Graphical diagnosis for the IDCR/SOWER abundance estimates using the OK method.

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ABSTRACT

This document presents the diagnostic plots of the Antarctic minke whales abundance estimation using the Okamura and Kitakado method. All the plots generally showed good fits.

1. INTRODUCTION

The SOWER abundance workshop made a list of necessary diagnostics to ensure that the line transect methods fit the survey data well (IWC, 2008). This document focuses on the graphical plots, while diagnostic tables are given in Okamura and Kitakado (2008). The method of estimating the predicted values corresponding to the observed values is generally based on the method that Justin Cooke suggested in the last year Scientific Committee.

2. MATERIALS AND METHODS

The data and the model are described in Okamura and Kitakado (2008).

For each diagnostic plot, the observed distribution of the quantity interested is compared with the predicted distribution of the same quantity obtained from the model. The perpendicular distances, forward distances, radial distances, sighting angles, school sizes, perpendicular and forward distances for the duplicate data, are plotted according to IWC (2008). For the perpendicular distances, the probability density of distance is given by

$$\tilde{f}(x) = \frac{\sum_{i \in J} l_i D_i^s g_i(x|\theta_i)}{\sum_{i \in J} l_i D_i^s \mathrm{esw}_i(\theta_i)}, \tag{1}$$

where J is the corresponding set (e.g., circumpolar set), l_i and D_i^s are the survey length and the school density of stratum that the ith sighting belongs to, respectively. $g_i(x|\theta_i)$ and $\mathrm{esw}_i(\theta_i)$ is the detection function and esw averaged by the school size distribution with the parameter θ_i, respectively.

For the forward distances, radial distances, and sightng angels, the probability densities are similarly given.

For the confirmed school sizes, the expected number of sightings of observed school size s is given by

$$\tilde{n}(s) = \frac{n_J \sum_{i \in J} c_k \pi(s) \mathrm{esw}_i(s, \theta_i)}{\sum_{i \in J} \mathrm{esw}_i(\theta_i)}, \tag{2}$$

where c_k is the confirmation probability, $\pi(s)$ is the probability mass function of school size and $\mathrm{esw}_i(s, \theta_i)$ is the esw with the school size s and the parameter θ_i.

3. RESULTS AND DISCUSSION

Fig. 1 shows the plots of perpendicular and forward distances for the Passing mode by circumpolar set. All the plots suggest that the model fits the observed data appropriately in general. Fig. 2 shows the plots of perpendicular and forward distances for the Passing mode categorized by circumpolar set and school size class. Figs. 3 and 4 shows the plots of perpendicular and forward distances for the Passing mode by stratum. Although the fit is not good when the sample size is small, the overall fits are generally good.

The plots of perpendicular distances in Fig. 3 sometimes indicate some heaping of observations at zero distance. While the model of Okamura and Kitakado (2008) doesn't have a 'shoulder', the model with $g(0)$ estimation may be robust to the so-called "shape criterion", since esw $= f(0)/g(0)$. In addition, most of the fits do not trace the spiked data overly. The plots of perpendicular and forward distances for the duplicate data correspond to the plots of duplicate success rates as a function of relative position suggested by Skaug (2008). The fits for the duplicate data look good (Figs. 5 and 6). The plots for the upper bridge data did not show any problem (Figs. 7 and 8). Fig. 9 provides the plots for radial distances and sighting angles. We can see some suggestion of fewer sightings at large sighting angle than expected so that there might be room that we are able to improve the fitting by changing the form of detection function.

The plots for observed school sizes also look good fits and do not suggest serious problems.

The whole impression for diagnostic plots is good. Although several plots indicate some departure, the sample size is relatively small in those cases.

REFERENCES

International Whaling Commission (2008) Report of the SOWER Abundance Workshop.

Okamura, H. and Kitakado, T. (2008) Abundance estimates of Antarctic minke whales from the historical IDCR/SOWER survey data using the OK method. Paper SC/60/IA8 presented to the IWC/SC (unpublished).

Skaug, H. (2008) Diagnostics used for NA minke whales. Paper SC/F08/A10 presented to the SOWER Abundance Workshop (unpublished).

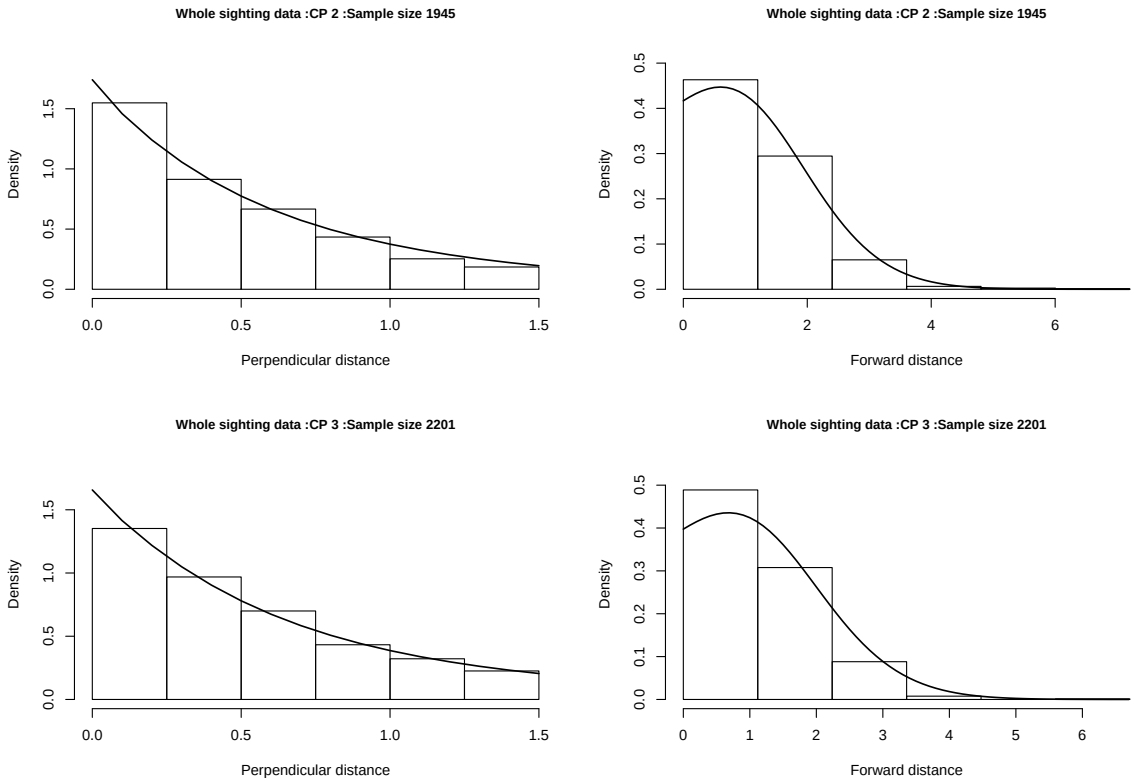


Figure 1. The plots of perpendicular and forward distances (n.miles) in the Passing mode in CPII and CPIII. The histograms denote the observation and the solid lines denote the fitted values.

