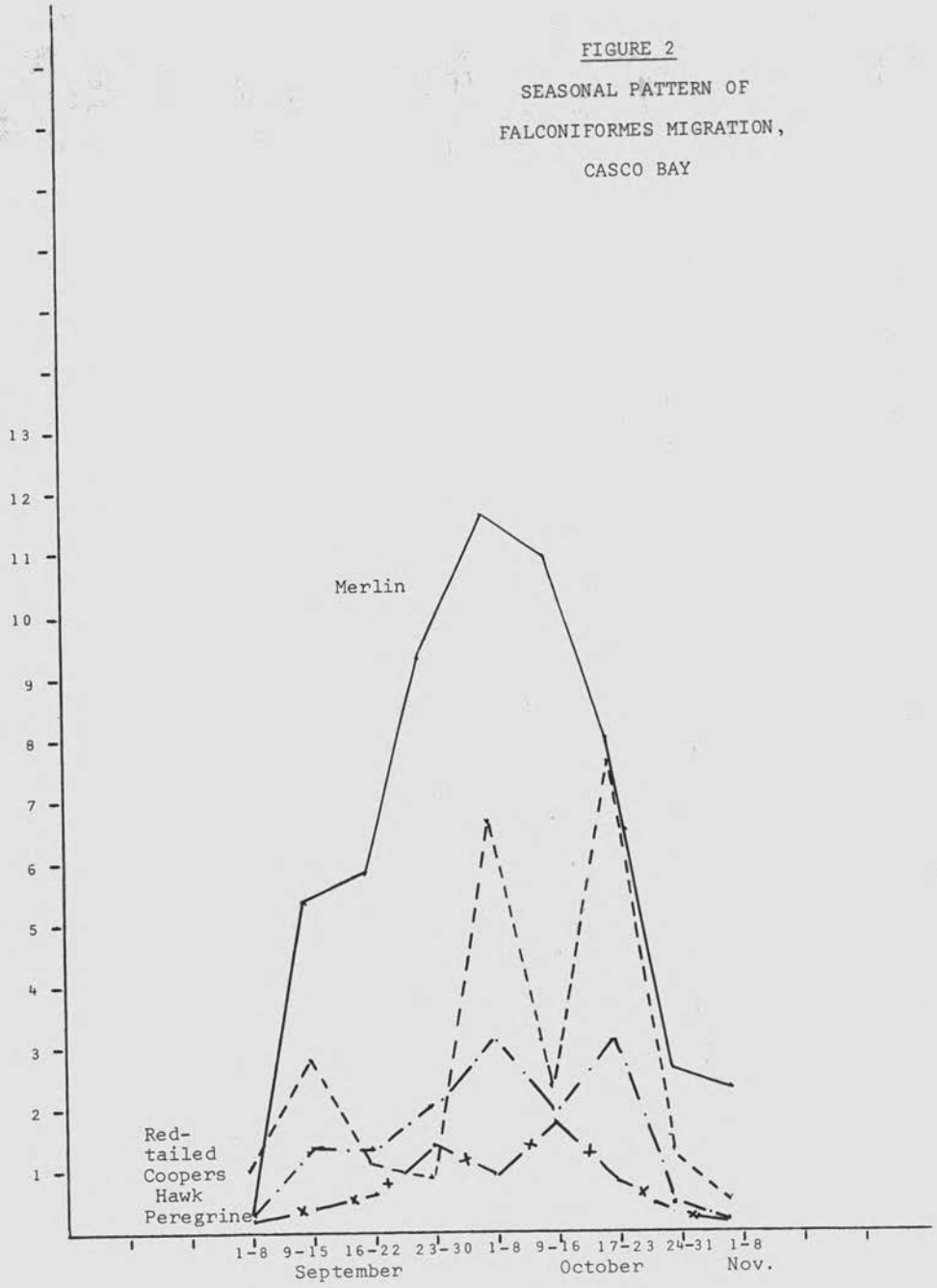

TABLE 3

SEASONAL PATTERN OF FALCONIFORMES MIGRATION, CASCO BAY

	September				October				Nov.
	1-8	9-15	16-22	23-30	1-8	9-16	17-23	24-31	1-8
Goshawk	.1	.4	.0	.1	.1	.4	.5	.5	.3
Sharp-shinned Hawk	6.4	130.4	149.9	204.5	289.4	173.9	141.7	48.2	12.4
Cooper's Hawk	.3	1.3	1.3	1.9	3.0	1.9	3.0	.4	0.0
Unident. Accipiter	.1	.8	.7	.5	2.1	.5	1.8	.3	.1
Red-tailed Hawk	.9	2.7	1.0	.8	6.6	2.2	7.6	2.6	2.2
Red-shouldered Hawk	0.0	.3	.5	.2	1.5	.3	.1	0.0	0.0
Broad-winged Hawk	5.2	279.2	85.7	53.5	35.5	.7	3.4	.9	.1
Rough-legged Hawk	0.0	0.0	0.0	0.0	0.0	0.0	.4	.5	.2
Unident. Buteo	.1	.3	.1	.9	1.5	.4	.9	.5	.1
