Santa Clara County Christmas Bird Count and the Palo Alto Summer Bird Count Data
A Primer

Introduction

The National Audubon Society has sponsored Christmas Bird Counts since the early 1900s and the resulting data base represents the oldest and largest wildlife survey in the world (Butcher et al. 1990). However, the use of these data for quantitative purposes remains a difficult problem and care must be taken in any analysis of the data (Bock and Root 1981, Butcher 1990, Butcher and McCulloch 1990, Sauer et al. 1996).

At the regional level, the Christmas Bird Count (CBC) data represent a unique resource and this is particularly true in gauging changes in avian populations where no other quantitative data exists. Qualitatively, the more obvious changes in local populations are easily detected by active observers. For example, the recent population increase of Red-shouldered Hawks in Santa Clara County is well known by local birders and the increases on the peninsula of Nuttall's Woodpecker, American Crow, and Common Raven are also part of our local knowledge. Local CBC data can quantitatively support these observed qualitative changes but, more importantly, these data provide insight into less obvious or unobserved changes in local populations. First, these data, when analyzed, may indicate significant quantitative changes in local bird populations that are not apparent to the majority of observers. Second, the data extend back, in many cases, to observation periods beyond the recollection of most of our current observers and this provides us a unique local perspective. As an example, Figure 1 shows the sum

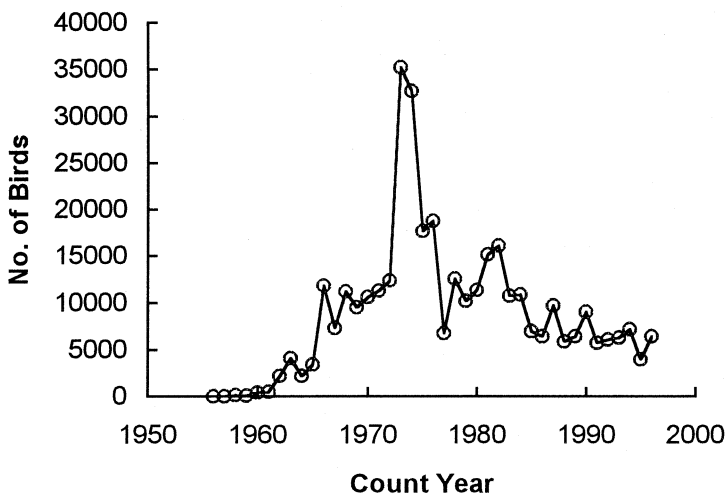

Figure 1. Total of European Starlings counted on the San Jose, Palo Alto, and Mt. Hamilton CBCs,

of all European Starlings recorded on the San Jose, Palo Alto, and Mt. Hamilton CBCs from the 1950s to the present. The winter population of this species shows an exponential growth up through 1973 or thereabouts, an invasion that has also been observed for California as a whole (DeHaven 1973). Subsequently, there was a collapse in the population to the relatively moderate level that is maintained to this day. To some degree, the qualitative nature of the invasion and growth of this species were known by the birders of this time as the first record of the starling was boldfaced on the San Jose count in 1958 and the Palo Alto count in 1960. During the growth period, count numbers were boldfaced in San Jose in 1962 and 1963 and Palo Alto in 1973 and

1974. However, despite the qualitative knowledge that existed at the time, I doubt today that there is any recollection of this invasion among active observers. I also question that anyone is aware of the collapse of these winter populations absent of these data. Thus, these quantitative data may substantially augment the atlas results as long as known problems with the data are identified and understood.

A Short History of the Santa Clara County CBCs and SBC

Within Santa Clara County, three CBCs have been run for at least 20 years. These three counts are overlaid on a map of Santa Clara County that also includes an overlay of the atlas blocks in Figure 2. This figure shows that none of these counts is entirely within Santa Clara County.

Figure 2. Outline map of Santa Clara County showing atlas blocks and Christmas Bird Count circles.

The Palo Alto count is 55–60% within Santa Clara County, but also includes portions that are in San Mateo and Alameda counties. The San Mateo County portion of the circle includes some redwood-Douglas fir forest and thus includes some of the coastal forest birds that are not normally found within Santa Clara County. The Alameda County portion of the Palo Alto count circle contains Dumbarton Point and this sometimes provides observations of more coastal birds such as Black Turnstone and Surfbird that are rarely or never found within Santa Clara County.

The San Jose CBC is about 90% within Santa Clara County, but does include a limited amount of land to the north in Alameda County. Some of the Alameda County wetlands within the circle provide habitat for bay ducks that are less often encountered on the more inland salt ponds to the south. The Mt. Hamilton count is about 70% within the county but also includes habitats in Alameda and Stanislaus counties. Because the atlas blocks extend beyond the county boundaries the within-county percentages noted here are conservative relative to the atlas. Not shown on the map of Figure 2 is the Morgan Hill CBC, which was run from 1981 to 1983 and probably was entirely within the county, nor the Moss Landing CBC which probably includes a sliver of the county in the vicinity of Mt. Madonna County Park.

Steve Rottenborn, in going through back issues of *Bird-Lore* to find information relative to local birds, found a Palo Alto Christmas Bird Count that was done in 1905 by A. K. and W. K. Fisher. Another Palo Alto count appears in 1947 (*Aud. Field Notes* 2:119–120 1948) with a single observer, James P. Rigby. But the regular series of Palo Alto CBCs did not start until the 1959 season and it has occurred continuously since that time. In Table 1 I provide a list of the count compilers up through 1995 and the count years that they were responsible for. As used here the count year refers to the December portion of the Christmas Bird Count period.

Table 1. Count compilers for Palo Alto Christmas Bird Count.

Count Years	Compilers
1959–1961	R. E. Wallace
1962–1983	E. A. Albertson
1984–1986	Clark Blake
1987	William G. Bousman
1988–1992	Clark Blake/William G. Bousman
1993–1994	William G. Bousman
1995	Jayne DiCandio/Michael Rogers

In his searches through back issues of *Bird-Lore,* Steve Rottenborn first found mention of a San Jose count for the 1927 season. It appears that the coverage in the San Jose count circle has been reasonably continuous since that time, but I have not obtained a continuous set of records for this count prior to 1956. In Table 2 I show the compilers for this count from 1956 to 1995.

Table 2. Count compilers for San Jose Christmas Bird Count.

Count Years	Compilers
1956–1965	L. Richard Mewaldt
1966–1967	Henry Weston, Jr.
1968	Emelie Curtis
1969–1970	Russell Greenberg
1971	Robert Gill, Jr.
1972–1973	Mike Brady
1974–1976	Phyllis Swanson
1977	Phyllis Swanson/Sue Kaiser
1978	Sue Kaiser/Larry Bezark
1979–1980	Jim Liskovec/Mike Rigney
1981	Jim Liskovec
1982	Jim Liskovec/Don Starks
1983	Don Starks/Steve Shugars
1984–1986	Jim & Sue Liskovec

Table 2. concluded.

Count Years	Compilers
1987	Jim & Sue Liskovec/Grant & Karen Hoyt
1988–1989	Jim & Sue Liskovec
1990–1991	Paul Noble
1992–1994	Reid Freeman
1995	Ann Verdi

The Mt. Hamilton CBC was started by Don Schmoldt in the 1977 season and he continues to run the count to this day–a prodigious and admirable effort.

David Houle, while at Stanford, proposed and carried out the first Palo Alto Summer Bird Count in 1981. This count was run in the Palo Alto CBC circle and used identical procedures to the winter count. In general this count takes place in the first week of June, but a few have moved a day or two one way or the other from the first week. This count is still underway but, unlike the CBCs, there is no publication of the data. In Table 3, I show the count compilers for this summer count, but I may have erred by a year or two for some of the transitions between count compilers.

Table 3. Count compilers for Palo Alto Summer Bird Count.