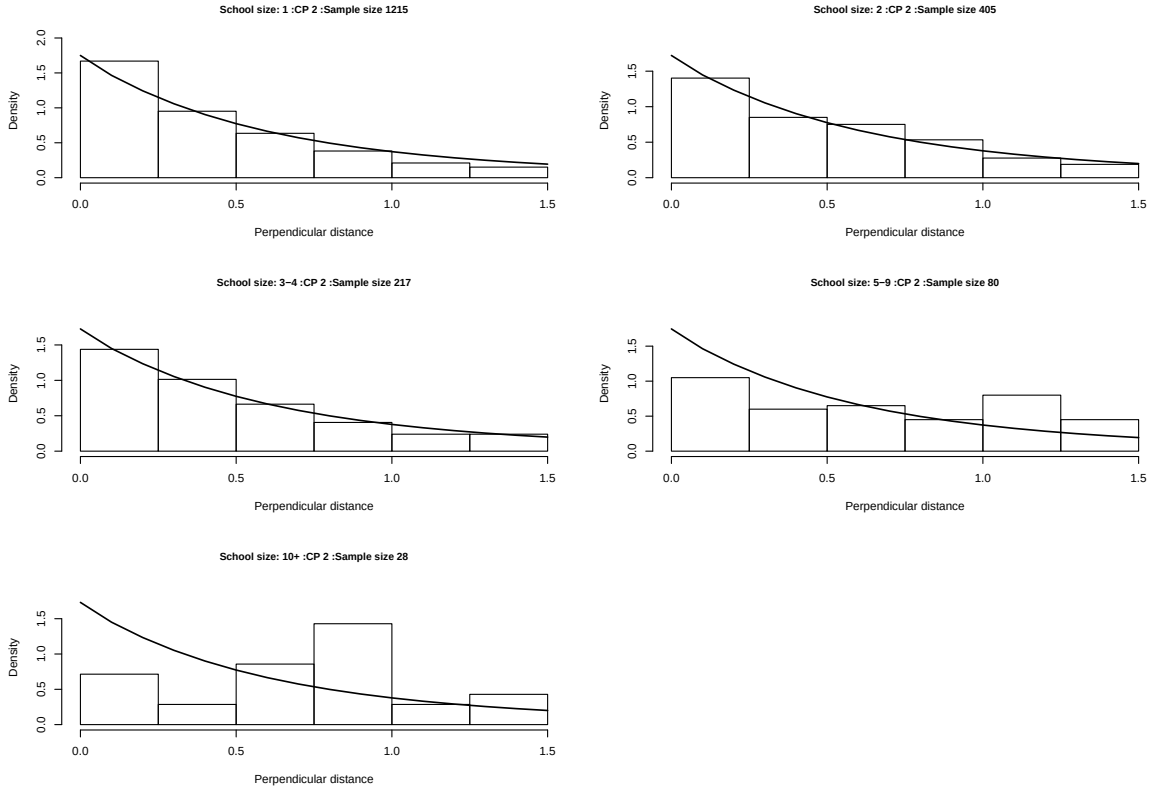


Figure 2. a) The plots of perpendicular distances (n.miles) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

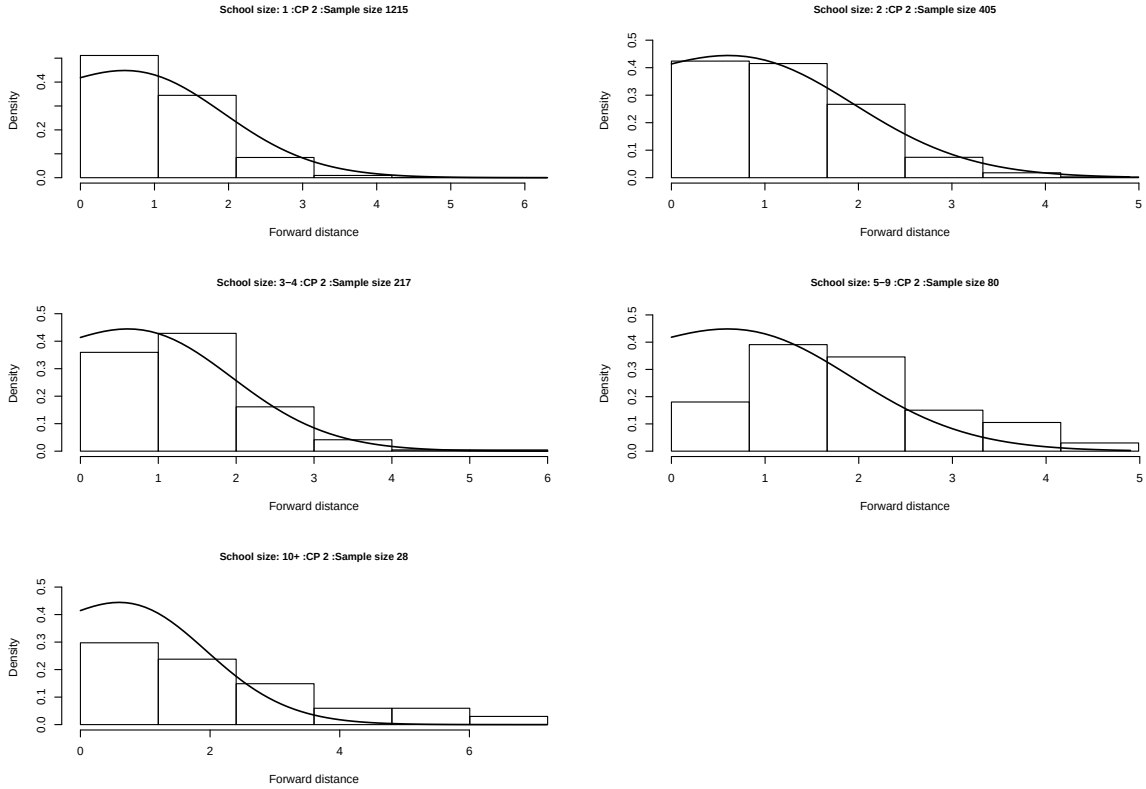


Figure 2. b) The plots of forward distances (n.miles) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

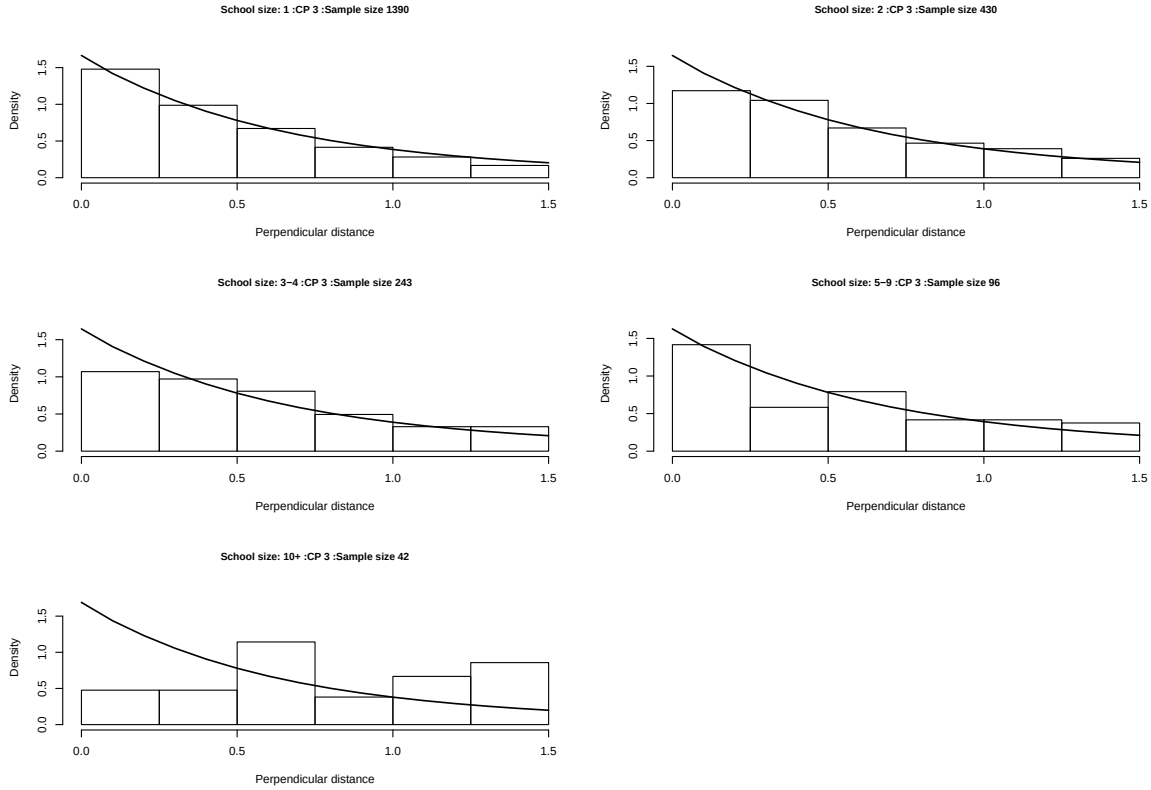


Figure 2. c) The plots of perpendicular distances (n.miles) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPIII. The histograms denote the observation and the solid lines denote the fitted values.