Marsh Hawk	1.6	12.7	8.6	8.3	9.1	5.4	6.3	3.6	2.4
Osprey	9.8	35.1	11.7	17.7	17.3	3.6	1.4	.3	0.0
Peregrine Falcon	0.0	.2	.4	1.1	.7	1.6	.6	.2	0.0
Merlin	.2	5.3	5.8	9.3	11.7	11.0	8.0	1.3	.3
American Kestrel	6.9	114.0	55.6	120.4	162.2	63.2	44.6	8.5	1.9
Unident. Falcon	.2	5.1	4.2	5.8	14.8	3.5	7.3	1.3	.1
Unident. Hawk	.2	2.3	1.9	2.6	7.7	1.0	.6	.4	.1
Totals	32.0	590.1	327.4	427.6	563.2	269.6	228.2	69.5	20.2

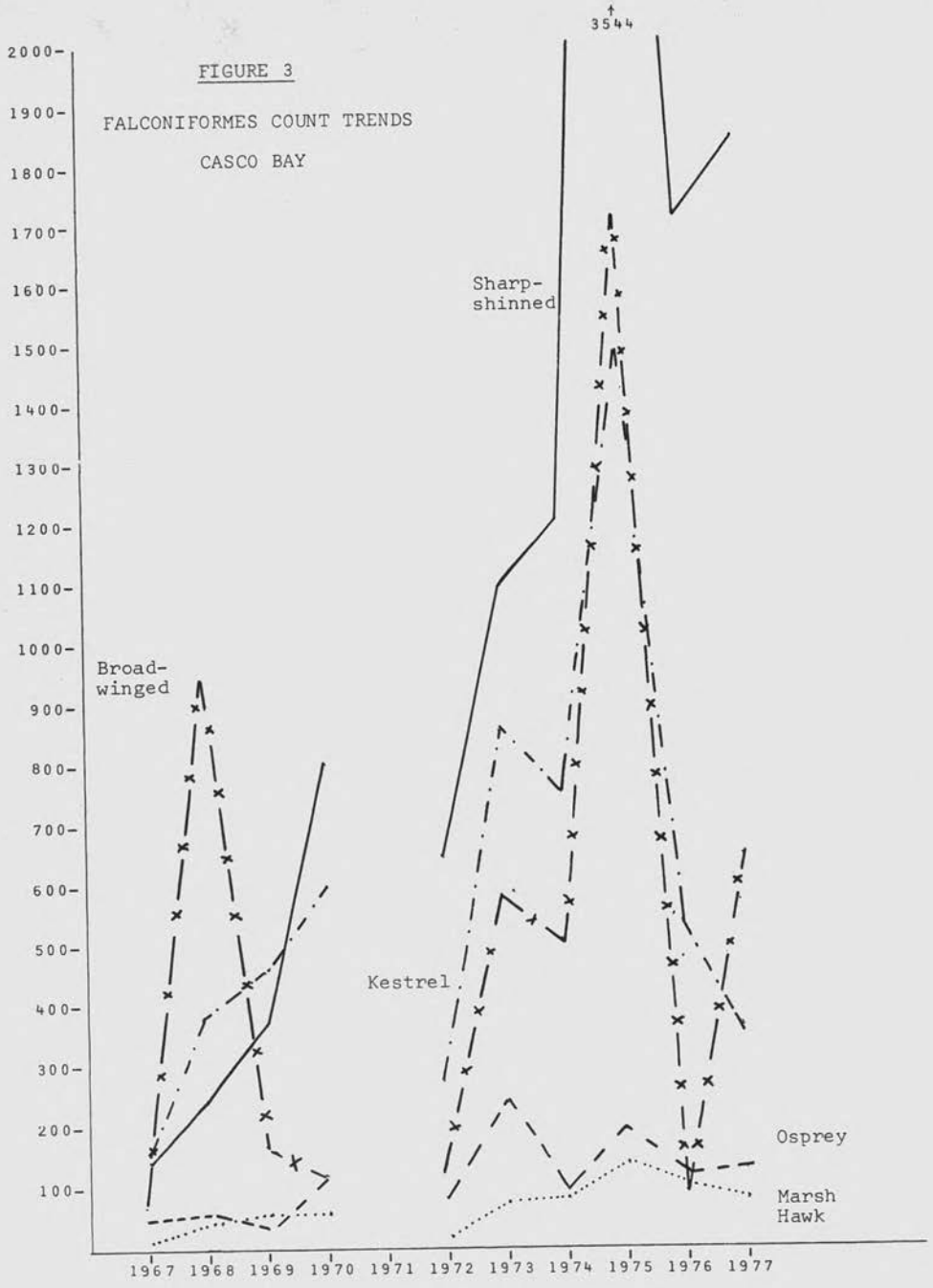
FIGURE 3
FALCONIFORMES COUNT TRENDS
CASCO BAY
3544
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
Sharp-shinned
Broad-winged
Kestrel
Osprey
Marsh Hawk
1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977

