even higher rates of parasite-related annual mortality. These estimates represent 11–14% of the natural mortality of the population, and support the concept that parasitism constitutes a major factor in natural mortality of small cetaceans.

Acknowledgments.—The dolphin specimens were collected by several field technicians aboard commercial tuna seiners. Especially helpful were J. M. Coe, D. B. Holts, and C. W. Oliver. J. G. Mead, C. W. Potter, and others at the National Museum of Natural History carried out the labor of preparing >500 skulls. J. Zweifel helped with the original experimental design. M. D. Dailey, J. G. Mead, S. H. Ridgway, and J. R. Geraci read the manuscript and offered suggestions for its improvement.

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Received 31 March 1978.
Accepted 5 March 1980.

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A NONMAPPING TECHNIQUE FOR STUDYING HABITAT PREFERENCES[1]

Analyses used to determine use of habitat require determining the available area of each habitat category. The method of mapping and using a planimeter to determine the area of well-defined plant communities was described by Neu et al. (1974). Other recent studies have used this or a similar technique (Nicholls and Warner 1972, Hirst 1975, Irwin 1975, Peek et al. 1976, Bloom 1978, Collins et al. 1978, Maxon 1978). Large diverse areas in rugged mountain terrain are difficult to map, and other habitat parameters, in addition to plant communities,

[1] Funding was provided by the McIntire-Stennis Federal Forestry Program administered through the School of Forestry, University of Montana; the USDA Forest Service Region 1 and Intermountain Forest and Range Experiment Station; and the Montana Department of Fish and Game, District 2.

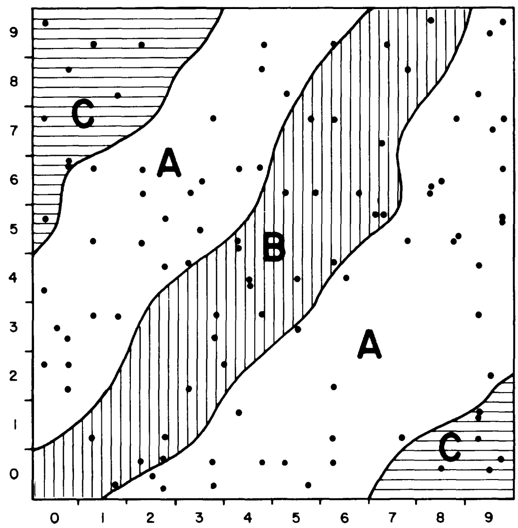

Fig. 1. A study-area map with 3 categories of habitat (A, B, C) and 100 randomly distributed points.

can be useful in examining habitat preference of animals. Habitat parameters that may be difficult to map include different categories of slope, slope position, elevation, or other topographic categories; and vegetative structural or successional characteristics. Distances from water, ecotones, or areas of human disturbance such as roads, recreation areas, or logging are other parameters that may be difficult to map.

We present a nonmapping technique for estimating the proportions of categories of several habitat parameters simultaneously, and a statistical treatment based on this procedure. The technique was developed during a study of elk (*Cervus elaphus nelsoni*) habitat preferences in western Montana (Marcum 1975).

ESTIMATION PROCEDURE

For clarity, the procedure is first illustrated using a simple artificial example in which the habitat categories can be mapped. Figure 1 represents a study area containing categories A, B, and C. The proportions of each category in the area are denoted by P_A, P_B, and P_C, which sum to 1. If categories can be delineated readily by boundaries, then a planimeter normally is used to determine the areas and obtain proportions. These proportions then are treated as known parameters, and compared to empirical data on use of the habitats. Planimetrically determined values for P_A, P_B, and P_C in Fig. 1 are 0.580, 0.276, and 0.144, respectively.

Assume that boundaries for A, B, and C cannot be drawn, but that any point in the study area can be classified as one of these categories. Estimates for P_A, P_B, and P_C still can be obtained by randomly distributing points (100 in this example) over the study area, and classifying each point A, B, or C. For this example, 58 points were classified as A, 27 as B, and 15 as C. Estimates for the categories are thus $\hat{P}_A = 0.58$, $\hat{P}_B = 0.27$, and $\hat{P}_C = 0.15$; and they were obtained without drawing boundaries. In practice, this is done using an accurate topographic map and/or large-scale (1:24,000) aerial photographs. However, ground-truth data may be necessary for some parameters.