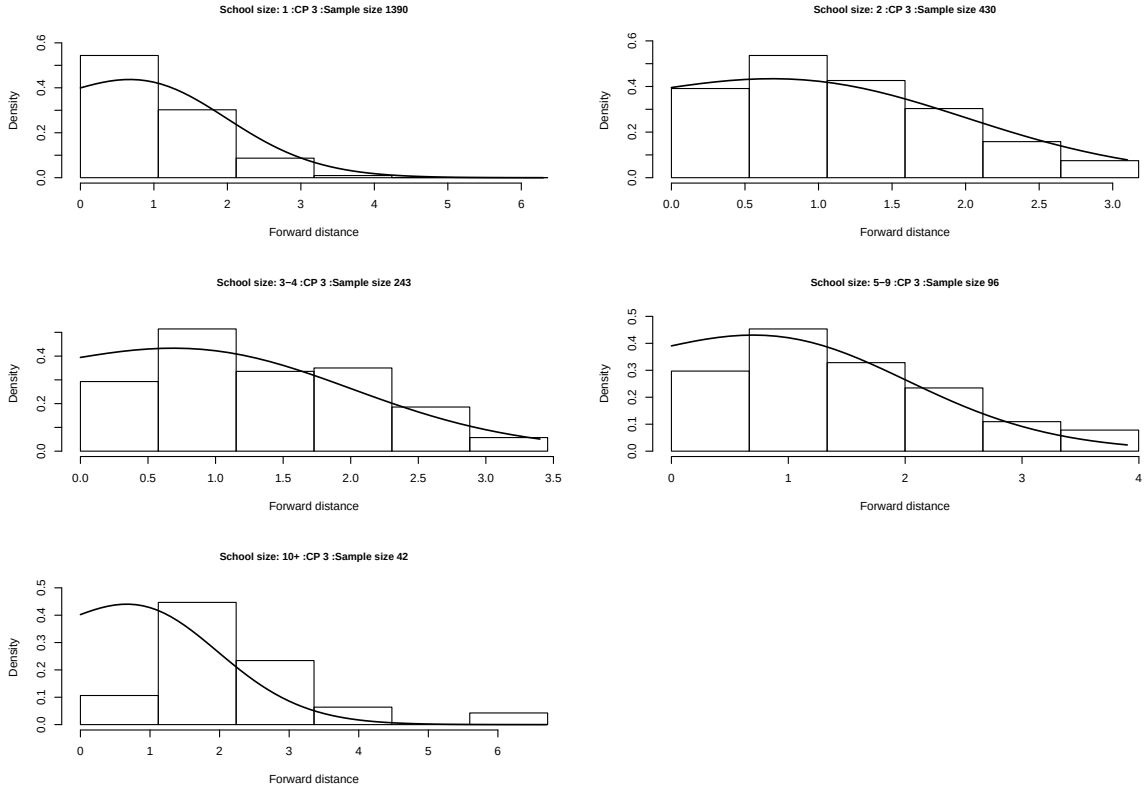


Figure 2. d) The plots of forward distances (n.miles) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPIII. The histograms denote the observation and the solid lines denote the fitted values.

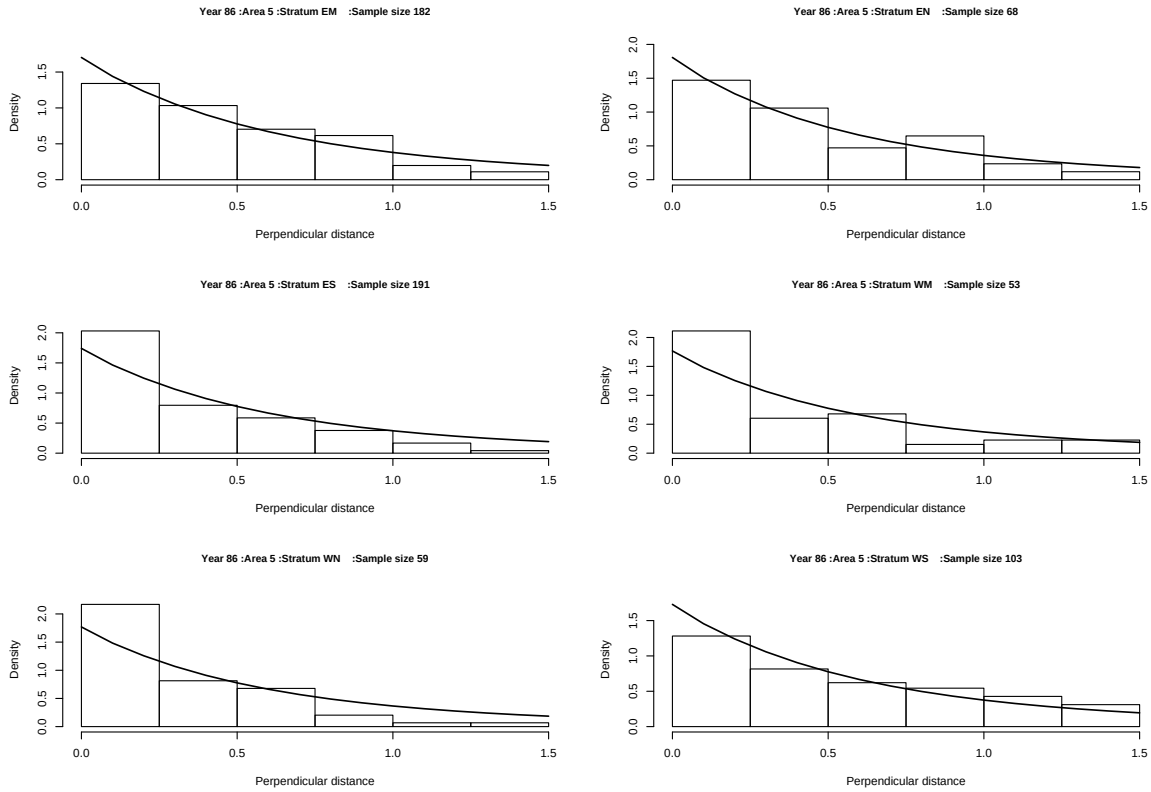


Figure 3. a) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1985/86. The histograms denote the observation and the solid lines denote the fitted values.