TABLE 4

FALCONIFORMES COUNT TRENDS, CASCO BAY*

	1967	1968	1969	1970	1972	1973	1974	1975	1976	1977
Goshawk	1	0	0	1	0	1	3	5	9	4
Sharp-shinned Hawk	137	241	368	803	640	1090	1203	3544	1708	1839
Cooper's Hawk	33	4	13	4	14	10	5	11	21	19
Unident. Accipiter	22	7	16	4	2	1	5	3	6	3
Red-tailed Hawk	76	5	17	13	22	13	16	14	36	56
Red-shouldered Hawk	4	2	2	2	1	5	10	2	2	1
Broad-winged Hawk	61	936	158	105	124	566	295	1701	79	641
Rough-legged Hawk	0	0	0	0	0	1	1	2	3	4
Unident. Buteo	11	4	12	2	2	3	3	4	7	0
Marsh Hawk	7	38	45	54	13	66	79	129	87	66
Ospey	31	43	23	111	64	223	80	180	103	117
Peregrine Falcon	2	1	2	4	0	4	0	13	14	8
Merlin	22	8	19	52	25	54	30	129	93	95
American Kestrel	147	367	450	591	273	846	744	1481	535	352
Unident. Falcon	66	34	60	64	22	35	42	51	23	26
Unidentified Hawk	17	7	28	10	2	8	16	41	15	24
Totals	637	1697	1213	1820	1204	2926	2532	7310	2741	3255

* Based on observations from 1967-1977 (1971 station not manned).