The random points in our example were distributed by first placing a 10 × 10 grid over the study area map, with rows and columns labeled 0, 1, 2, . . . , 9. A table of random numbers then was used to obtain a pair of random digits, e.g., 6 and 2. This point belongs in row 6, column 2. Because the grid in the example is fairly coarse, this process was repeated on a finer scale to locate the point within square 62. This was repeated until 100 points were distributed randomly over the study area. For actual use, it is best to use a fine grid where one of the squares is for all practical purposes, a point. This procedure is done easily using a computer, and it gives a random

Table 1. Observed and expected values for randomly distributed points shown in Fig. 1, and hypothetical elk locations.

	Subregion						
	A		B		C		
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Total
Random points	58	47.2	27	40.8	15	12	100
Elk locations	60	70.8	75	61.2	15	18	150
Total	118		102		30		250

distribution of points (Reinhardt and Loftsgaarden 1977:305).

In general, n points are distributed randomly over the study area, which consists of k areas. The problem is to estimate the proportion of the area that belongs to each subarea. Statistically, the problem is that of estimating the parameters in a multinomial probability model with k classes (Mendenhall 1971:290).

The number of random points needed is determined as follows. Denote by p the proportion of the study area in a particular habitat category. This proportion is the parameter in a binomial probability model, and the number of observations needed to approximate it is determined easily (Mendenhall 1971: 195). The number of points needed is a function of the quantity $p(1 - p)$. Although p is unknown, $p(1 - p)$ has a maximum value of ¼ for p in the interval [0, 1]. Thus if nothing is known about p, the most conservative (largest) value for $p(1 - p)$ is used; if a rough estimate for p is known, it can be used instead. Determine the number of points needed for each habitat category under construction, and then choose the largest number as the sample size.

STATISTICAL ANALYSIS

A habitat-preference analysis is illustrated by using the above technique along with habitat-use data. Suppose 150 locations of elk were obtained: 60 in habitat category A, 75 in B, and 15 in C. These data, along with those from the previous section, are summarized in Table 1.

These random points and elk sightings represent 100 observations from 1 multinomial distribution with parameters P_{1A}, P_{1B}, and P_{1C}, which sum to 1; and 150 observations from a 2nd multinomial distribution with parameters P_{2A}, P_{2B}, and P_{2C}, which sum to 1. For the 1st distribution, P_{1A}, P_{1B}, and P_{1C} are the proportions of the study area in habitat categories A, B, and C, respectively. For the 2nd distribution, P_{2A}, P_{2B}, and P_{2C} are the theoretical proportions of the elk locations in categories A, B, and C, respectively. The hypothesis being tested is H: $P_{1A} = P_{2A}$, $P_{1B} = P_{2B}$, $P_{1C} = P_{2C}$ (i.e., that elk use each habitat category in proportion to its occurrence in the total area). This involves comparing the proportion of the random points falling in each habitat type with the proportion of elk sightings occurring in each habitat. One way of testing this hypothesis is a chi-square test of homogeneity (Mendenhall 1971:299).

Table 1 also gives the expected numbers in each of the 6 cells. For example, the 47.2 is found as (118·100)/250. The test statistic is:

$$\begin{aligned}\chi^2 &= \Sigma\,(\text{observed} - \text{expected})^2/\text{expected} \\ &= (58 - 47.2)^2/47.2 \\ &\quad + (27 - 40.8)^2/40.8 + \ldots \\ &\quad + (15 - 18)^2/18 \\ &= 13.15\end{aligned}$$

Table 2. Observed and expected values for randomly distributed points and elk locations by forest-overstory canopy coverage class for summer–fall 1973. Data from Marcum (1975).

