Estimating Aircraft Activity at Nontowered Airports: Results of the Aircraft Activity Counter Demonstration Project

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ABSTRACT

The findings and conclusions of the Aircraft Activity Counter Demonstration Project are reported and data obtained at 24 of the airports studied are used to evaluate alternative methods of estimating aircraft activity from sample data. The counter project used acoustical aircraft activity counters to obtain periodic samples of activity at selected Northwest airports throughout a full year. The paper analyzes the use of independent measures of variation for expanding sample counts and develops a sampling plan for use at nontowered airports when reliable independent measures are not available. Analysis of independent measures of variation includes operations data from related towered airports, weather data, and record of fuel sales. The paper concludes that tower data are not a reliable source for estimating nontowered airport activity because the variations in operations over the year at towered and nontowered airports are not sufficiently similar. Fuel sales data will probably prove to be a more useful indicator of variation, but more research is needed. The paper recommends the use of seasonally stratified, systematic samples of aircraft activity for estimating operations at nontowered airports. This type of sample data may be used to estimate the seasonal distribution of operations and peak loadings and to estimate total annual operations.

Insufficient knowledge of activity at nontowered airports has been a concern of state and federal aviation agencies as well as local airport sponsors. Until recently there was no accurate alternative to visual observations for determining aircraft activity. This means that where there is no tower, estimates of operations are often no better than guesses. This is especially true of small general aviation facilities which often are without full time managers or fixed-base operators.

The Aircraft Activity Counter Demonstration Project was conducted from November 1980 through April 1982 (1). During the project operations data were gathered at 37 nontowered airports in Oregon, Washington, and Idaho by using acoustical aircraft activity counters. These counters record the sound of departing aircraft on cassette tapes which are then audited and the activity is classified by time and date. The sounds of departing aircraft can often be classified into several aircraft types; however, results of the project indicate that the most reliable data are based on total fixed-wing departures. Usually a single counter was used to make periodic counts at several airports throughout a 1-year period.

The estimates of annual operations presented in Table 1 are based on sample data for 24 of the airports in the study. Data on the 13 other airports were not complete enough for use in evaluating alternative sampling and estimating methods. Although there was no attempt to obtain a proportional representation of general aviation airports in the study, a review of the operations estimates in Table 1 indicates a cross section of medium to small general aviation airports. The airports are widely distributed geographically throughout Washington and Oregon and represent a variety of general aviation uses.

Because data were obtained throughout a full year at each of the airports in the study, the data provide information on the seasonal variation of operations. These data were used to test the accuracy of independent data sources as measures of variation of operations at nontowered airports. Independent data sources analyzed include tower operations data, weather data, and fuel sales data. The project data also provide valuable information for designing sampling procedures when accurate independent estimates of seasonal variation are not available. Analysis of sampling procedures and project data demonstrates the use of sampling for estimating seasonal, daily, and hourly variations as well as total annual operations.

TABLE 1 Estimated Annual Total Fixed-Wing Operations at Selected Northwest Airports (based on accoustical counter data), 1981 *(1)*

Airport	Estimated Annual Total Fixed-Wing Operations	Approximate Sampling Error at 95 Percent Confidence Level (%)
Oregon		
Albany	30,272	23
Arlington	618	35
Ashland	16,460	12
Beaver Marsh State	630	36
Christmas Valley	3,232	19
Creswell	26,196	16
Hermiston	15,956	9
Hood River	11,174	15
Josephine County	22,498	15
LaGrande	5,940	21
Lebanon State	11,662	19
Medford-Jackson County	89,244	16
Newport	12,472	18
Pinehurst State	390	36
Seaside State	1,650	23
Siletz Bay State	4,146	27
Sunriver	10,138	16
Tillamook	8,242	25
Wasco State	3,954	36
Washington		
Hoquiam	13,810	26
Kelso	28,404	32
Omak	11,556	13
Richland	25,118	12
Wenatchee	31,938	13

USE OF INDEPENDENT DATA TO ESTIMATE OPERATIONS AT NONTOWERED AIRPORTS

Because of the high cost of obtaining complete visual counts of operations, independent data are often used in conjunction with a limited sample of observed operations to estimate annual operations at nontowered airports. The underlying assumption in the use of independent data is that they measure the variation in operations throughout the year. The measured variations then are used to extrapolate the limited sample into an estimate of annual operations. Estimates of operations based on independent data have always been suspect, because until recently there has been no means of testing the degree of error in such estimates.