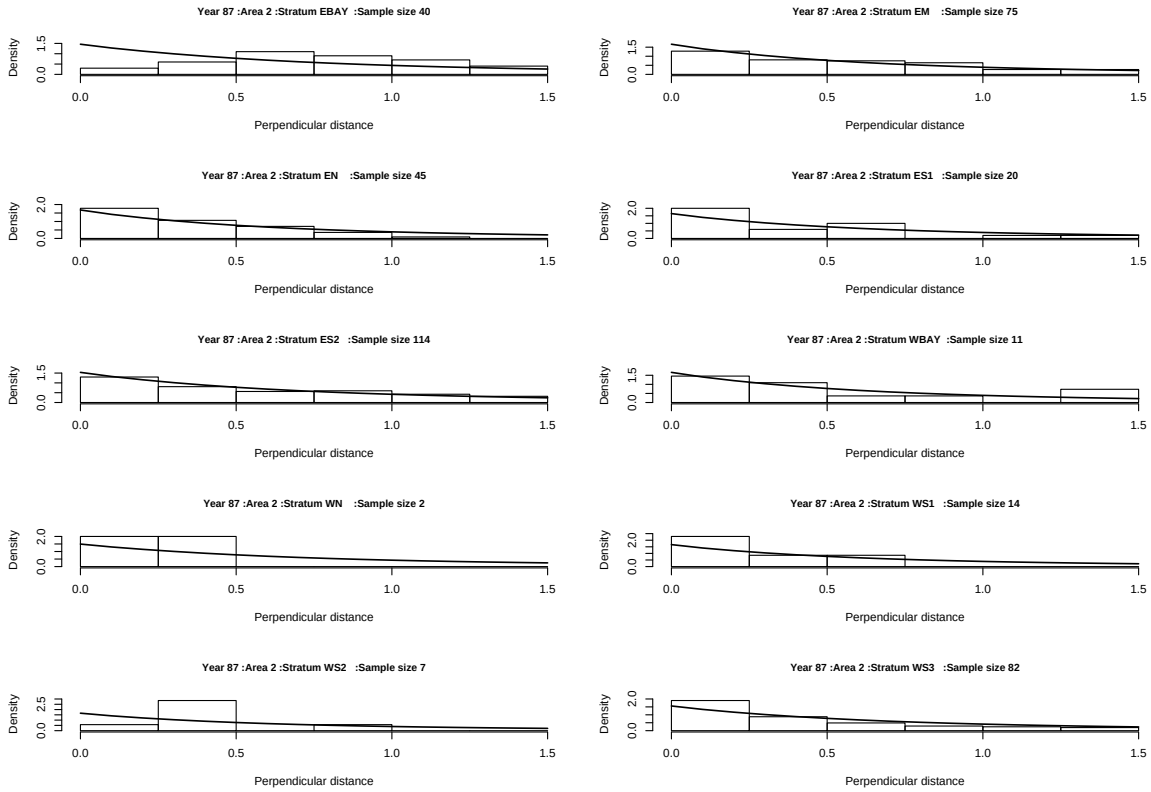


Figure 3. b) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1986/87. The histograms denote the observation and the solid lines denote the fitted values.

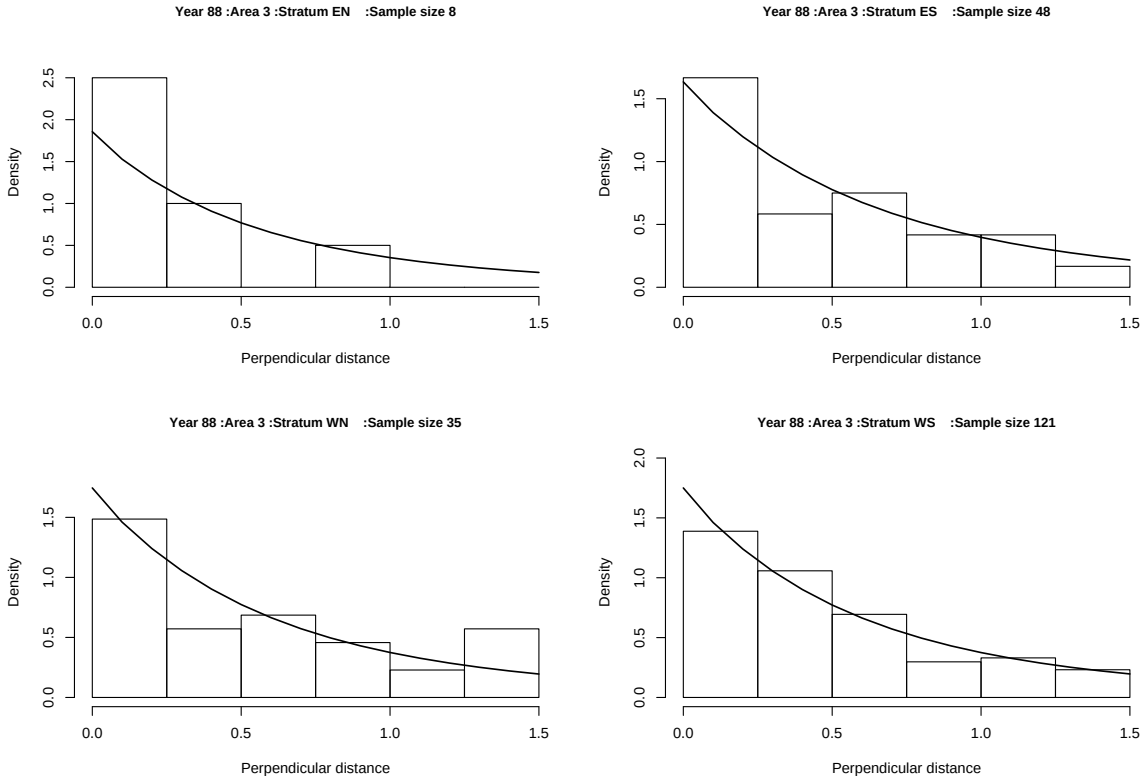


Figure 3. c) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1987/88. The histograms denote the observation and the solid lines denote the fitted values.

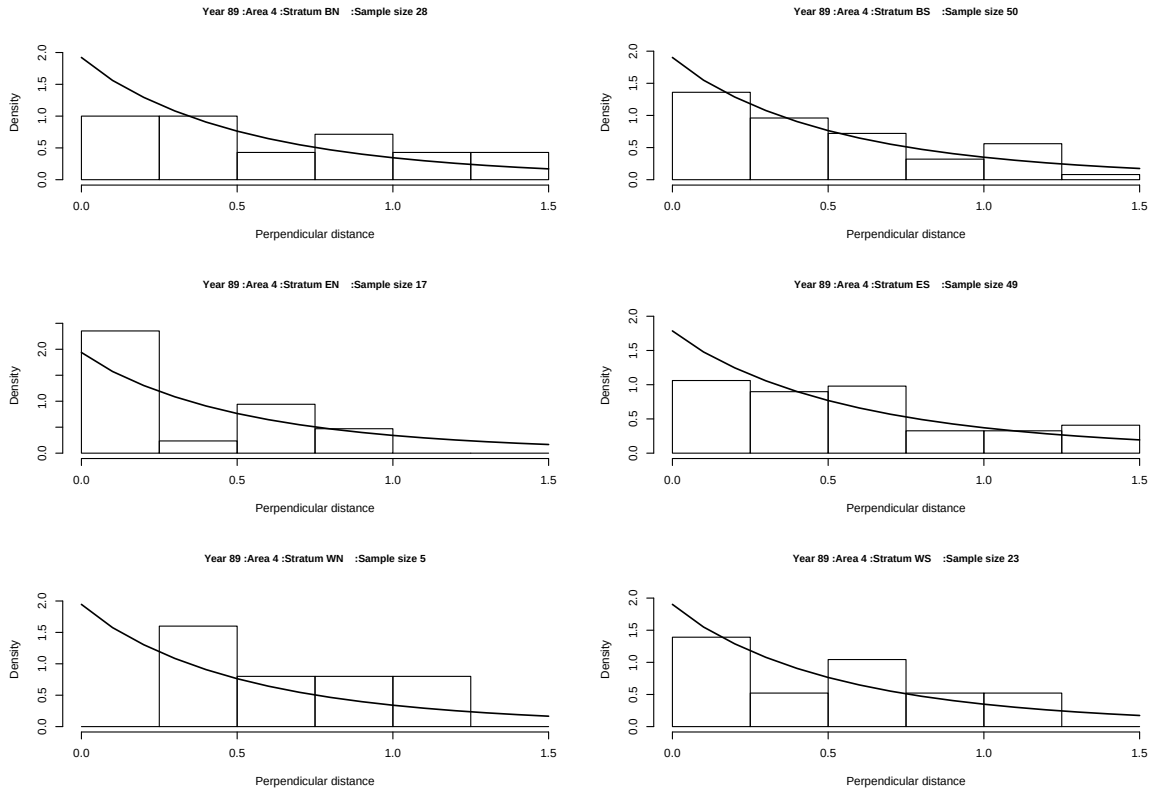


Figure 3. d) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1988/89. The histograms denote the observation and the solid lines denote the fitted values.