Count Years	Compilers
1981	David Houle
1982–1986	Clark Blake
1987–1992	Clark Blake/William G. Bousman
1993–1995	William G. Bousman

The number of observers recorded participating on these counts is shown in Figure 3. Both the San Jose and Palo Alto CBCs show an exponential growth in numbers from the 1950s to

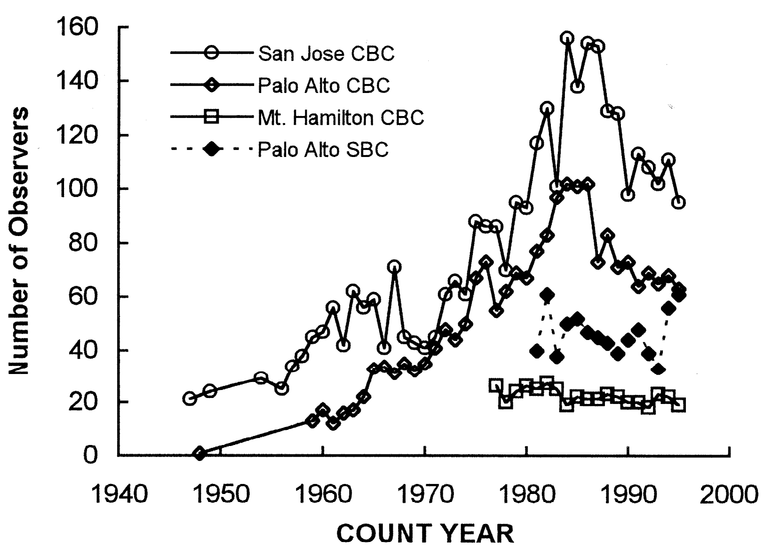

Figure 3. Number of observers in Santa Clara County counts.

the 1980s. The numbers participating in these counts peaked in the mid-1980s and have declined since that time. It is unclear from the data shown here whether the numbers of observers has currently stabilized. The reasons for the changes in the number of observers participating in these counts are not completely understood. The early period shown here, from the 1950s to the 1980s, coincides with the growth of the environmental movement in this country. The period from the mid-1970s to the mid-1980s is a period when the National Audubon Society raised their participant fees from $1 to $5. As a count compiler at the end of that period, I received many complaints from participants about the increased fees and some refused to continue their participation in the counts because they believed the fee increases were unreasonable. In the case of the Palo Alto CBC this period also coincided with a transition from a count that was largely organized and populated by employees at the U.S. Geological Survey in Menlo Park to a more broad-based count and the re-organization of the count led to some hard feelings at that time at the Survey and a number of past counters declined to continue their participation.

It is interesting to note that the Mt. Hamilton CBC appears to have gone from the late 1970s until now with little change in the number of observers. Perhaps, at some level, the dedication of CBC participants is unaffected by financial considerations or perceived mismanagement. The number of participants on the Palo Alto SBC has also been fairly stable for this same period.

The variation in the number of parties with time is similar to the number of observers as shown in Figure 4. These two measures are, as expected, closely correlated: $r^2 = 0.86$ for the

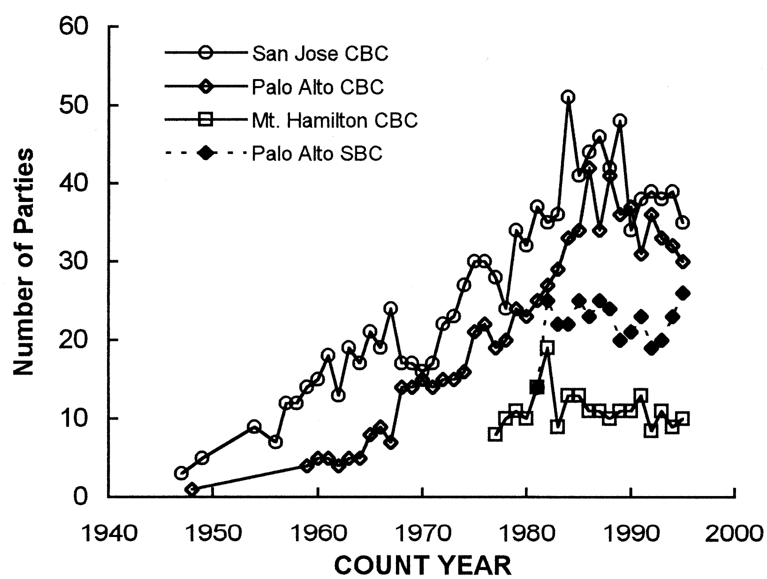

Figure 4. Number of parties Santa Clara County counts.

combined counts. The same trends are seen as before, with an exponential increase in numbers from the 1950s to the 1980s, a plateau, and a slight decline in the 1990s. The number of parties is sometimes reported as a range, that is, “46–50 parties,” in which case I record only the mean value.

Figure 5 shows the totals of party-hours for the four Santa Clara County counts and, as expected, the general trends are similar to the measures shown previously ($r^2 = 0.87$ with respect to the number of observers and $r^2 = 0.92$ with respect to the number of parties). Some of the variation shown here is a consequence of compiler errors and corrections for these errors will be discussed below. Butcher and McCulloch (1990) have graphed the party-hours recorded for all North American CBCs in the 1982 count year and I've indicated some of their percentile values in Figure 5. For the last two decades, the Mt. Hamilton CBC has been above the 50th percentile of all United States counts in party-hours while the San Jose and Palo Alto counts are above the 95th

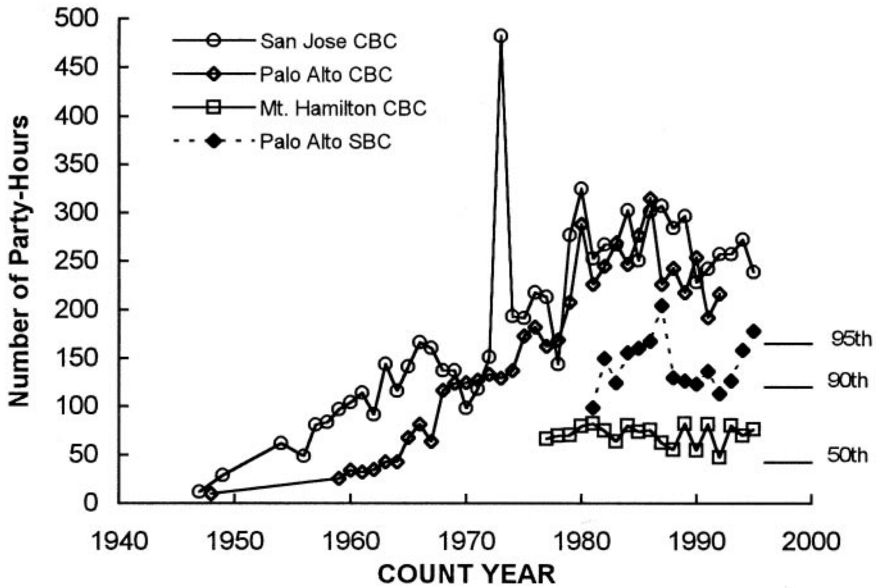

Figure 5. Number of party-hours for Santa Clara County counts.

percentile in terms of observer effort. In this sense, then, these two counts may be somewhat nonrepresentative of the typical national counts that have been examined by previous investigators.

The fourth measure of effort shown here is the tally of party-miles for these counts, as shown in Figure 6. This measure shows a different trend from the previous figures in that a

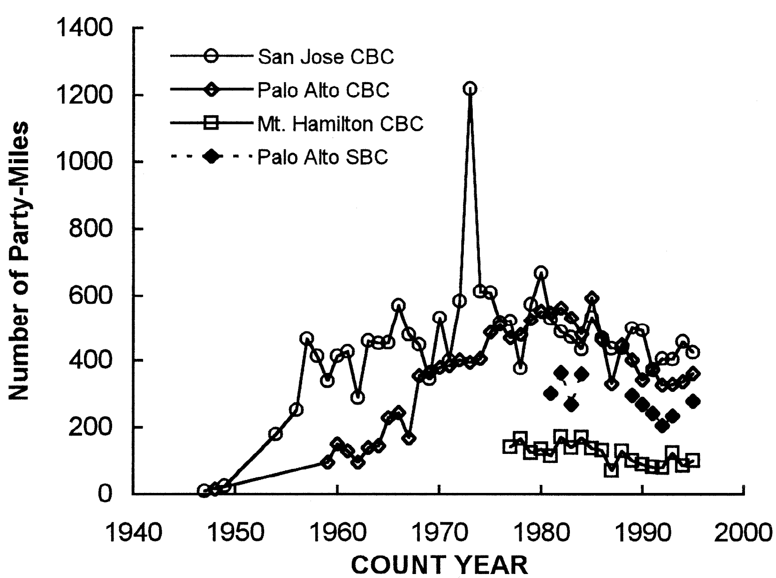

Figure 6. Number of party-miles for Santa Clara County counts.

plateau in party-miles appears to be achieved much earlier than the plateau in the number of parties or number of party-hours. For San Jose it appears that this plateau might have been reached as early as 1970 while in Palo Alto it appears to have been reached around 1975. As with the party-hour statistics it appears that some of the variation shown here is a consequence of compiler errors and this will be discussed below. The number of party-miles shown here is a combination of party-miles by car and party-miles by foot (and other transportation modes). The different behavior noted in this figure with respect to the other figures showing level of effort may reflect a change in distribution between modes and this will also be discussed below.