Tower Operations Data

Airport operations data at towered airports are used currently to estimate operations at nontowered airports. An FAA publication (2) identifies five methods for estimating operations. Tower data are used to adjust nontower operations data obtained from a small (7- to 21-day) sample. Several different estimating equations are presented, but all are based on the ratio relationship of Equation 1.

$$\bar{y}/\bar{Y} = \bar{x}/\bar{X} \quad (1)$$

where

- $\bar{y}$ = average daily nontower operations during the sample period,
- $\bar{Y}$ = average daily nontower operations during the year,
- $\bar{x}$ = average daily tower operations during the sample period, and
- $\bar{X}$ = average daily tower operations during the year.

Equation 1 assumes that paired towered and nontowered airports will have a similar distribution of operations over the year. The equation also assumes that towered and nontowered airports can be logically paired according to similarities in mix of operations, weather, and daily traffic variation.

Method of Comparing Towered and Nontowered Airports

To test these two assumptions, estimates of each quarter of annual operations at 23 nontowered airports were compared with quarterly operations data for the closest or otherwise best-paired towered airport. The Medford Airport was used as a control because both tower operations data and data gathered by acoustical counters were available. Tower operations data were obtained from unpublished FAA tower operations data for 1981. A total of seven towered airports in Washington and Oregon were used in the study. Only itinerant and local general aviation data for towered airports were used so that the data would be comparable to the type of data available from nontowered airports.

The quarterly distributions of operations at towered and nontowered airports were considered to be similar if they did not differ by more than 25 percent in any one quarter. A 25 percent difference was allowed because (a) it provides for a liberal but reasonable tolerance of variation and (b) the quarterly distribution of sampled operations data at Medford Airport differed by as much as 23 percent during a single quarter from the quarterly distribution of tower data for the Medford Airport. The difference in the quarterly distribution of operations between the Medford sample data and tower data may be due to (a) the difference between a sample and a complete count and (b) the fact that the sample estimate reflects all operations, whereas only general aviation statistics were used from the tower data.

Result of Comparison of Operations

The comparison of the quarterly distributions of operations at nontowered and nearby towered airports yielded few similar pairs (see Table 2). Of the 23 paired towered and nontowered airports studied, only six had similar distributions of operations. The other 17 towered and nontower pairs were not similar because of the wide fluctuation in the quarterly distributions of operations at nontowered airports.

Among nontowered airports, the proportion of annual operations that occurred in a single quarter ranged from a low of 7 percent to a high of 61 percent. Furthermore, among nontowered airports there was no consistent pattern in the distribution of operations across quarters. With few exceptions, each nontowered airport exhibited a unique distribution of quarterly operations.

By comparison, the distribution of operations among towered airports followed a much more consistent pattern across quarters. The proportion of annual operations that occurred in a single quarter ranged from a low of 14 percent to a high of 36 percent, less than half the range of nontowered airports. Generally the first and fourth quarters each accounted for about 20 percent of annual operations, and the second and third quarters each had about 30 percent of annual operations.

This relationship is more visible in pre-1981 tower data. The 1981 data were affected by the air traffic controller walkout and the recession, which lowered fourth quarter activity at towered airports.

This comparison indicates that the distributions of operations at towered airports are not sufficiently similar to paired nontowered airports for estimating purposes. Therefore, tower operations data should not be expected to provide reliable estimates of operations at nontowered airports.

This conclusion would hold even if nontowered airports were paired with different towered airports. Given the similarity in the quarterly distribution of operations among all towered airports, and the varied distribution of operations among nontowered airports, it is not probable that a better pairing of towered and nontowered airports could improve the estimating capability of tower operations data. Most of the nontowered airports are dissimilar to their paired towered airport and also dissimilar to all other towered airports in the study.

An example using the Josephine County nontowered airport illustrates how an overestimation of operations at Josephine County Airport could result from using Medford tower operations data. Josephine County Airport is about 25 miles from the Medford Airport. The two airports share the same weather and, therefore, the same flying conditions. Based on acoustical counter data Josephine County Airport was estimated to have 22,498 operations a year, which is 19 percent of the general aviation activity at the Medford Airport. Data reports for Medford tower show 122,961 general aviation operations in 1981. This number differs from the Medford operations estimate given in Table 1 because that estimate is based on a sample and does not include helicopters or missed approaches.