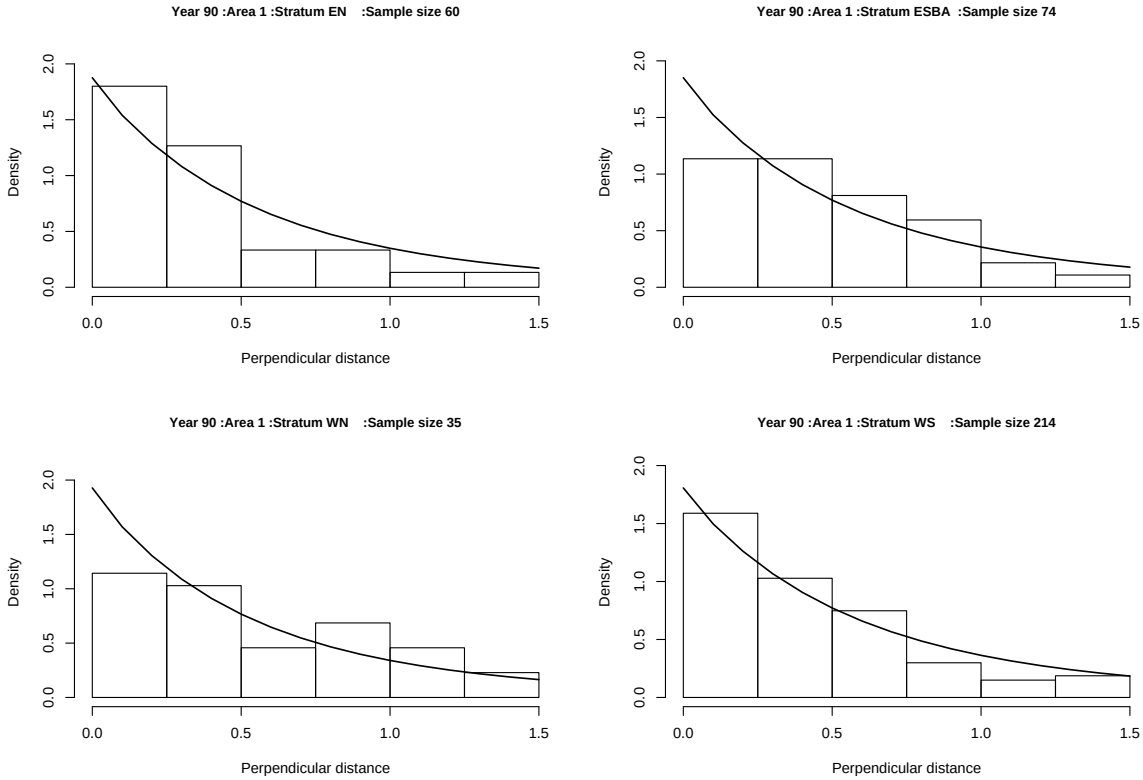


Figure 3. e) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1989/90. The histograms denote the observation and the solid lines denote the fitted values.

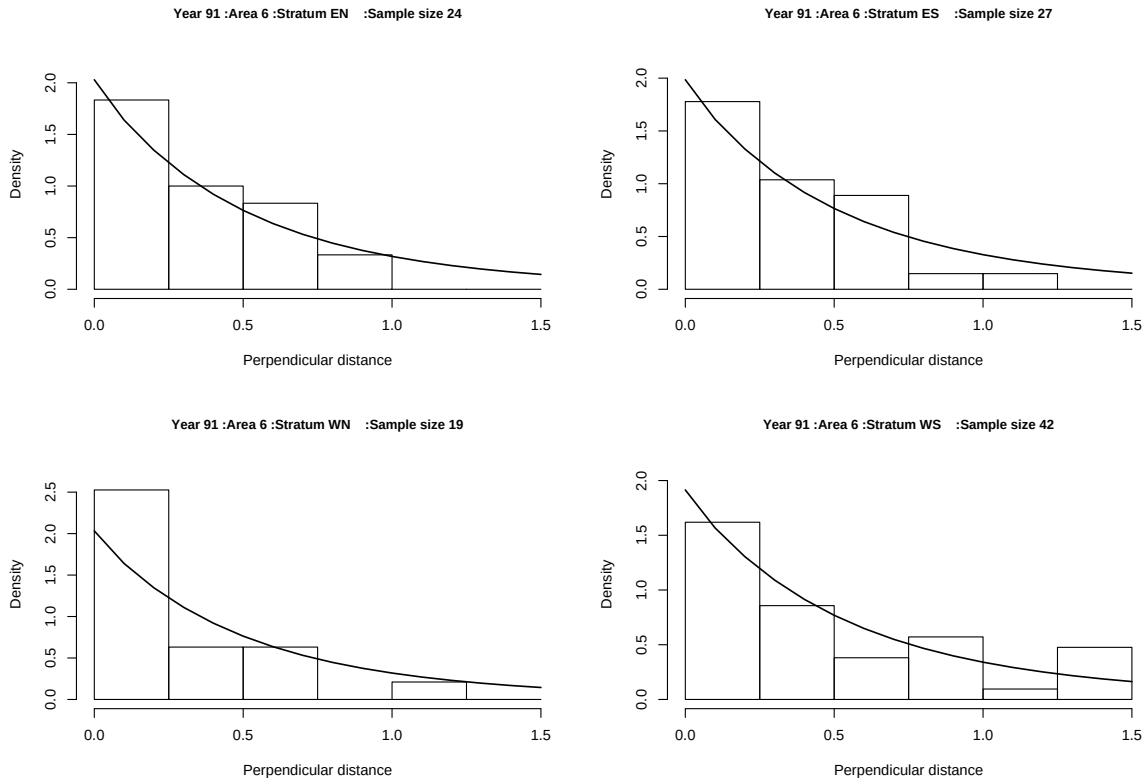


Figure 3. f) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1990/91. The histograms denote the observation and the solid lines denote the fitted values.