Seasoned compilers compute the number of party-hours/party and party-miles/party as a means of checking the tally sheets that are provided to them. Both of these numbers must be reasonably bounded as they represent the actual efforts of any party. The total party-hours/party for the four counts are shown in Figure 7. It is to be expected that most counts will average

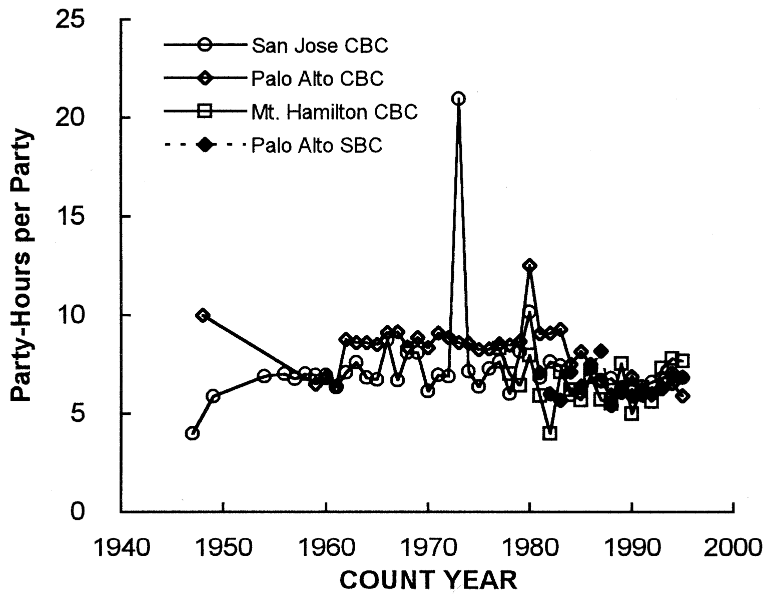

Figure 7. Party-hours per party for Santa Clara County counts.

between 6 and 8 party-hours/party. Some parties consistently manage dawn-to-dusk coverage of 10 or even 10.5 hours, but in the aggregate most counts obtain lower means. What is immediately noticeable in Figure 6 are some outlying points: 21.0 hours per party in 1973 and 10.2 hours per party in 1980 for San Jose, and 12.5 hours per party in 1980 for Palo Alto. The 4.0 hours per party recorded on the Mt. Hamilton CBC in 1982 appears unusually low. I have corrected all of the high points noted here, that is, those that exceed 10.0 hours per party, by assuming the number of parties for the count is correct and multiplying this number by the mean value of party-hours/party for the four adjacent count years. I have not corrected the Mt. Hamilton low value, but I believe that in this case the error is in the number of parties tallied, not the party hours. I have not automated this approach as recommended by Peterson (1994), as the quantity of data and the number of errors are so slight.

Figure 8 shows the party-miles/party for the four counts and, as with the party-hours/party, some of the variation appears to be a consequence of compiler error. In particular, the 53 party-miles/party recorded in 1973 is about twice what was expected at that time. What is most interesting about these data is that there appears to be a transition starting in the 1970s, when the average party managed about 20 miles for the day, until today, when the value is closer to ten.

Some insight into this transition is obtained by comparing three-year averages for these statistics broken down by transportation mode. I show these statistics in Table 4 for the San Jose and Palo Alto counts. Over this time period the mean number of parties increased from 16.7 to 40.0 for San Jose and from 14.3 to 34.7 for Palo Alto. The number of party-miles on foot appears to have remained much the same over this period, while the number of party-miles by car has dropped

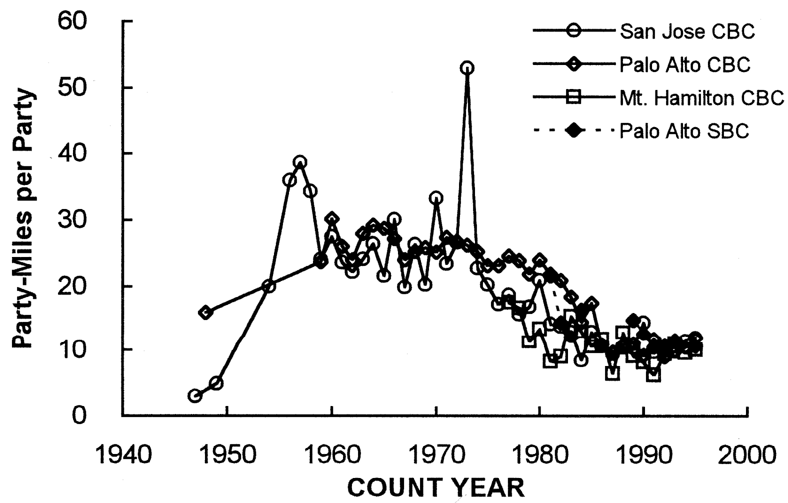

Figure 8. Party-miles per party for Santa Clara County counts.

substantially. Part of this may be a filling or saturation effect, that is, as the number of parties increase, larger areas that required a car for adequate coverage by a single party could now be split up and covered by multiple parties on foot. Another reason, at least in the Palo Alto count circle, is that purchases by the Midpeninsula Regional Open Space District starting in 1972 opened up extensive areas in the foothills and the Santa Cruz Mountains that previously were only covered by car from adjacent roads and now are mostly covered on foot. It is expected that a similar analysis of party-hours, which are also broken down by mode, would show this same effect.

Table 4. Party-miles/party by mode for San Jose and Palo Alto CBCs (3-year means).

Count	San Jose			Palo Alto		
Year	Foot	Car	Bicycle	Foot	Car	Bicycle
1970	4.1	21.3	0.0	5.2	21.0	0.0
1990	3.7	7.7	0.0	4.4	6.0	0.4

The total number of birds recorded on the four counts are compared in Figure 9. As with the various measures of effort, the San Jose and Palo Alto CBCs are fairly comparable. However, far fewer birds are found on the Mt. Hamilton CBC and the Palo Alto SBC. This disparity in numbers is a result of the large numbers of wintering waterfowl, shorebirds, and gulls in the South San Francisco Bay. Exceptional numbers have been achieved in a few winters and these normally depend on unusual concentrations of just one or two species. The 1983 Palo Alto CBC recorded in excess of 250,000 birds including 86,000 Northern Shovelers, nearly 22,000 Ruddy Ducks, and 16,000+ American Coots. Record highs were also obtained for a number of other species that year. However, these conditions are unusual and the Palo Alto CBC normally ranges from 75,000 to 150,000 birds, while San Jose normally varies from 50,000 to 100,000 birds.

The San Jose and Palo Alto CBCs are closely matched in terms of the number of species recorded over the years as shown in Figure 10. In the last 20 years the Palo Alto CBC has recorded the most species 13 times, San Jose has had the highest count four times, and there have been three ties. The Mt. Hamilton CBC records roughly half the species that are seen on the San Jose and Palo Alto CBCs and this is a consequence of the harsher winters in the Diablo Range with a reduced prey base to sustain wintering birds. The Palo Alto SBC records only 15–20 fewer

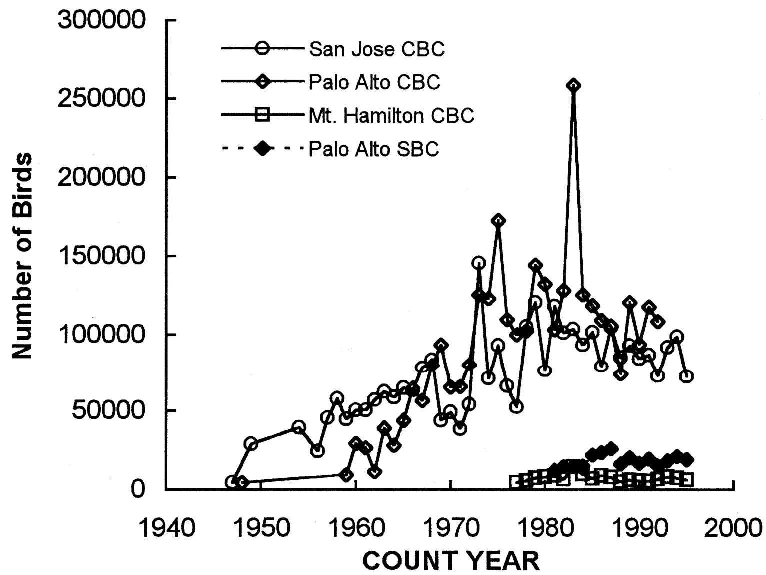

Figure 9. Total number of birds counted for Santa Clara County counts.