The two airports appear to be a good nontowered

TABLE 2 Quarterly Distribution of Operations at Selected Towered and Nontowered Airports, 1981

Towered Airport	Nontowered Airport	Percent of Annual Operations[a] Quarter 1	Quarter 2	Quarter 3	Quarter 4
McNary (Salem, Oreg.)		24	34	28	14
	Newport	19	27	33	21
	Albany	22	29	32	17
	Creswell	18	31	34	17
	Lebanon State	19	35	32	15
	Siletz Bay State	9	36	36	19
Portland-Hillsboro (Oreg.)		24	29	29	18
	Tillamook	22	21	20	37
	Seaside State	9[b]	34	43	15
	Hoquiam	18	32	15	35
	Kelso	33	27	13	28[c]
Portland-Troutdale (Oreg.)		23	32	29	16
	Hood River	12	27	45	16
Kingsley (Klamath Falls, Oreg.)		22	30	33	14
	Sunriver	12	27	49	12
	Christmas Valley	23	25	38	14
	Beaver Marsh State	9	48	30	14
Medford-Jackson County (Oreg.)		22	29	31	19
	Medford-Jackson County	17	33	34	16
	Josephine County	35	30	28	7
	Ashland	26	27	34	13
	Pinehurst State	15	29	48	8
Walla Walla (Wash.)		25	36	22	17
	LaGrande	10[b]	26	52	12
Tri-Cities (Pasco, Wash.)		20	31	29	20
	Richland	21[b]	22	26	31
	Omak	29	24	28	18
	Wenatchee	22	29	27	22
	Wasco State	61	14	14	10
	Arlington	36	50	7	7
	Hermiston	20[b]	30	28	22

[a]Quarterly percentages may not sum to 100 because of independent rounding.

[b]Quarterly distribution is for the first quarter of 1982 and is not strictly comparable to 1981 first quarter tower data.

[c]Quarterly distribution is for fourth quarter of 1980 and is not strictly comparable to 1981 fourth quarter tower data.

and towered pair for the purposes of estimating nontowered operations. However, the quarterly distribution of operations at the two airports is not similar. If general aviation operations data from the Medford Airport were used to expand sample data from the first quarter at the Josephine County Airport, annual operations would be estimated at 38,390. This estimate was obtained by using the minimum change estimate (MCE) equation given by FAA (2).

The estimate of 38,390 annual operations is 71 percent higher than the 22,498 estimate of annual operations based on a more complete sampling of actual activity at Josephine County. This large discrepancy is due to the compounding of two errors in the estimating technique. First, the technique assumes that the proportion of annual operations that occur in the first quarter at Josephine County and Medford Airports are the same. This was not the case. Medford had 17 percent of annual operations occurring in the first quarter, whereas Josephine County had 35 percent of annual operations in the first quarter (Table 2). This difference in the distribution of operations accounted for 65 percent of the error in the estimate. Second, the technique relies partially on the use of previous activity estimates which, for Josephine County Airport, have been much higher than actual counts indicate. The use of a high estimate in the technique accounted for an additional 6 percent error in the estimate. The resulting 71 percent error is in addition to the sampling error.

The above example was based on first quarter operations to avoid any impacts on the distribution of operations caused by the air traffic controllers walkout in August 1981. Worse case examples are apparent in Table 2, such as the 205 percent difference in the proportion of first quarter operations at Tri-Cities and Wasco State Airports. Another example is the 136 percent difference between third quarter operations at Walla Walla and LaGrande Airports.

On the other hand, some paired towered and nontowered airports had similar distributions of operations in each of the four quarters. The Wenatchee and Tri-Cities Airports are the best example. Quarterly operations at these two airports differ by 10 percent or less in each quarter. In this case, estimating operations at Wenatchee by using Tri-Cities tower data would have a 10 percent or less error (plus the sampling error). The problem is that one does not know beforehand which nontowered airports can be successfully estimated from tower operations data, or in which quarter to sample operations, without more knowledge of seasonal operations at nontowered airports.

The difference in seasonal distributions of operations at towered and nontowered airports appears to result from a combination of factors, including the effect of weather and the types of uses that tend to concentrate at nontowered airports. General aviation activity appears to be more sensitive to weather conditions at nontowered airports. An obvious reason for this difference is the nature of the airport facilities. Towered airports provide for instrument approaches, whereas the majority of nontowered airports do not have this capability. Another reason for the varying impact of weather may be because business and commuter aircraft constitute a higher proportion of the operations at towered airports. Business aircraft tend to be better equipped for instrument flying and more likely to fly regardless of the weather. By contrast, training and recreational flying probably account for a larger proportion of operations at nontowered airports. This type of fair weather activity tends to be more sensitive to weather conditions.