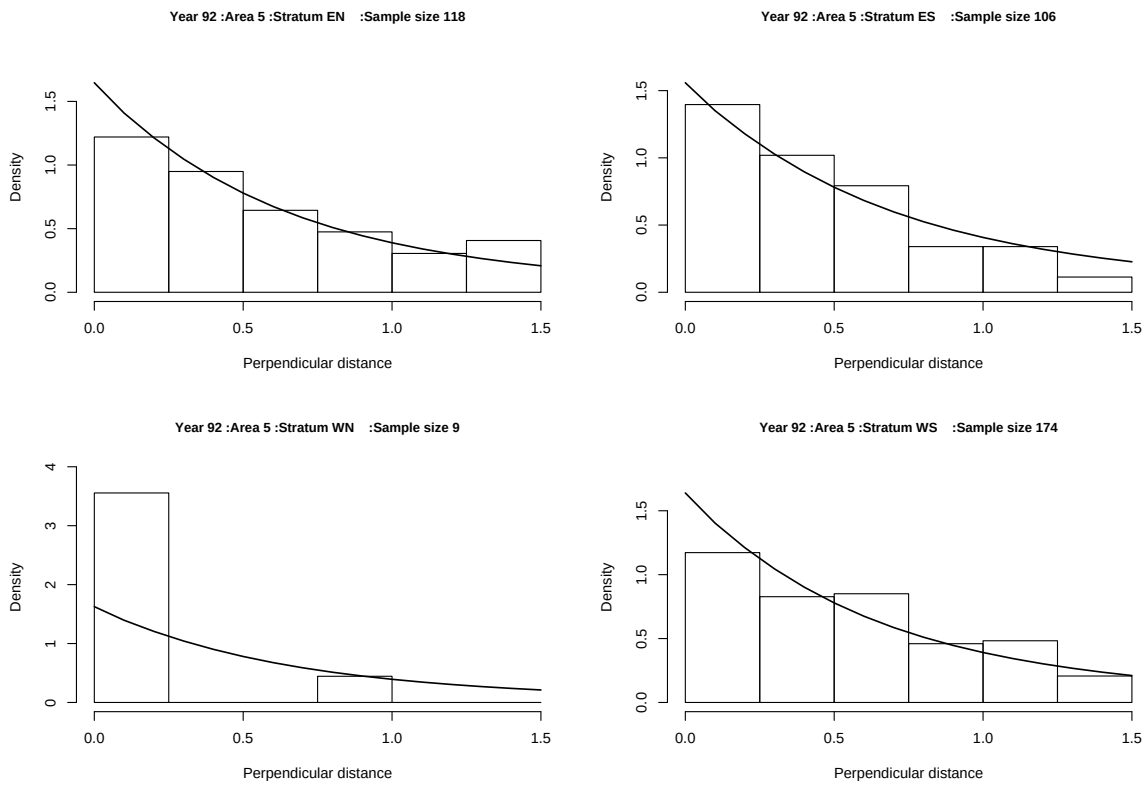


Figure 3. g) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1991/92. The histograms denote the observation and the solid lines denote the fitted values.

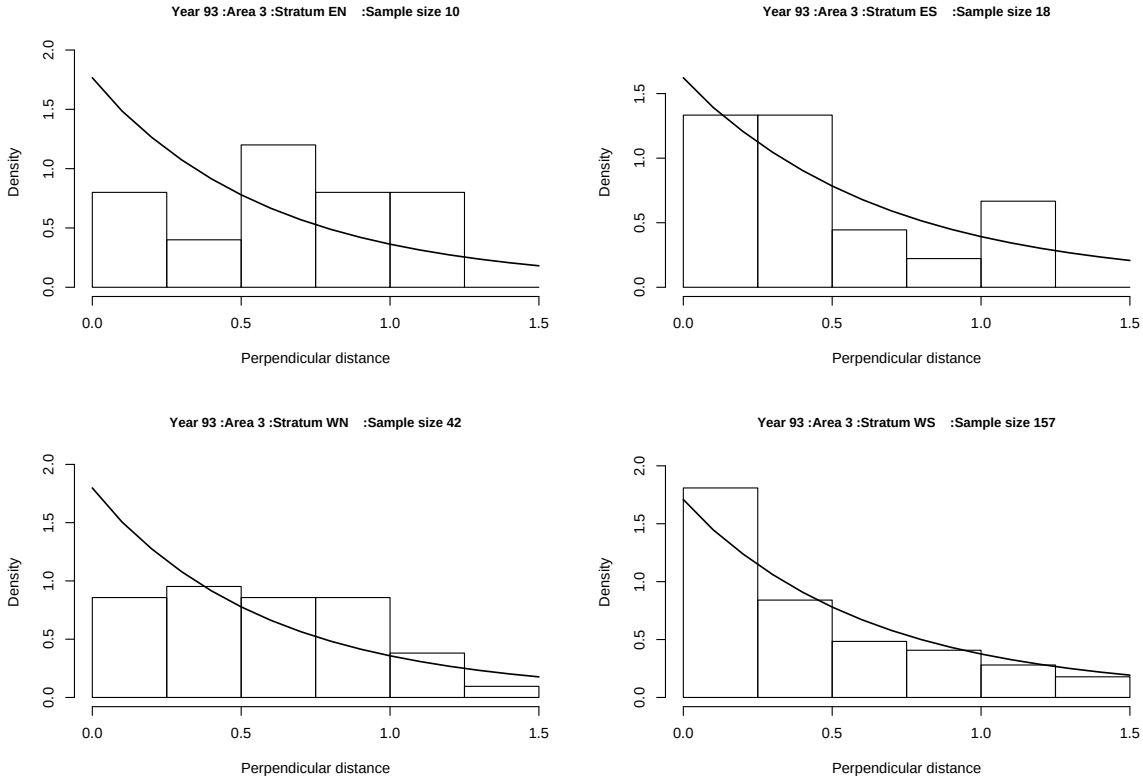
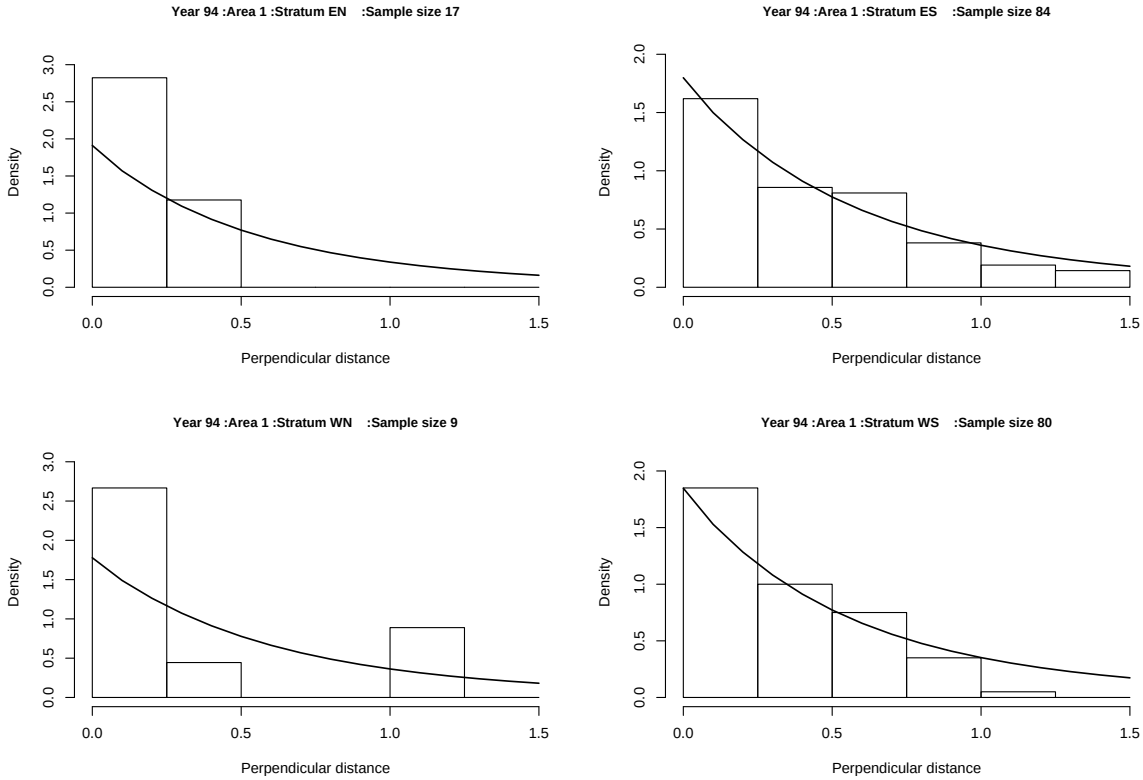


Figure 3. h) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1992/93. The histograms denote the observation and the solid lines denote the fitted values.