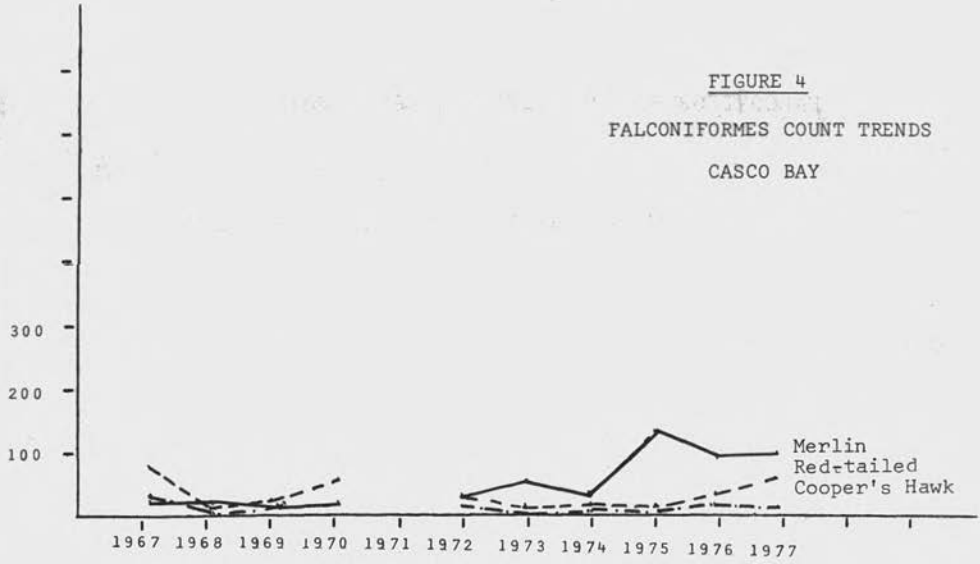

FIGURE 4

FALCONIFORMES COUNT TRENDS

CASCO BAY

Sociality in Migrating Falconiformes

One of the obvious characteristics of the Casco Bay hawk migrations is the formation of groupings, both conspecific and interspecific, as they pass over. We have been collecting data on these groupings in order to determine to what degree there is a preference for sociality among the various hawk species.

I tested for the degree of sociality by comparing the number of hawks passing in groups of their own species, or in groups associated with other species, to those passing singly. This gives us a measure for the preference for sociality (see Table 5). Please note that this figure is very conservative. We have not included Column B, since this might not indicate sociality so much as aggression or hunger. Our observational methodology is also very conservative. Though this is not the place for an extended discussion, it is obvious that the hawks themselves are in a much better position to see other hawks and adjust their flight patterns to them than are ground observers. We also do not yet have any but the most rudimentary way of selecting for behavioral acts that indicate sociality. For example, I doubt the Peregrine Falcon data. Last year we saw a Peregrine followed within a minute by another; though I suspect they were traveling in company, we entered them as two singles.

However, it is worth noting that the Merlin seems to be least social, the Broad-winged Hawk most social, and the Sharp-shinned Hawk and American Kestrel in between.

In Table 6 are listed the largest observed groupings of particular species.

TABLE 5

SOCIALITY IN MIGRATING FALCONIFORMES*

	A	B	C	D	
	Passing Singly	Passing as Individuals Associated With Other Species	Passing in Groups of Own Species	Passing in Groups With Other Species	Preference for Sociality**
Goshawk	23	1	-	-	-
Sharp-shinned Hawk	6377	197	3837	299	39%
Cooper's Hawk	110	10	12	2	11%
Red-tailed Hawk	206	14	46	2	19%
Red-shouldered Hawk	20	3	7***	-	-
Broad-winged Hawk	474	24	3752	184	89%
Rough-legged Hawk	8	3	-	-	-
Marsh Hawk	445	29	67	6	14%
Osprey	722	29	201	4	22%
Peregrine Falcon	45	3	-	-	-
Merlin	448	21	32	-	7%
American Kestrel	3693	161	1691	107	33%

* Based on observations from 1967-1977 (1971 station not manned).

** $\frac{C+D}{A+C+D}$

*** I question the validity of this sighting of seven Red-shouldered Hawks in one group.

TABLE 6

SIZE OF LARGEST GROUPING

Goshawk	1
Sharp-shinned Hawk	44
Cooper's Hawk	2
Red-tailed Hawk	6
Red-shouldered Hawk	7*
Broad-winged Hawk	250
Rough-legged Hawk	1
Marsh Hawk	4
Osprey	4
Peregrine Falcon	1
Merlin	2
American Kestrel	8

* The reliability of this figure is questionable.

The Sharp-shinned high of 44 individuals seems rather interesting. I again note that the figure for Red-shouldered Hawk is probably unreliable.

With regard to interspecies groups--I refer to the data in Column B, Table 5--the most frequently occurring ones are the Sharp-shinned--American Kestrel combination followed by the Sharp-shinned--Broad-winged combination. The third most frequent combination is Sharp-shinned--Marsh Hawk followed by Sharp-shinned--Osprey (see Table 7). The Sharp-shinned Hawk has the highest preference for interspecific groupings, and it is followed by the American Kestrel.

The Pulse Phenomenon

When you are on station, it becomes quite clear that the migrating hawks do not come through randomly but in bursts. That is, superimposed on the diurnal cycle are fluctuations of small amplitude, which I call pulses. Peter Cannell (personal communication) has made a statistical test of the data on these pulses and has confirmed that the pulses are real. Furthermore, it should be noted that these pulses are not necessarily composed of conspecifics but may be interspecific.