The dissimilarity in the seasonal distribution of operations also may be due to different types of activities. At nontowered airports it is probable that a large portion of operations results from specialized activities. For example, the LaGrande Airport is used extensively by the U.S. Forest Service when fighting forest fires during the summer months. This activity results in an unusually high percentage (52) of annual operations occurring in the third quarter. At the Wasco State Airport 61 percent of annual operations occurred in the first quarter because of local crop spraying schedules. These types of local activities are not reflected in tower operations data.

Weather Data

During the Aircraft Activity Counter Demonstration Project weather data were gathered for most of the days on which aircraft departures were sampled. Daily comparisons indicate that there is a correlation between weather condition and departures. As a result, daily departures were generally higher in the second and third quarters (April through September), when flying conditions tended to be better, than in the fourth and first quarters (October through March). Furthermore, departures varied with weather conditions within each quarter.

If daily weather data for a sampled airport were available, they would be expected to help provide an estimate of variation in operations so that the size of the sample of operations could be reduced. Unfortunately, using weather data as an independent indicator of variation has several drawbacks. Weather data must be available for every day of the year, not just when flying activity is being sampled. Data collected by the National Weather Service do not include visibility and cloud ceiling, which are the most important weather factors affecting operations. Also, site-specific weather data are not available for many nontowered airports. Finally, use characteristics of individual airports result in different sensitivities to weather conditions; therefore, even if adequate weather data were available, it could not be expected to account for all variations that affect operations. Other components of variation, such as type of day (weekday, or weekend or holiday) and other nonweather seasonal variations would still have to be captured directly by sampling operations.

Fuel Sales Data

In Oregon retail sales of aviation gasoline and jet fuel are reported monthly by most retail dealers. A comparison of fuel sales data and number of departures was made for seven nontowered Oregon airports. Analysis was limited to the months that had both adequate samples of departures and complete fuel sales data. The correlation coefficient of gallons of aviation gasoline sold and number of departures was between 0.92 and 0.97 at five of the seven airports. The other two airports had coefficients of about 0.68. Jet fuel was also sold at three of the airports studied but inclusion of jet fuel sales in the analysis did not improve the coefficients. One of the airports with the lower correlation coefficient also had a very high ratio of departures per gallon, indicating that most users of this facility probably bought their fuel elsewhere.

To test the use of fuel sales data for estimating operations, a ratio of departures per gallon of aviation gasoline sales was calculated for each airport for each month in which complete data were available. In spite of the close relationship of fuel sales and aircraft activity, these data indicate that wide errors could result if fuel data were used to expand a single weekly count to an annual total. On the other hand, when the average departures for all months were used to estimate operations from fuel sales, the results were similar to those obtained by the direct survey, even for those airports with the lower correlation coefficients.

Extreme ratios of departures to fuel sales probably resulted from a combination of two factors. First, the data on departures actually consisted of week-long samples expanded to a full month. Although this sampling period provides a very good confidence interval over a several month period, it allows for wide deviation in a single month. Second, changes in types of aircraft and types of activity throughout the year may have affected the ratio of departures to fuel sales.

In response to this second concern, a check was also made to determine if variations in the ratio of departures to fuel sales followed a seasonal pattern. Although a pattern was not identified, it is interesting to note that the greatest variation in the measure of departures to fuel sales occurred in the first quarter at most airports.

The comparison of departures-to-fuel-sales ratios among airports also provides useful information on the relationship between fuel sales and operations. Although there was a high correlation between fuel sales and departures at most of the individual airports studied, there were significant differences in the ratios of departures to gallons of fuel sales among airports. Mean ratios of departures per gallon were tested for significant difference at a 95 percent confidence level using a one-tailed t-test with pooled variance. Of 21 possible pairings, 19 were significantly different.

Two studies are needed to confirm these general findings and determine the potential accuracy of methods relying on fuel sales as an independent indicator of variation. One is to conduct operations counts during periods that correspond exactly to the fuel reporting periods. Both the operations counts and fuel data should be collected periodically over a full year. Second, a follow-up study is needed to determine fueling practices at each airport surveyed. For instance, how much in fuel sales is not reported because of private tanks or unlicensed dealers and how much is consistently ferried into or out of the airport?