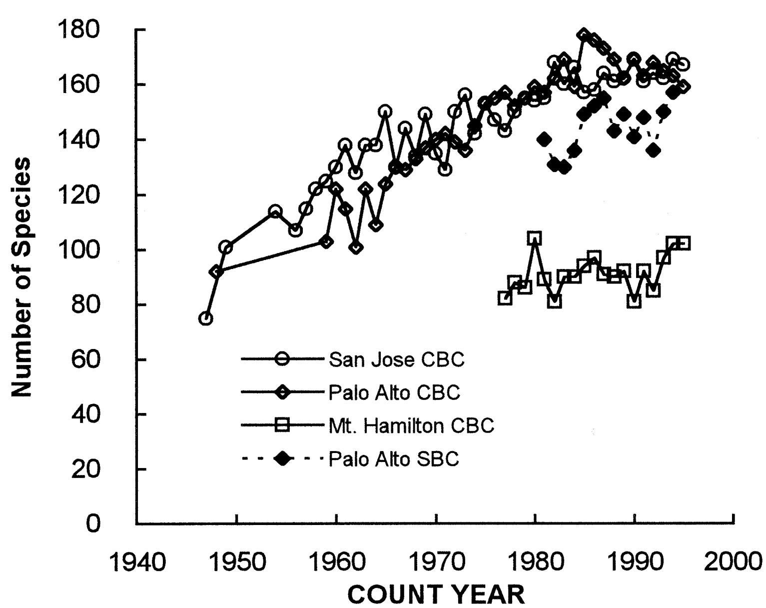

Figure 10. Number of species for Santa Clara County counts.

species than the winter count in most years. The wintering waterfowl and shorebirds are mostly gone in summer, but a few species linger in small numbers and these are augmented by a number of summer residents.

Use of CBC and SBC Data from a Local Perspective

Bird count tallies, extending over a long period of time in a particular region, can be a valuable adjunct to breeding bird atlas information in the same area. However, for these data to be useful, a number of points must be considered:

1. While SBC data are generally of direct value, since they are obtained at the peak of the breeding season, the winter count data are only of use for resident populations whose numbers are not significantly augmented by nonresident birds in the winter.
2. Population changes documented within a count circle can provide quantitative insight for that circle. In themselves, however, these data cannot be extrapolated beyond the count circle.
3. It has not been demonstrated that density estimates based on CBC and SBC data are sufficiently accurate to provide useful information.
4. Population trend data are most useful for common species and are least useful for rare species.

The first point on my list deals with the use of CBC data which are obtained in the winter as a means of understanding breeding populations. For residential and largely sedentary species the CBC data may be of considerable value. As an example, I would expect few of our woodpecker species to show significant local movements although some woodpeckers are clearly migratory, for example, the Red-breasted Sapsucker. Winter and summer data are shown in Figure 11 for Nuttall's Woodpecker and this is probably representative of most woodpeckers in the local area. The data from the Palo Alto count circle are particularly useful as we have both winter and summer data for this count circle. The Figure 11 data clearly show the expansion of this species in the Palo Alto count circle from the early 1970s. The population increases, 15.4% and 8.7%, are both significant at the $p < 0.0002$ level and show fairly good agreement (The population increase on the winter count is 8.2% using the SBC time span). Differences between winter and summer numbers are not surprising as there are real seasonal differences in population size because of yearly mortality and replacement as well as differences in detectability during seasons. Note that San Jose, where this species has always occurred, has also shown a highly significant population increase, while there is no significant change in the Mt. Hamilton CBC population.

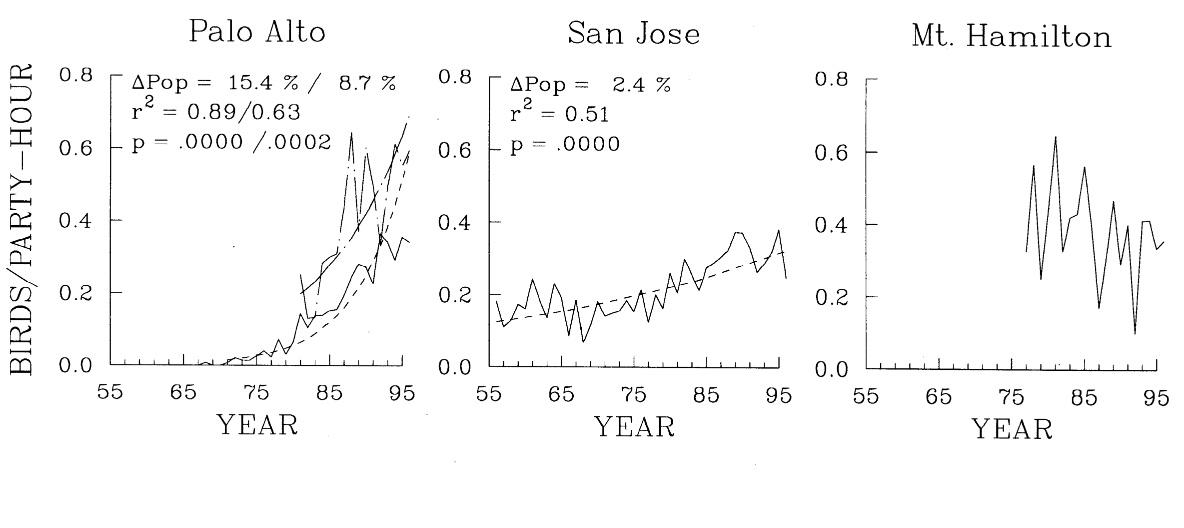

Figure 11. CBC and SBC data for Nuttall's Woodpecker.

It is just as clear, however, that the winter data for other species are unsatisfactory. The Yellow-rumped Warbler is an abundant winter visitor in the county, but in the summer it is a rare nesting species in limited areas of the Santa Cruz Mountains and, perhaps, near Mt. Hamilton. For this species only the Palo Alto SBC data are of value.

There are a number of species for which there may be a significant augmentation of the resident population by wintering birds and such species require examination. Figure 12 shows the local CBC and SBC data for European Starling. As noted previously (Figure 1), wintering populations went through an expansion phase that peaked in the mid-1970s and have been in decline ever since. The data in Figure 12 show that most of these birds have been found on the San Jose and Palo Alto CBCs, while few birds have been found on the Mt. Hamilton CBC. The declines on the San Jose and Palo Alto CBCs since the early 1970s, –7.4% and –5.8% respectively, are significant at the $p < 0.0001$ level. The summer population in the Palo Alto count circle, however, is much smaller than the winter population and is barely detectable in this figure. Unlike the winter population, however, its numbers have been increasing by 6.6% a year ($p < 0.01$).