	Percent forest-overstory canopy cover								
	0		1–25		26–75		>75		
	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Obs.	Exp.	Total
Random points	15	6.9	61	57.5	84	101.0	40	34.7	200
Elk locations	3	11.1	90	93.5	181	164.0	51	56.3	325
Total	18		151		265		91		525

The critical chi-square value with significance level 0.05 and 2 df is 5.991. The hypothesis of homogeneity of the 2 multinomial distributions is rejected, and the conclusion is that elk do not use each habitat category in proportion to its occurrence.

If H is rejected, the next step is to determine which categories the animals prefer. This is done by obtaining $100(1 - \alpha)\%$ simultaneous confidence intervals for $P_{1A} - P_{2A}$, $P_{1B} - P_{2B}$, and $P_{1C} - P_{2C}$, respectively. For category i, (i = A, B, C), if the confidence interval includes 0, the decision is that $P_{1i} = P_{2i}$ and that category i is used in proportion to its availability. If 0 is not in the interval and both end points of the interval are positive, $P_{1i} > P_{2i}$ and category i is used significantly less than in proportion to its availability. If 0 is not in the interval and both end points of the interval are negative, $P_{1i} < P_{2i}$ and category i is used significantly more than in proportion to its availability.

With $\alpha = 0.09$, 91% simultaneous confidence intervals for $P_{1i} - P_{2i}$, i = A, B, C, are constructed. Simultaneous confidence intervals mean that the probability that all 3 confidence intervals simultaneously include the true parameter values is 0.91. Using the Bonferroni approach (Miller 1966:67), ordinary 97% confidence intervals are constructed in each case. For $P_{1A} - P_{2A}$, a 97% confidence interval (Mendenhall 1971:193) is

$$(\hat{P}_{1A} - \hat{P}_{2A}) \pm Z_{0.985} \cdot [\hat{P}_{1A}(1 - \hat{P}_{1A})/n_1 + \hat{P}_{2A}(1 - \hat{P}_{2A})/n_2]^{\frac{1}{2}},$$

where n_1 = number of points randomly distributed over the study area, $\hat{P}_{1A}$ = proportion of these points that fall in category A, n_2 = total number of elk locations, $\hat{P}_{2A}$ = proportion of the elk locations that fall in category A, and $Z_{0.985}$ = 98.5th percentile for a standard normal distribution = 2.17. Comparing availability of habitat category A with elk locations in A yields

$$(58/100 - 60/150) \pm 2.17 \cdot [0.58(0.42)/100 + 0.6(0.4)/150]^{\frac{1}{2}},$$

which gives (0.04, 0.32).

Because the confidence interval for $P_{1A} - P_{2A}$ is (0.04, 0.32), it is concluded that $P_{1A} > P_{2A}$ and that habitat category A is used less than in proportion to its availability. Analogous confidence intervals for $P_{1B} - P_{2B}$ and $P_{1C} - P_{2C}$ are (−0.36, −0.10) and (−0.04, 0.14), respectively. The conclusion is that category B is used more than in proportion to its availability and category C is used in proportion to its availability.

In general, when constructing $k \cdot 100 \cdot (1 - \alpha)\%$ simultaneous confidence intervals using the Bonferroni approach, a confidence level of $1 - \alpha/k$ is used for the individual confidence intervals. For the example, $\alpha = 0.09$, $k = 3$, and $1 - \alpha/k = 0.97$, and 97% confidence intervals were constructed. In general, the Z value used in constructing the individual confidence intervals is $Z_{1-\alpha/2k}$, which is $Z_{0.985}$ for this example. This gave $100(1 - \alpha)\% = 91\%$ simultaneous confidence intervals. If k is fairly large, a larger α (e.g., 0.20) may be chosen so that individual intervals do not become so wide that they are no longer useful (this happens because $1 - \alpha/k$ can be very large). This means that if one is forming a large number of simultaneous confidence intervals, one must be willing to accept a lower probability that all are simultaneously correct.