SAMPLING DESIGN FOR NONTOWERED AIRPORTS

Use of Systematic Cluster Samples

When there is no accurate independent indicator of seasonal variation at a particular nontowered airport, or in cases where the indicators themselves must be tested for reliability, it will be necessary to conduct samples of activity throughout the year. A cost-effective method of sampling activity using an acoustical counter is to sample clusters of 7 days systematically throughout the year. All departures occurring during each of the sampled 7-day periods would be counted.

Analysis of data obtained in the Aircraft Activity Counter Demonstration Project indicates that significant differences in airport activity are associated with day of the week and season of the year. In order to sample where the variation occurs, days should be stratified into weekdays, and weekends and holidays. Seasons should be stratified based on annual weather patterns. For most areas of the country two, three, or four seasons could be used. If four seasons are used, the sample would be stratified into eight separate cells.

If 7-day clusters are used, a stratified sample is automatically proportional with respect to the day of the week. A systematic sample of 7-day clusters, which provides for an equal number of evenly spaced clusters per season, will provide proportionality of seasons. If seasonal as well as annual estimates of operations are desired, it is necessary to sample at least two 7-day clusters in each season.

To ensure randomness in the sample, the first of the sample weeks is chosen randomly. Subsequent sample weeks occur at equal intervals throughout the year. The sample size may be chosen to reflect the desired trade-off between cost and accuracy. Preliminary estimates of sampling error for alternative sample sizes and expected numbers of annual operations are shown in Table 3 (3).

TABLE 3 Approximate Percentage of Sampling Error in Estimates of Annual Operations by Size of Airport and Size of Sample

Approximate Annual Operations at Airport Being Sampled	No. of Weeks Sampled per Year				
	4	6	8	10	12
	Approximate Sampling Error (%)				
900	54	44	37	32	29
900- 2,399	51	41	34	30	27
2,400- 4,399	47	38	32	28	25
4,400- 7,199	44	35	30	26	23
7,200-10,499	40	32	27	24	21
10,500-14,599	36	29	25	21	19
14,600-19,199	33	26	22	19	17
19,200-24,599	29	23	20	17	15
24,600-30,499	25	20	17	15	13
More than 30,500	22	17	15	13	12

Sample Cost

One of the most significant aspects of the acoustical aircraft activity counter is that it permits periodic sampling or continuous monitoring at nontowered airports at a reasonable cost. The cost of resampling the Oregon airports previously counted as part of the Aircraft Activity Counter Demonstration Project was calculated based on the sampling plan presented in this paper and cost factors relevant to Oregon. Assuming a sample size to keep the sampling error in the range of 20 percent, costs range from $1,000 to $2,000 per airport. Costs would be higher if a larger sample was desired to reduce the sampling error. Costs could be lowered by tolerating less accurate estimates.

Estimating Annual Operations from Sample Data

After the sampling of departures has been concluded, the sample data must be extrapolated to estimate a full year of operations. This section illustrates how annual operations and sampling error are estimated from data gathered according to the sampling plan discussed previously. Specifically this estimating procedure assumes that sample data consist of counts of departures taken during two or more 7-day periods in each season.

Total operations (landings and departures) during each season may be estimated by expanding the sum of the sampled departures in each season by $2(N/n)$; where N = number of weeks per season (e.g., 13 if quarters are used), and n = number of weeks sampled in each season. Total annual operations is estimated by summing the seasonal operations estimates.

Calculation of the variance of the estimate is not as straightforward because the sampling plan was based on weekly clusters instead of random days. The variance of the estimated seasonal operations is estimated by Equation 2:

$$\hat{V}(2\hat{D}_j) = (2^2)(N^2)[1-(n/N)]\left[n\sum_{i=1}^{n} d_{ij}^2 - \left(\sum_{i=1}^{n} d_{ij}\right)^2\right]/n^2(n-1) \quad (2)$$

where

$\hat{D}_j$ = estimated departures in the jth season,

$\hat{V}(2\hat{D}_j)$ = estimated variance of estimated total operations for the jth season, and

d_{ij} = departures counted during the ith week of the jth season.

The variance of the estimate of total annual operations then is given by Equation 3.

$$\hat{V}(2\hat{D}) = \sum_{j=1}^{J} \hat{V}(2\hat{D}_j) \quad (3)$$

where J = total number of seasons.