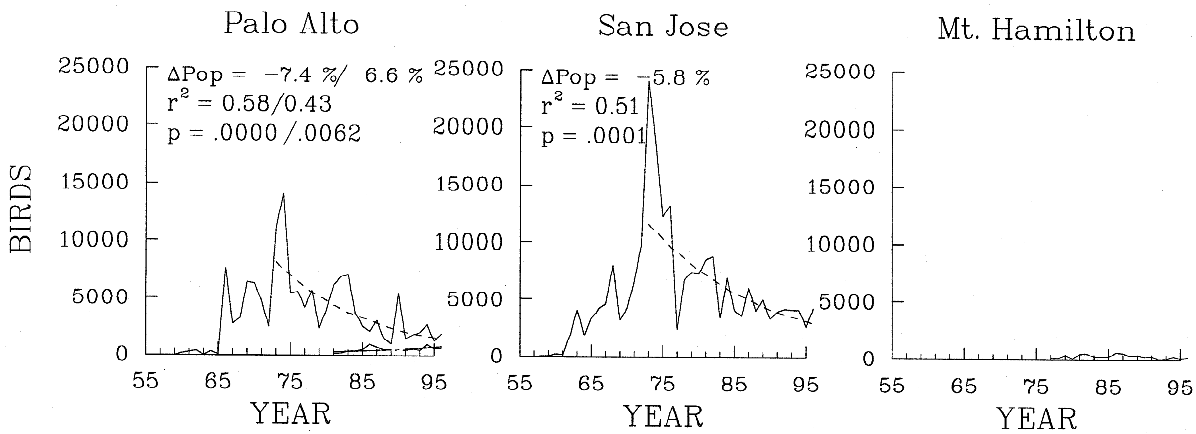

Figure 12. CBC and SBC data for European Starling.

Populations of some species may be showing declines in multiple count circles as with the European Starling in Figure 12. However, it is important to understand, as enumerated in my second point above, that trends identified in any count circle are representative only of that circle. Without additional information we are unable to say to what degree these trends are representative at a greater geographical scale. Nonetheless, such trends are of interest to the degree that they provide us insight into local factors that are impacting the populations of particular species.

An example of the difficulty of extrapolating population trends from a single count circle is shown in Figure 13 for the Black-crowned Night Heron. The Palo Alto CBC data shows a 5.0% decline and the SBC data show a 10.2% decline, yet in the San Jose CBC circle a 3.5% increase is seen. Statistically, all of these trends are significant at the 5% level. The explanation for these changes is, perhaps, that we are seeing a shift in local populations from one circle to the other over this period. If we use these measures for all nine of the local CBCs that encircle San Francisco Bay we find that there has been no significant change in this species' population in the bay region over the last 30 years (unpublished analysis).

The third point I make above is that density estimates derived form CBC or SBC data have not been demonstrated to be trustworthy. From this it follows that we cannot compare numbers

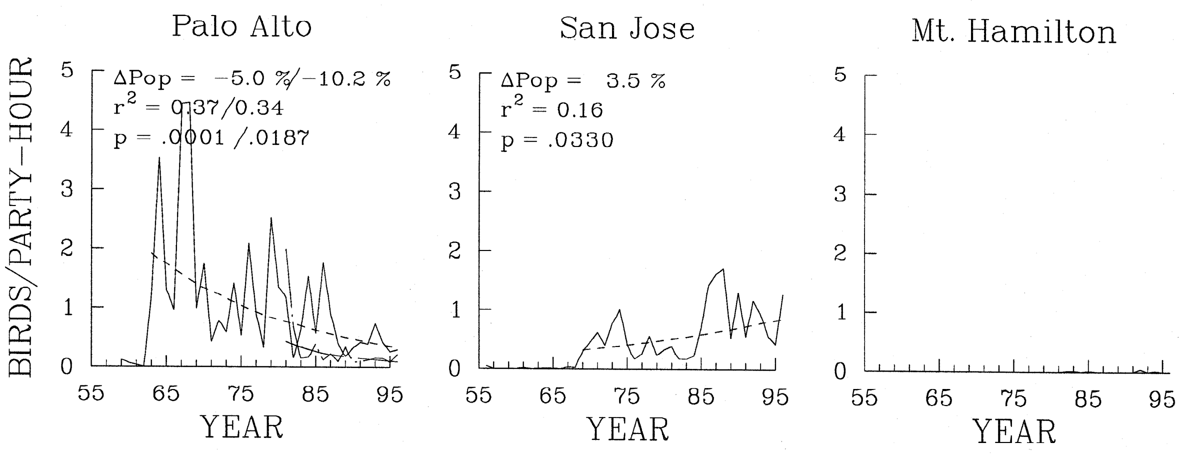

Figure 13. CBC and SBC data for Black-crowned Night Heron.

from one count with another and conclude that a particular species is more or less common. There are a number of aspects that work against the trustworthiness of density estimates when comparing two or more count circles. First, although we know the amount of effort in each count circle we really don't know how that effort is divided between various habitats. A coarse estimate has been provided by count compilers of the proportions of various habitats within the count circles, but these are imprecise. Exceptions to this general rule will follow, however, where large differences between the numbers from two count circles are seen and errors in habitat coverage are not sufficiently large to explain the differences. As an example, the Yellow-billed Magpie is found commonly on both the San Jose and Mt. Hamilton CBCs, as shown in Figure 14, but it is almost never found on the Palo Alto CBC. The numbers on the two eastern counts are roughly comparable in terms of birds/party-hour and these differences may be a consequence of habitat coverage or actual differences–we cannot tell. But it is clear that the very low numbers on the Palo Alto CBC (the scale would have to be blown up by a factor of ten just to see the few birds that have been found) truly represents a distributional difference.

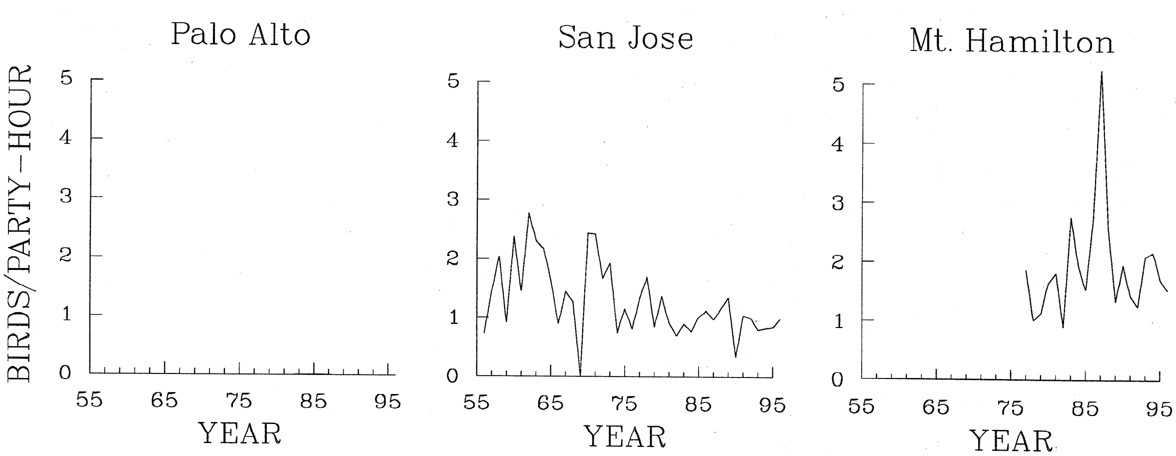

Figure 14. CBC and SBC data for Yellow-billed Magpie.

The fourth point I've enumerated above concerns the accuracy of trend information depending upon whether a species is common or rare. For species that are quite common there tends to be reasonably low variance in the population numbers which means that trends are more easily detected. For species that are quite rare, the variance increases substantially and it is much more difficult to identify statistically significant trends. This distinction is fairly obvious but, nonetheless, worth mentioning.

The Use of CBC Data from a National Perspective

The CBC protocols, although now fairly well established, have not been constant over the years and, even when followed exactly, are nonstandardized. For example, there is no control on either coverage or time. Thus, observers may spend as much or as little time as they choose for the regions that they are assigned and their effort may vary considerably over a period of years. This may be contrasted with the Breeding Bird Survey that is sponsored by the U.S. Fish and Wildlife Service that requires a fixed route with assigned stops and fixed time periods for observation. However, neither the BBS nor the CBC protocols control for long-term habitat changes.

Butcher (1990) summarized a number of points that he believed needed to be considered when CBC data are to used to identify broad, regional trends:

1. Consider any potential identification problems for species being examined.
2. Consider potential counting biases. These may include improvements in skill levels or equipment over long time periods.
3. Consider biases in habitat coverage. There is an emphasis on spending observer time where the best birds are found rather than distributing that effort uniformly and this will bias the coverage.
4. Consider whether cold or wet weather will affect the count data.
5. Decide how to treat count circles that have moved between years.
6. Determine how to account for observer effort. Bock and Root (1981) suggest normalizing by party-hours for most species, but not waterbirds.
7. Consider the use of references species where this can be accommodated.
8. Do not rely on data from one count or one year to justify conclusions.