TABLE 7

TYPES AND FREQUENCIES OF INTERSPECIAL GROUPINGS*

	Frequency of Grouping
Sharp-shinned Hawk - American Kestrel	162
Sharp-shinned Hawk - Broad-winged Hawk	32
Sharp-shinned Hawk - Marsh Hawk	21
Sharp-shinned Hawk - Osprey	19
American Kestrel - Merlin	10
Sharp-shinned Hawk - Cooper's Hawk	6
Sharp-shinned Hawk - Red-tailed Hawk	5
Sharp-shinned Hawk - Merlin	5
American Kestrel - Merlin	5
American Kestrel - Osprey	5
Sharp-shinned Hawk - American Kestrel - Broad-winged Hawk	4
American Kestrel - Broad-winged Hawk	2
Sharp-shinned Hawk - Merlin	2
Sharp-shinned Hawk - American Kestrel - Marsh Hawk	2
Cooper's Hawk - Red-shouldered Hawk	2
Sharp-shinned Hawk - Rough-legged Hawk	2
Broad-winged Hawk - Marsh Hawk	1
Broad-winged Hawk - Osprey	1
Broad-winged Hawk - Cooper's Hawk	1
Broad-winged Hawk - Red-tailed Hawk	1
Osprey - Red-tailed Hawk	1
Osprey - Merlin	1
Marsh Hawk - Red-tailed Hawk	1
Sharp-shinned Hawk - Goshawk	1
Peregrine Falcon - Sharp-shinned Hawk	1
Peregrine Falcon - Merlin	1
Peregrine Falcon - American Kestrel	1
Red-tailed Hawk - Merlin	1
Sharp-shinned Hawk - Osprey - Cooper's Hawk	1
Sharp-shinned Hawk - American Kestrel - Red-tailed Hawk	1
Sharp-shinned Hawk - American Kestrel - Osprey	1
Sharp-shinned Hawk - American Kestrel - Merlin	1
Sharp-shinned Hawk - Marsh Hawk - Broad-winged Hawk	1
Sharp-shinned Hawk - Osprey - Red-tailed Hawk	1
Sharp-shinned Hawk - Marsh Hawk - Red-tailed Hawk	1

* Based on observations from 1967-1977 (1971 station not manned).

One of the difficulties in dealing with the pulse phenomenon has been in depicting or mathematically describing it, so that we can better grasp its significance. In figures 5, 6 and 7 I present examples of the pulse phenomenon.

FIGURE 5

PULSE PHENOMENON, OCTOBER 10, 1977

9:30-35_		1SS				
35-40						
40-45_		1SS				
45-50__		2SS				
50-55_		1SS				
55-60___		3SS				
10:00-05____	Wind dying	2SS	2PF			
05-10__	Thermalling behavior	2SS				
10-15_____		10SS				
15-20__		1AK	1o			
20-25						
25-30__		1SS	1AK			
30-35__		1AK	1o			
35-40_		1SS				
40-45__		1SS	1AK	1MH		
45-50_____	Moving thermal to thermal	9SS	1o			
50-55_____		4SS	1AK			
55-60_____		4SS	2AK	2MH	1o	1M
11:00-05____		1SS	2AK	1MH		
05-10__		2SS				
10-15____		1SS	3AK			
15-20___		3SS				
20-25_	Wind springs up from SW	1SS				
25-30__		1SS	1AK			
30-35						
35-40_		1SS				
40-45						
45-50						
50-55_		1SS				
55-60_____		3SS	1o	1M		
12:00-05__		1SS	1o			
05-10___		1SS	1MH	1UF		
10-15						
15-20_____		5SS	2AK	1UF		
20-25___		3SS				
25-30						
30-35____		1SS	2AK	1PF		
35-40_____		4SS	2AK	1M		
40-45_____		4SS	3AK	1CH		
45-50___		2AK	1M			
50-55___		1SS	2AK			
55-60___		1SS	1M			
1:00-05_____		6SS	2AK	1M		
05-10___		2SS	1M			
10-15_____		2SS	5AK			
15-20_____		5SS	1PF			
20-25						
25-30___		3SS				
30-35__		1AK	1MH			
35-40_____		10SS				
40-45____		3SS	1AK			
45-50_____		6SS				
50-55____		2SS	1AK	1MH		
55-60_____		7SS	3AK	1M		

See Figure 7 for Key. _ = one individual.