A brief example using data from Marcum's (1975) elk study is presented in Table 2. Classes of forest-canopy coverage occurred as a complex mosaic over the study area, and would have been extremely difficult to map accurately. Confidence intervals (90% simultaneous, 97.5% individual) for the 4 canopy cover classes in Table 2 are (0.02, 0.11), (−0.07, 0.12), (−0.24, −0.04), and (−0.03, 0.12), respectively. Elk used the 0% class significantly less than in proportion to its availability and the 26–75% class significantly more than in proportion. There was no significant difference between use and availability for the 1–25% and >75% canopy coverage classes.

DISCUSSION

During Marcum's (1975) study the random-points method was compared to the mapping/planimeter procedure where possible, and no significant differences in proportions were found. In highly diverse study areas the random-points method is probably superior to mapping. In such areas it is difficult to obtain accurate estimates by mapping, whereas the random-points method does not depend in any way on how a particular habitat type is distributed over the study area. Another advantage of this technique is that several mutually exclusive habitat parameters can be handled simultaneously when random points are examined, whereas with mapping, each parameter would require a separate map.

As pointed out by Neu et al. (1974:542), observations concerning habitat use in relation to availability must meet 2 assumptions, "(1) that the animal has an opportunity to select any of the habitat which is deemed available, and (2) that observations are collected in a random unbiased manner." These assumptions can be met by a number of field methods. However, observations must be spaced temporally so that the animal has access to the entire area considered. Therefore, when animals have distinct seasonal home ranges, the analysis must be done separately for each season.

The random-points method was developed primarily for use in habitat-preference studies, but it may be used for availability estimates alone. For instance, using old and recent maps and aerial photographs, a rapid and accurate estimate of habitat changes resulting from agricultural, forestry, suburban development, or other land-use practices could be obtained. Also, the technique could be useful to wildlife managers working to provide inventories of habitats in large-area planning units.

Acknowledgments.—We thank L. J. Lyon and B. W. O'Gara for reviewing the manuscript.

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Received 11 February 1977.
Accepted 2 February 1980.

EDITORIALS

Transitions Among Editorial Staffs

In 1977, former Editor Charlie MacInnes recommended changing *Journal* staffing to the editor-in-chief/associate-editors system that my associates, assistant, and I have since installed. Charlie's idea was a good one if the compliments that manuscript authors and others have directed to us are to be believed. Of course, we're inclined to believe them.

Charlie's idea, essentially, was to provide more editorial time: time to think and plan, to edit more helpfully, and to provide more consistency among the *Journal*'s volumes. The thinking and planning time has allowed Editorial Assistant Georgie Healy and me to write an entirely new operations manual that is designed for continuing revision and amendment by our successors. Previous incoming editors had no such written guidance; some, like me, were not even aware at first of the questions that our manual answers. The increased editing time has allowed us to provide more help to authors than was possible before—my associates and I commonly have put manuscripts through 2 or 3 revisions before acceptance. Consistency in the *Journal* will be improved over time through use of our new 29-page guidelines for authors. More than 3,000 copies of it were distributed recently, and others (single copies) are available on request to my successor, Clait Braun.

Improved consistency will also stem from a more gradual changeover between editorial staffs than in the past. Four of my associates, including Clait as editor in chief, are continuing their service to the *Journal*. And, my editorial assistant and I were able to help Clait train his assistants and his 4 new associates.

Now, as has happened to 14 preceding editors of the *Journal*, it's time to cut the cord. I do so with confidence that a first-rate editorial staff will continue to improve the *Journal*. If my staff's experience is repeated, the new staff members will enjoy great personal satisfaction from assisting nearly a thousand authors, about 99% of whom will conduct themselves in accordance with the high ethical standards that our profession demands.

JOHN D. GILL
Editor in Chief, 1979–80

Continued Evolution of *The Journal*

Starting in the next issue and continuing indefinitely, the names and addresses of authors of *Short Communications* will appear just below the title of the article instead of at the end. This change was recommended to many journal editors by Eugene Garfield, president of the Institute for Scientific Information, which publishes *Current Contents*. The change accommodates readers who want to know whose work they are reading without having to flip to the end of the article, simplifies preparing indexes and abstracts, and does not affect publishing costs.

CLAIT E. BRAUN
Editor in Chief, 1981–82