LETTERS AND COMMENTS/LETTRES ET COMMENTAIRES

On Group Testing for Diseases

Worlund and Taylor's (1983) note on group testing contained a totally inadequate review of the scientific literature. The methodology that they described was previously derived by Gibbs and Gower (1960), Thompson (1962), Sobel and Elashoff (1975), Hoenig (1981), and Hoenig and Lawing (1982).

The idea of pooling or grouping samples in a random way goes back at least as far as 1943 when Dorfman (1943) proposed a mass screening of armed forces inductees for syphilis by combining blood samples. Dorfman's work was followed by numerous studies of optimum group size for initial screening and subsequent retesting of subgroups (see Sobel and Groll 1959; Hoenig 1981).

Gibbs and Gower (1960) and Thompson (1962) proposed the use of group testing for estimation. They derived the maximum likelihood estimator and its asymptotic variance as well as studied the bias and discussed the design of studies. Sobel and Elashoff (1975) considered estimation when positive groups could be broken into subgroups for subsequent testing. We also invented group testing but did not publish the basic idea because of the priority of the above authors. We had to content ourselves with studying ways to design an experiment to avoid a large bias (Hoenig 1981; Hoenig and Lawing 1982).

Our work (Hoenig and Lawing 1982) appeared in a fishery newsletter. A recent review of the subject appeared in *American Statistician* (Loyer 1983). *Current Index to Statistics* lists numerous articles on the subject.

We find few problems with Worlund and Taylor's treatment of the subject. However, the following points should be made (Hoenig 1981):

(1) Individual samples must be randomly assigned to groups in order for the binomial model to apply.

(2) A cost function was incorporated into our procedure for choosing optimal testing conditions.

(3) Optimal value of group size, k, is only asymptotically independent of the number of groups. We treated the small sample case.

(4) We discussed an approximate formula for the bias and an exact formula for the mean square error (MSE), which were not provided by Worlund and Taylor.

(5) As an aid to planning studies, it can be noted that the bias is low when the probability of obtaining all tests positive is low. This can be seen from the expectation of $\hat{p}$ conditioned on not getting all tests positive. When all tests are positive, the estimator is 1.0 even though the actual value of p can be much lower.

Worlund and Taylor might have pointed out other potential uses for the methodology. For example, Dare (1977) and Cone and Moore (1981) described laboratory procedures for testing groups of mussels for parasitic copepods and groups of salmonids for pancreatic virus, respectively. These procedures lend themselves to the statistical methodology of group testing. Reviews of other applications can be found in Loyer (1983) and Hoenig (1981).

Finally, it should be noted that group testing can be generalized to more complicated models such as trinomial responses, bivariate binomial models, and testing with groups of variable size (Loyer 1983; Hoenig and Lawing, in prep.) — John M. Hoenig, *Minnesota Department of Natural Resources, Section of Fisheries, Box 12, Centennial Bldg., St. Paul, MN 55155, USA*, and William D. Lawing, *Department of Statistics and Department of Industrial Engineering, University of Rhode Island, Kingston, RI 02881, USA.*

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