FIGURE 6

PULSE PHENOMENON, SEPTEMBER 19, 1976

8:00-05_	Sunny and hazy	1o		
05-10				
10-15				
15-20				
20-25				
25-30				
30-35				
35-40				
40-45				
45-50_		1SS		
50-55				
55-60				
9:00-05				
05-10____	Wind picks up	5SS		
10-15____		4SS		
15-20_____		10SS		
20-25__		2SS		
25-30_____		9SS	1AK	
30-35_____		11SS		
35-40_____		10SS	1o	
40-45_____	Wind dropping	10SS		
45-50____		5SS		
50-55				
55-60_		1SS		
10:00-05	Calm			
05-10____		5SS		
10-15____		5SS		
15-20____		3SS	1AK	
20-25____		5SS		
25-30_		1RT		
30-35_____	Wind picks up, SSW	5SS	1o	
35-40_____		9SS		
40-45____		7SS		
45-50____		5SS		
50-55_____		6SS		
55-60_		1MH		
11:00-05_____		5SS	1PF	
05-10___		1SS	1AK	1MH
10-15_____		5SS	1AK	
15-20_____		6SS	1AK	
20-25___		3SS		
25-30___		3SS		
30-35___		3SS		
35-40__		2SS		
40-45_		1SS		
45-50__		1SS	1o	

See Figure 7 for Key.

_ = one individual.

FIGURE 7

PULSE PHENOMENON, SEPTEMBER 11, 1977

7:15-20	
20-25_	1RT
25-30	
30-35	
35-40	
40-45	
45-50	
50-55	
55-60	
8:00-05	
05-10	
10-15	
15-20___	1SS 1MH 1o
20-25__	2SS
25-30	
30-35	
35-40	
40-45	
45-50	
50-55	
55-60	

KEY: _ = one individual.
SS = Sharp-shinned Hawk
CH = Cooper's Hawk
RT = Red-tailed Hawk
MH = Marsh Hawk
o = Osprey
PF = Peregrine Falcon
M = Merlin
AK = American Kestrel
UF = Unidentified Falcon

NOTE: The wind was light and from the southwest. The sky was originally overcast. However, it began to clear in the west with a distinct edge of clouds moving to the east. As this edge of clouds moved over the water, the sun broke through brilliantly on the water. Between 8:15 and 8:25 the hawks rose from their roosts in trees on the edge of the shore as the line of clearing weather moved towards them. The movement began three or four minutes before the roosts were in the sun, but, it appeared, in response to the breaking through of sunlight on the water.

What are the causes of the clumping of hawks in their migratory behavior? We suggest the following:

1. When thermals develop, various species move towards them, work their way up to the top, and then peal off in a loose gathering (see Figure 5 10:00 to 11:00 a.m.).

2. Aggressive behavior contributes to the make-up of pulses. For instance, I have the observation of Sharp-shinned Hawks moving toward a Red-tailed Hawk to harass it, and then move on together past the observation station.

3. Pulses also arise through fraternization; a hawk sees another pass by and joins it.

4. An increase in wind speed seems to stimulate the hawks to rise out of their roosts and move (see Figure 6 9:00 and 10:00 a.m.).

5. Weather conditions may be conducive to migration in one region but not in another. Once a group starts moving, it continues as a group, or as a pulse, through the next region.

6. A change in sunlight can trigger a movement (see Figure 7).

7. Wind patterns may produce a pile-up of hawks, as for example, at the crest of a wind wave rising over a high point.

Agonistic Behavior

We have also been making observations of agonistic behavior. By this I refer to combative behavior, in some instances showing the quality of a contest, rather than outright naked aggression, although this is at times involved. Agonistic behavior also includes what is termed harassment. From a sample of 456 observations (see Table 8), I have compared the species rates of agonistic behavior (see Table 9).

The Merlin initiated agonistic behavior the most frequently, while the Broad-winged Hawk is the least aggressive. Note that certain species--the Merlin, Sharp-shinned Hawk, and Peregrine Falcon--have initiation rates of agonistic acts that are significantly higher than the proportion of their species to all migrating species together. There are also certain species which have a significantly lower rate of initiation of agonistic acts, such as Osprey and Broad-winged Hawk.