Each of Butcher's points is important if the CBC and SBC data are to be used to augment the atlas results and I will discuss them below. Relative to his first point about species' identification, a number of investigators have shown that CBC data are unreliable for species' groups such as Sharp-shinned and Cooper's Hawks (Daniels 1975) and Thayer's and Herring Gulls (Mark 1981). I question's Daniels' approach of comparing hawk watch data from fall migration with winter population estimates, but I do agree that any reliance based on accipiter separation is probably not warranted. In addition to the Thayer's/Herring Gull problem I would also add the Greater/Lesser Scaup and Short-billed/Long-billed Dowitcher pairs. In addition, great care needs to be taken in interpreting all gull numbers as the effort expended in any year to separate these by species or lump them as "gull spp." is variable as is the skill level required for such separation. The identification problems need to be kept in mind in using any of these numbers but except for the caveats mentioned here I believe that the identifications recorded in the last 40 years on all of these local counts are trustworthy. I do not believe there are any identification-based problems with any of the county's breeding species.

Butcher's second point deals with counting biases. These include biases relating to the skill levels of participants, biases based on local knowledge, biases related to rare or staked-out birds, and biases related to roosting birds. The evolving skill level of most participants is difficult to compensate for. Although optics are not now significantly better than they were two generations ago, the field guides available today and other information on identification are significantly improved. I would guess that in the 1950s, most observers would simply count all cormorants seen as Double-crested. Now, however, a fraction of our birders are well aware that either Brandt's or Pelagic may show up on occasion and they are willing to sort through cormorant flocks to look for the rarity. With time we gain experience with birds that are very local. There may be an unusual habitat that sometimes has a rarity and we will spend some extra time there just to catch that one bird. That doesn't mean that we don't count the other birds that are there, but it does mean we spend more time at that spot than we would if we were doing standardized sampling. Similarly, for known rarities or staked-out birds, we may go to a single spot again and again during the day, just to record that one species. In most of these examples the bias error is one that overemphasizes rare species. However, in the larger frame of using CBC results to estimate winter population trends, variation in the number of rare species is of no consequence. There may be some value in graphing the occurrence of rarities over the last 30 or 40 years, just to see how they are distributed temporally, but trend information cannot be trusted.

The last counting bias problem that is noted has to do with roosting birds. This problem is greatest in count areas with either large numbers of waterfowl, gulls, or blackbirds that shift from year to year. We certainly see large variations in the numbers of these species locally, and we must be very careful before we suggest that there are any meaningful trends in these data for winter counts. In the summer we have seen substantial variation in the numbers of oversummering shorebirds but this is of no consequence for the atlas.

Butcher's third point has to do with biases associated with habitat coverage and this has a number of aspects. At one level there is a tendency to put the most birders in the richest birding areas. However, as coverage levels increase there are enough good observers to go around and this tends to even out the coverage. In my years as a count compiler for both the Palo Alto winter and summer counts I frequently had difficulties in filling in for missing counters, and I learned that very few active, skilled participants wanted to shift from areas with which they were familiar to new areas, even when the new areas were far richer in species. In part, this may reflect that most of our count areas in the Palo Alto circle have a chance for a good bird and, therefore, remain attractive. Nonetheless, I was surprised by the difficulties I encountered in adding one or two more parties along the bay in some years.

A more difficult problem related to Butcher's third point is that our local habitats are all undergoing change, sometimes over a generation or two, and sometimes more quickly. By and large, none of these changes are documented. This problem is also faced by the highly-standardized Breeding Bird Survey. There were attempts in the earlier years to have counts report habitat coverage each year, but a close examination of these numbers suggests that they were not carefully derived as they sometimes showed wild fluctuations between years. At best the effects of habitat changes on the population indices can only be guessed.

How weather affects count tallies is Butcher's fourth point. Falk (1979) and Smith (1979) have both looked for weather effects on count data and neither was able to show significant and consistent effects. My own experience with some rainy counts, particularly on Mt. Hamilton, is that I shortened the time that I spent counting, but I kept an accurate record nonetheless of my actual time and distance.

As a means of evaluating weather effects for the three CBCs I have scored the weather for each count on a scale from 0 to 8, where 0 is clear and 8 is heavy rain morning and afternoon. The mean scores over the years suggest relatively mild weather: 0.7 for San Jose, 0.9 for Palo Alto, and 1.0 for Mt. Hamilton. A value of 1.0 is equivalent to half a day of light rain. I have looked at the correlation between total birds recorded on Mt. Hamilton with the weather score and, surprisingly, it is positive, that is, more birds are tallied when the weather is bad ($r^2 = 0.11$). However, the number of species recorded drops by 10% with bad weather ($r^2 = 0.24$). Neither of these trends is significant.

Butcher's fifth point is to be aware of changes in count circle location. According to published records, neither the Palo Alto counts nor the Mt. Hamilton CBC have moved their centers in the years that they've been held. The San Jose CBC was originally centered at the corner of Capitol Expressway and Maybury Road. In 1972, the center was shifted to Capitol and Cropley Road. This shift was about 2.7 mi to the NNW and provided additional coverage in the Alviso area and reduced the coverage in the southern part of the count. This indicates that changes in waterbird numbers are probably not comparable between these periods. More important, however, than the center shift is the issue of access to private land along and in the Bay. No documentation is available that deals with changes in access to habitats in the Alviso area.

Butcher's sixth point addresses the problem of how to account for observer effort in examining trends in species' numbers over the years. It seems reasonable to expect that small passerines, such as Chestnut-backed Chickadee or Bushtit, will be recorded in proportion to the time spent in appropriate habitat. Thus, the numbers of these species need to be normalized by some measure of observer effort–Bock and Root (1981) suggest that numbers should be divided by party-hours. It also seems reasonable that large and obvious waterbirds, such as American White Pelicans, will be independent of observer effort and, therefore, trends should be evaluated based on the number of birds recorded. Butcher and McCulloch (1990) examined the variation in the numbers of birds as a function of party-hours or party-miles for all the United States' counts in one year, and demonstrated that for some species, such as Red-tailed Hawk, the numbers were strongly dependent on observer effort, while for others, such as Mallard, the numbers appeared to be independent of the level of effort.

In comparing CBC counts over a broad region, the numbers of a particular species will be dependent upon the local habitat in each count circle as well as some measure of effort. The approach used by Butcher and McCulloch lumps these two effects together as there is no simple way to address the effects independently. However, for a single count, habitat changes will be relatively minor from year to year and observer effort, therefore, should have a greater influence on the number of species recorded. Thus, for a single count circle, the Butcher and McCulloch approach should be of substantial value in assessing normalizing factors. In Figure 15 I show a matrix of trend results for Red-tailed Hawk based on our regional count data. The columns represent the three local CBCs: San Jose, Palo Alto, and Mt. Hamilton, plus the Palo Alto SBC is shown as the fourth column. The first two rows represent two measures of the number of birds recorded on the counts. The first row shows the raw data and the second row shows the number of birds normalized by party-hours (Bock and Root 1981). Other normalizing factors could be used, such as the number of parties or the number of observers, and the results would be largely the same as each of these measures of observer effort are highly correlated. The third row, following Butcher and McCulloch (1990), shows the number of birds recorded as a function of party-hours. This technique is quite useful for the San Jose and Palo Alto CBCs, as the variation in party-hours ranges from a lower limit of 50 or 60 party-hours to over 300 party-hours. The variation in the number of party-hours is much less for the Mt Hamilton CBC, ranging from about 50 to 90 party-hours. Party-hours for the Palo Alto SBC vary from about 90 to 200, which is less variation than seen on the Palo Alto winter count.

Looking at the bottom row first, it is clear that over the period of time that the San Jose and Palo Alto counts have been run, a great deal of the variation in the number of Red-tailed Hawks recorded is a consequence of level of effort. For the San Jose count roughly 85% of the variation is explained by party-hours and for the Palo Alto CBC about 78% of the variation is a result of party-hours. There is less variation in party-hours for the Mt. Hamilton CBC and the Palo Alto SBC but nonetheless, for the Mt. Hamilton CBC, there is a significant effect ($p = 0.0055$). This suggests that for this species trends based on the raw data will be erroneous, while the normalized data that have been corrected for the party-hours, will provide a more reliable estimate of population trends. For the Red-tailed Hawk, it appears that there has been a small, but significant population increase in the local area over the last 40 years.