The estimated variances of the estimates of seasonal and annual operations may then be used to calculate the percent sampling error of each estimate at the 95 percent confidence level by using Equations 4 and 5. The sampling error of seasonal estimates is

$$\hat{E}(2\hat{D}_j) = 100\,[\hat{V}(2\hat{D}_j)]^{1/2}/\hat{D}_j \quad (4)$$

and the sampling error of annual estimates is

$$\hat{E}(2\hat{D}) = 100\,[\hat{V}(2\hat{D})]^{1/2}/\hat{D} \quad (5)$$

It should be noted that the procedure for estimating sampling error can be used even if the seasons in the stratified sample are not proportional. However, if proportionality of the day of week stratification is lost, further adjustments are required.

Distribution of Operations

Often the distribution of operations, including seasonal distributions and monthly, daily, and hourly peaks, is as important to airport planning, funding, and management decisions as the estimate of total annual operations.

A representative sample of departures can provide information on the distribution of airport activity. The empirical or observed distribution of sample data can be considered the most probable distribution of the population in the absence of other information about the population distribution (4).

The seasonal distribution may be determined by dividing the seasonal estimates of operations by the annual estimate. Independent information, such as fuel sales data, also may be useful in making estimates of seasonal or monthly operations, especially when the sample is small.

Samples of departure data can also provide a frequency distribution of hourly and daily departures for planning purposes. Because daily operations are expected to be twice the number of daily departures (assuming an equal number of landings and departures), the distribution of daily operations should mirror the distribution of daily departures. However, the distribution of hourly operations cannot be inferred from the distribution of hourly departures because it cannot be assumed that an equal number of landings and departures will occur in any one hour.

The peak number of departures can be identified directly from the frequency distribution of departures per hour or day. Peak daily operations are used to plan for airport design capacity, airport improvement projects, and service demands. Peak hourly departures are useful to airport managers and fixed-base operators in planning for service demands and staffing requirements.

In some cases, the daily or hourly peak-to-mean ratio also may be a useful statistic. Sample data indicate that peak-to-mean ratios tend to be inversely related to the size of the airport. Peak departures tend to increase as mean departures increase, but at a slower rate.

IMPACT OF ECONOMIC DOWNTURN AND AIR TRAFFIC CONTROL WALKOUT ON FINDINGS

Before concluding, some attention should be given to two important factors that affected the level of operations during the sample period used in this analysis. The severe economic downturn in 1981 reduced all aviation activity. In August 1981 the air traffic controllers walkout resulted in an additional reduction in operations at many airports. Because of these events, 1981 may have been an atypical year for aviation, but it is improbable that they affected the major conclusions of the study.

Conclusions about the comparison of towered and nontowered operations are based on differences in the seasonal distribution of operations. Seasonal variations of operations would not have been changed substantially because of economic recovery or the elimination of the third quarter downturn resulting from the air traffic controllers walkout. The sampling procedures developed and the estimates of confidence intervals reflect the seasonal and daily variations in operations at nontowered airports. Sample size requirements might be reduced if these variations were reduced, but the procedure itself would not change substantially.

CONCLUSIONS

Aircraft operations data gathered during the Aircraft Activity Counter Demonstration Project have proved useful in analyzing and testing alternative sampling procedures for estimating aircraft activity at nontowered airports. The results of this analysis indicate that the most commonly used sampling procedures, which rely on comparisons of nontowered airports with towered airports, cannot be expected to provide reliable results. Other independent measures of aircraft activity, such as fuel sales data, may prove to be more useful than tower data for estimating activity at nontowered airports. However, further research is needed on the relationship between fuel sales data and aircraft operations at nontowered airports.

The most cost-effective procedure for making statistical estimates of aircraft activity at nontowered airports is to use an acoustical aircraft activity counter to obtain a series of cluster samples systematically drawn throughout the year. Such samples can provide valuable information on seasonal and peak use patterns as well as total annual operations.

Based on these findings it is recommended that the FAA devote more attention to techniques that do not rely on comparisons with tower data to estimate air activity at nontowered airports. Further research should be devoted to finding and evaluating alternative independent measures of variation in activity at nontowered airports. Further research is also needed on the use of acoustical aircraft activity counters or similar equipment to reduce the cost of periodic sampling.

The Oregon Aeronautics Division is currently conducting a counting program using the procedures recommended in this study as part of the federally sponsored Continuous Aviation System Planning Process. Activity counts are being used in system planning and to update Airport Master Records (5010 forms); and significantly improved data are being supplied to airport sponsors, managers, fixed-based operators, and planners.

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