TABLE 8

OBSERVED ACTS OF AGONISTIC BEHAVIOR (1965-1977)

	Target										
Aggressor	Sharp-shinned	American Kestrel	Broad-winged	Red-tailed	Osprey	Marsh Hawk	Merlin	Goshawk	Peregrine Falcon	Red-shouldered	Totals
Sharp-shinned Hawk	166	74	42	16	14	12	10	1	1	1	337
American Kestrel	31	17	6	8	3	5					70
Broad-winged Hawk	1		2								3
Red-tailed Hawk	1										1
Osprey	1		1								2
Marsh Hawk	2		1	1							4
Merlin	21	9	3		1		2		1		37
Goshawk											
Peregrine Falcon	1										1
Cooper's Hawk	1	—	—	—	—	—	—	—	—	—	1
	225	100	55	25	18	17	12	1	2	1	456

TABLE 9

RATES OF AGONISTIC BEHAVIOR

	Rates of Initiation (per thousand)	Probability that Proportion of Agonistic Acts Significantly** Higher	Lower
Merlin	62.3	<.001	
Sharp-shinned Hawk	28.1	<.001	
Peregrine Falcon	17.2*		
American Kestrel	10.2	<.001	
Marsh Hawk	6.2		.03
Cooper's Hawk	5.9		
Red-tailed Hawk	2.9		.04
Osprey	1.8		<.001
Broad-winged Hawk	.6		<.001

* Sample very small.

** The question posed: Is the proportion of a species initiation significantly different from the proportion of that species migrating to all species migrating?

In Table 10 I show rates for targets of harassment; that is rates of receiving acts of agonistic behavior. Note that the Red-tailed Hawk is attacked significantly more frequently than all other hawks. The Broad-winged receives a significantly lower rate of harassment than one would expect, considering the larger proportion of this species migrating. I believe that these two significant rates are related to flight behavior. The Broad-winged Hawk frequently moves through at great heights, making it a less available target, while the Red-tailed Hawk moves closer to the ground, intruding into the temporary territories that hawks may have taken up during a pause in their migrating movements.

I have also asked the question as to whether the various species of hawks have a preference in their agonistic behavior for other species (see Table 11). Note that the Sharp-shinned Hawk prefers the Red-tailed Hawk, as does the American Kestrel. The Sharp-shinned Hawk also prefers the Broad-winged Hawk and has a tendency, on the edge of significance, to attack other Sharp-shinned Hawks. The preference of the Merlin for the Peregrine is based on too small a sample to be beyond suspicion.

TABLE 10

TARGETS OF HARASSMENTS

	Harassed Rates (per thousand)	Probability that Proportion of Being Harassed Significantly** Higher	Lower
Red-tailed Hawk	71.6	<.001	
Peregrine Falcon	34.5*		
Marsh Hawk	26.2		
Merlin	20.2		
Sharp-shinned Hawk	18.8	.02	
Osprey	16.5		
American Kestrel	14.6		
Broad-winged Hawk	10.9		<.001

* Sample very small.

** The question posed: Is the proportion of a species being harassed to all acts of harassment significantly different from the proportion of that species migrating to all species migrating.

Notes

1. The station is usually manned by me, my wife, Laura W. R. Appell, and my three daughters, Laura Parker, Amity, and Charity, who devote their weekends to observing and recording. During this past year the station was manned by Peter Cannell, when we were not able to be there, and he joined us for much of the other observing time as well.

2. Bill Clark, Raptor Information Center (personal communication), points out that the second peak of the American Kestrel migration would tend to coincide with the movement of adults through Cape May shortly thereafterwards. The earlier peak probably indicates a movement of immature American Kestrels.

TABLE 11

TEST FOR SIGNIFICANCE OF AGONISTIC PREFERENCE BY SPECIES

	Initiations		
	Sharp-shinned Hawk	American Kestrel	Merlin
Target			
Sharp-shinned Hawk	(+) .05		
American Kestrel			
Broad-winged Hawk	(-) .003	(-) .029	
Red-tailed Hawk	(+) .001	(+) .001	
Osprey			
Marsh Hawk		(+) .01	
Merlin			
Peregrine Falcon			(+) .001

NOTE: (+) indicates that the proportion of the target species selected for harassment to all acts of aggression is higher than the proportion of the target species to all species migrating.

(-) indicates that the proportion of the target species selected for harassment to all acts of aggression is less than the proportion of the target species to all species migrating. The standard error of proportions for species by species harassment were computed to determine whether any species significantly preferred any other species or significantly avoided any other species for harassment. The probability of this distribution of acts of harassment are computed from data in Table 4.

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