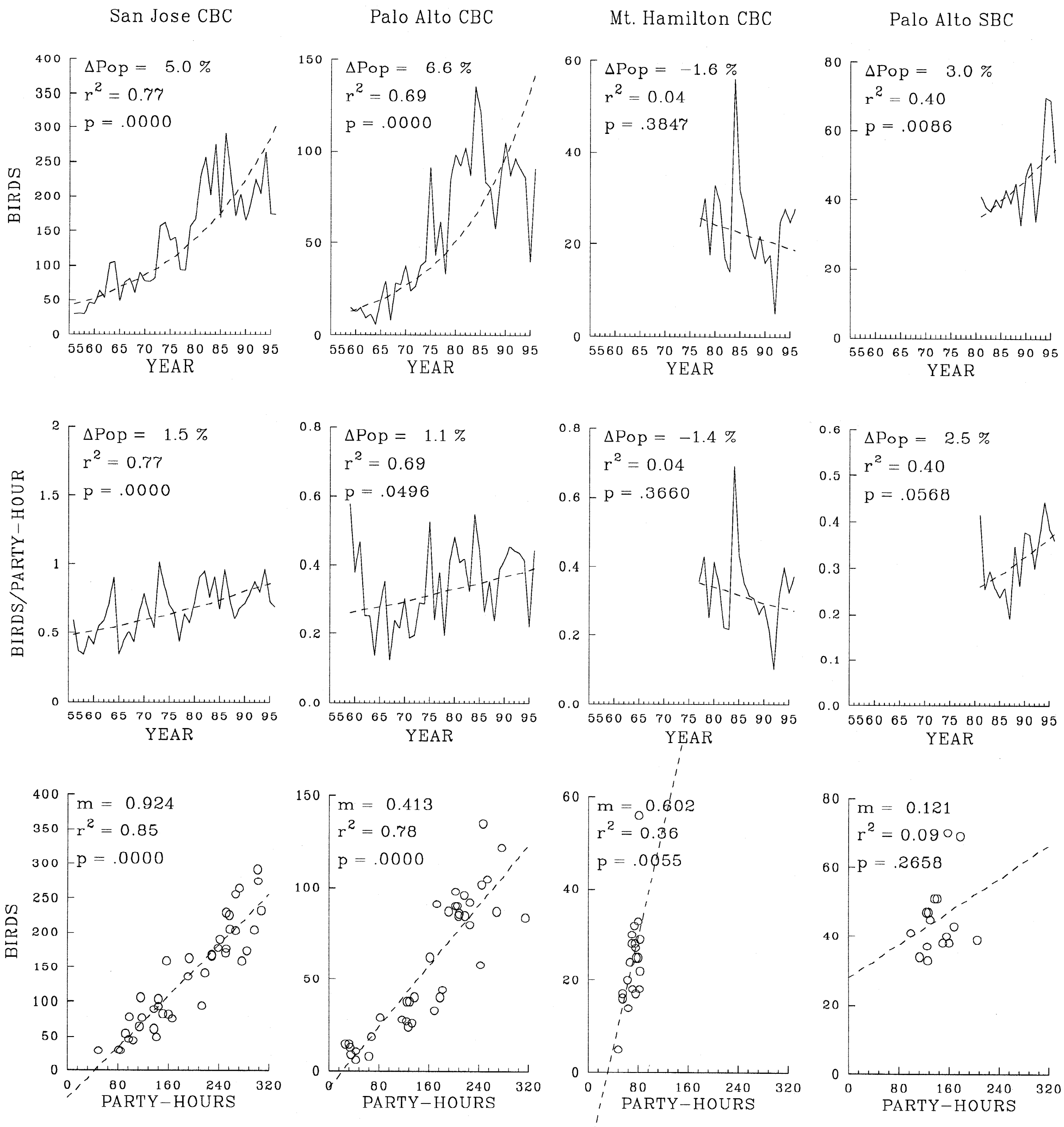

Figure 15. Red-tailed Hawk trend matrix.

Normalization by party-hours is satisfactory for Red-tailed Hawk and, as expected, this is also appropriate for many of our local passerines. However, in some cases wintering populations may be more strongly influenced by other factors. A case in point is shown in Figure 16 for American Robin. Here the bottom row shows that there is no correlation between the number of robins recorded on the San Jose and Palo Alto winter counts and party-hours. Therefore, the variation is caused by other, unquantified factors. It is well known that American Robin winter movements are highly variable and depend upon both food availability and weather. It seems clear in this case that trend information based on the raw data is preferable to the normalized data. Note,

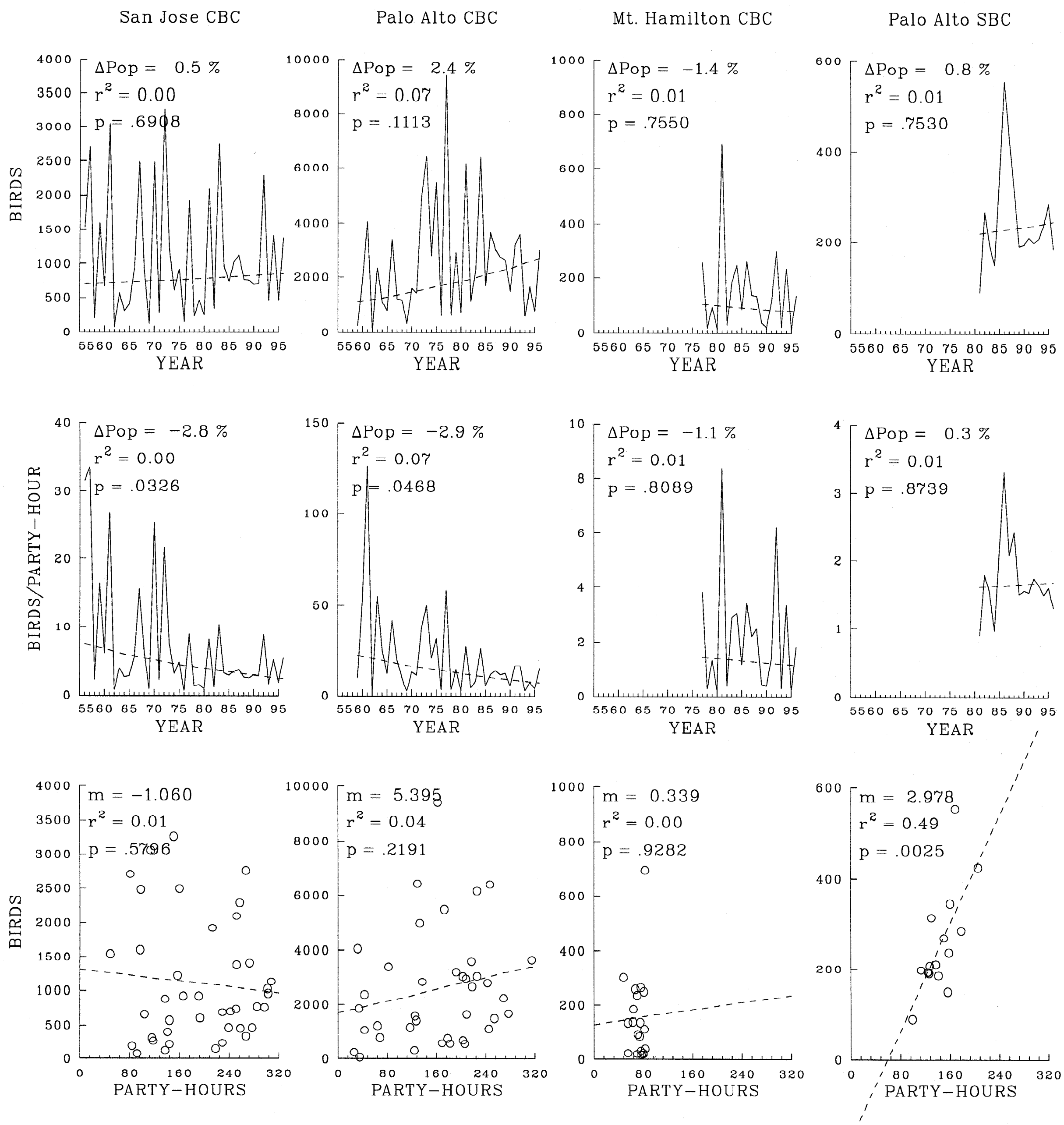

Figure 16. American Robin trend matrix.

however, that that the number of birds recorded during the breeding season, as measured by the Palo Alto summer count, is well correlated with party-hours. In this case normalization by party-hours is appropriate.