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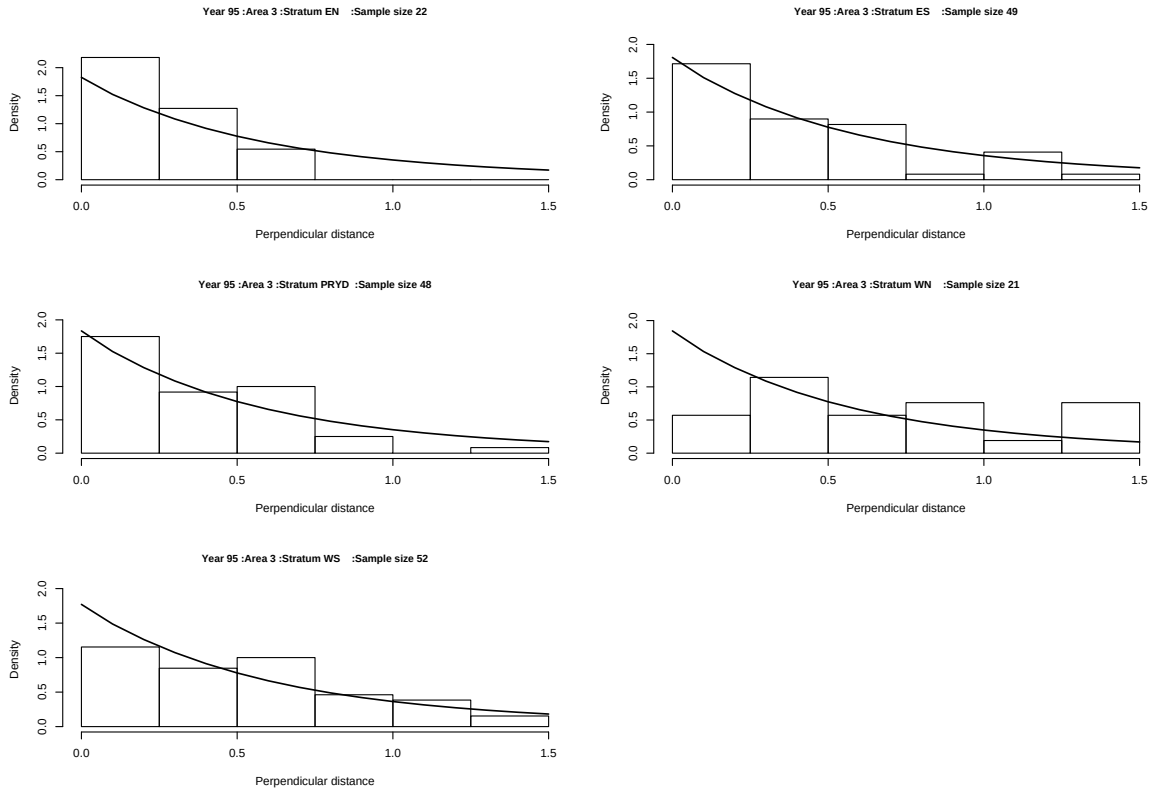


Figure 3. j) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1994/95. The histograms denote the observation and the solid lines denote the fitted values.

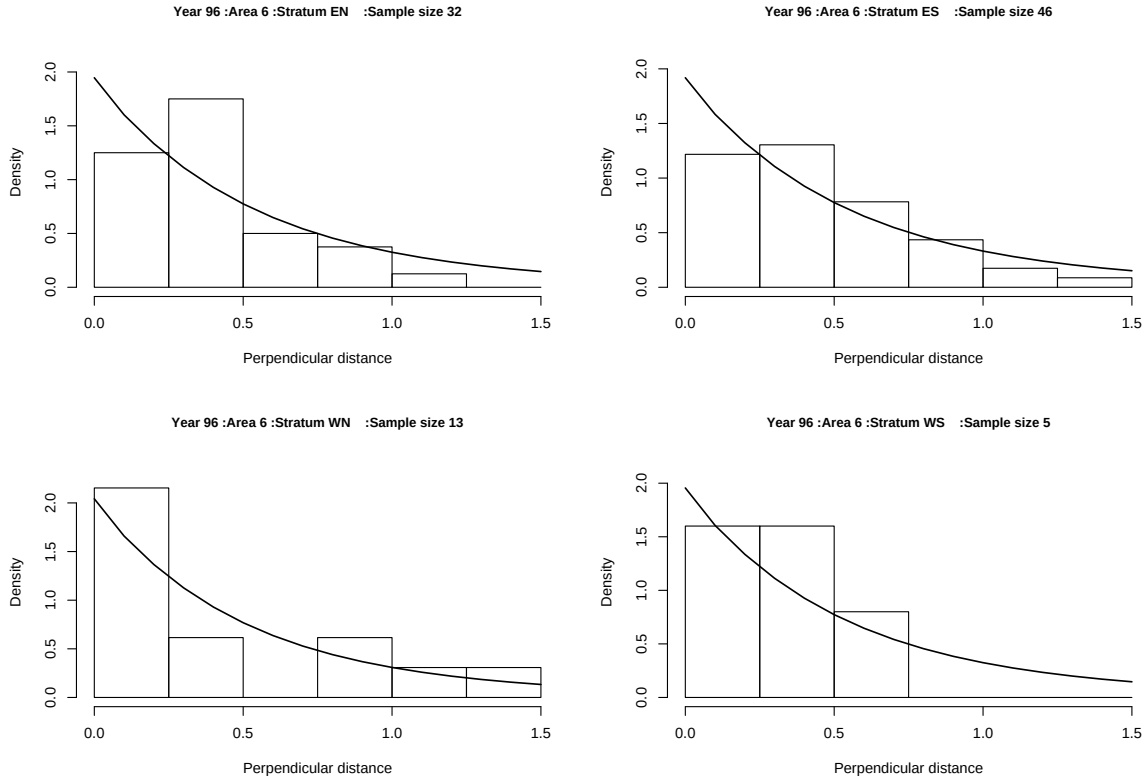


Figure 3. k) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1995/96. The histograms denote the observation and the solid lines denote the fitted values.