Butcher and McCulloch (1990) found that the numbers of Mallards recorded on CBCs across the continent were independent of the number of party-hours. In Figure 17, I show the trend matrix for Mallard and the results are not as clear cut as with most other species. On the San

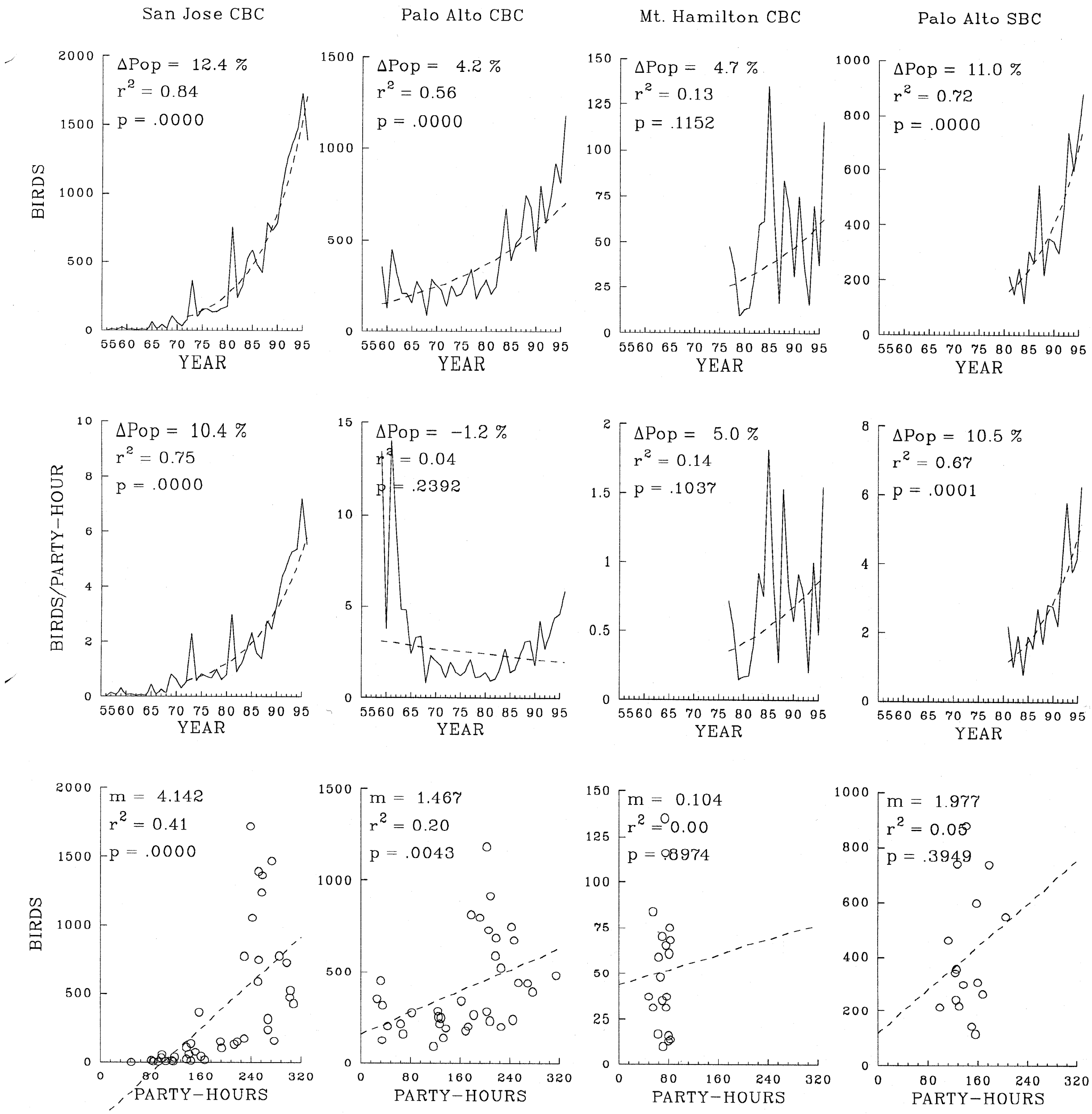

Figure 17. Mallard trend matrix.

Jose CBC the number of birds recorded is well correlated with the number of party-hours ($p < 0.00005$). Based on data since the count circle shift in 1972 there has been a significant increase in the numbers of wintering birds. However, the question of normalization appears relatively unimportant as the increase in wintering birds is only slightly greater if the raw data are used. The results for the Palo Alto CBC are ambiguous, however. An examination of the number of birds found compared to the number of party-hours shows that the data are highly significant, although the coefficient of determination, r^2, is only 20%. Large number of birds were detected in the first years of the count when there were very few observers. As the number of party-hours increased through the 1960s, fewer birds were counted, indicating a decline in numbers based on normalized data. However, since the early 1980's, the wintering population has increased and the trends for the Palo Alto count circle are essentially the same for both the winter and summer.

Butcher's seventh point emphasizes the value of reference species when making comparisons between counts and over time as a means of correcting for the lack of standardization. This is not explicitly addressed in the atlas as the results for each species are shown in isolation. Implicitly, however, results are reported for all breeding species and, in many cases, one species may act as a reference for another species. In the large, however, this point is neglected in the atlas.

Butcher's final point recommends that data from multiple counts and multiple years be evaluated before reaching conclusions. Although data from the three Santa Clara County CBCs are used to assess population trends this falls far short of the requirement for multiple counts as described by Butcher. However, the time series that are being examined here extend from 15 to 40 years and this more than meet Butcher's second criterion. There are two major reasons behind Butcher's eighth point and it is important to understand both of these reasons before using the CBC and SBC data. The first reason has to do with the ability of large data sets to reduce errors just through sheer sample size, while the second reason has to do with the fundamental limitations that obtain in examining results from a small geographic area.

There is a general observation that when data sets with large variance are combined there is a tendency for a reduction in the relative variance so that specific statistical tests that fail for the individual data sets may succeed for the combined set. This is the basis for meta-analysis of large and sometimes poorly related data bases and is a topic of active debate in the scientific community. I have seen no tests of the value of combined data bases using CBC data, but it has been widely observed that the year-to-year variation in numbers of a species drops significantly as the number of counts are increased. This improvement in signal with increasing size of a sample is not possible with the present analyses of population trends for just our three local counts. Our local knowledge of how these counts were run may encourage us to put more faith in these numbers than we would otherwise have, but this is, to a degree, just an act of faith.

The second reason why a large number of counts is required to interpret trends is simply due to the problems of scale. A 15-mile diameter circle simply does not contain enough area that trends observed at the local scale can be extrapolated to a wider area. This is not to say that local trends observed in a single count circle are not valuable. They are valuable and, because of their quantitative nature and adherence to standardized protocols, they can be repeated in the future. But a declining population in the Palo Alto circle may mean nothing more than that the birds have gone elsewhere as I have shown in a previous example for the Black-crowned Night Heron.

Summary

Quantitative data are available from local CBCs and the Palo Alto SBC and can augment our knowledge of birds breeding in Santa Clara County. I have examined in this primer factors that must be considered for the use of these data to support an atlas publication as well as factors that have been raised by studies of CBC data at the national level (Butcher 1990). Based on my examination I consider quantitative trends from CBC and SBC data to be valuable adjuncts to the atlas data within the following constraints:

1. The CBC data is useful only when it applies to resident and sedentary populations.

2. Trends within one count circle, even when statistically significant, can only be used to demonstrate local changes. They do not apply necessarily apply for the county or region as a whole.

3. Habitat changes and habitat coverage within the count circles are not quantified and any trends that are impacted by such changes must be understood in this context.

4. Comparisons between counts for the number of birds recorded, whether normalized or not, are qualitative as both the habitats and the coverage of these habitats differ between count circles.

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