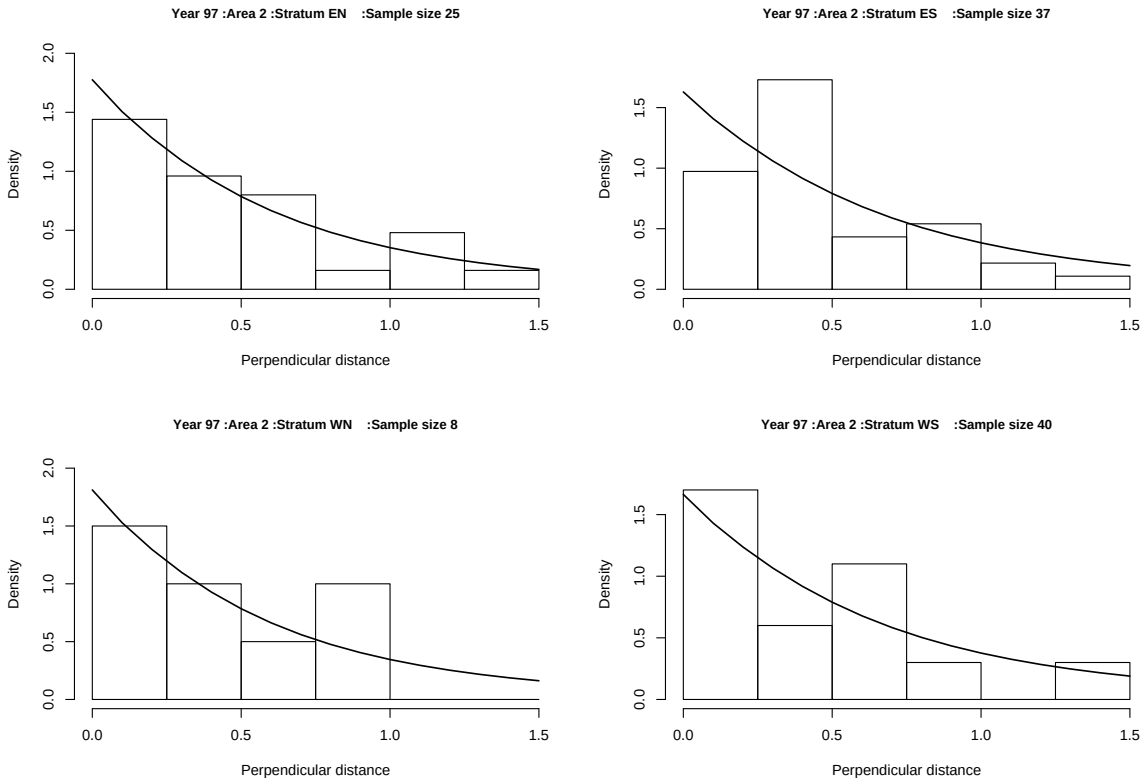


Figure 3. l) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1996/97. The histograms denote the observation and the solid lines denote the fitted values.

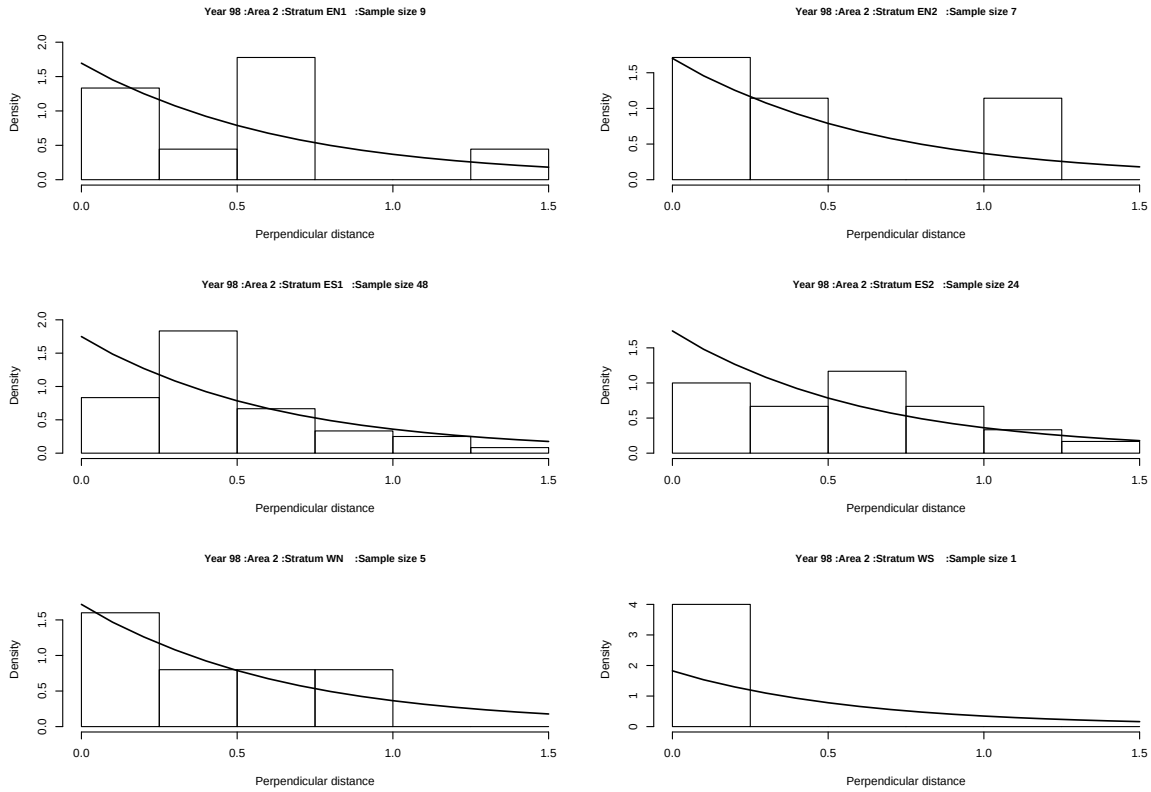


Figure 3. m) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1997/98. The histograms denote the observation and the solid lines denote the fitted values.

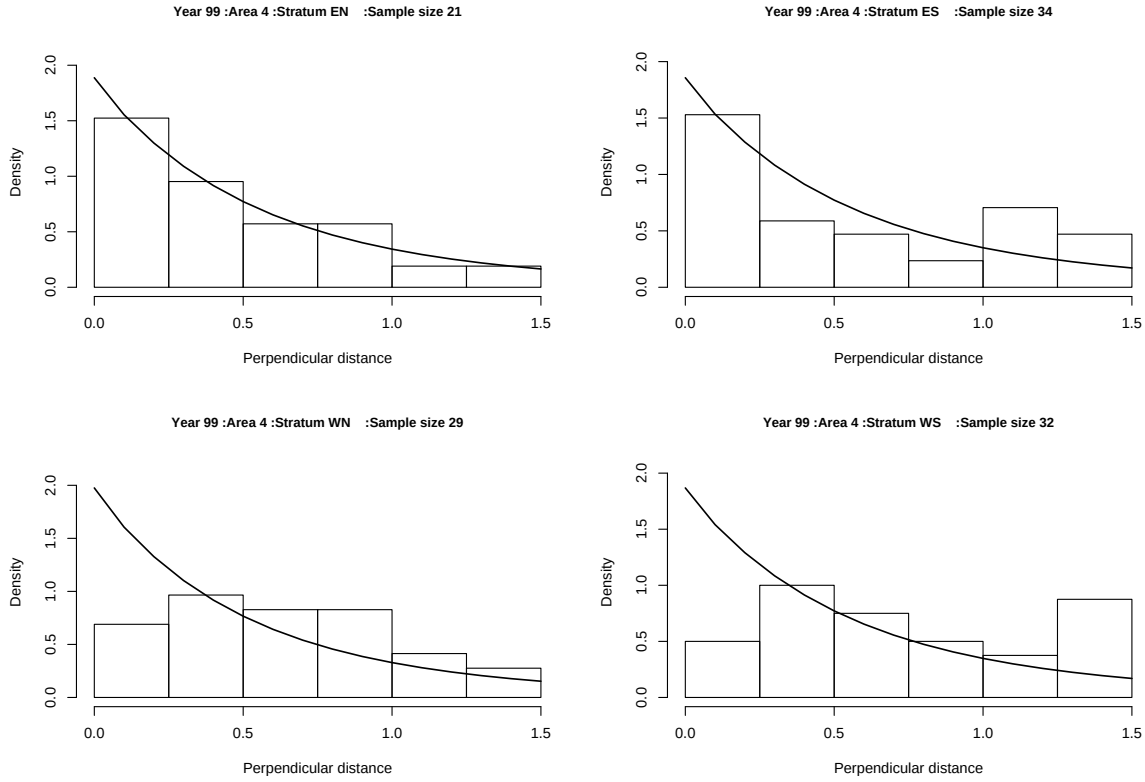


Figure 3. n) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1998/99. The histograms denote the observation and the solid lines denote the fitted values.

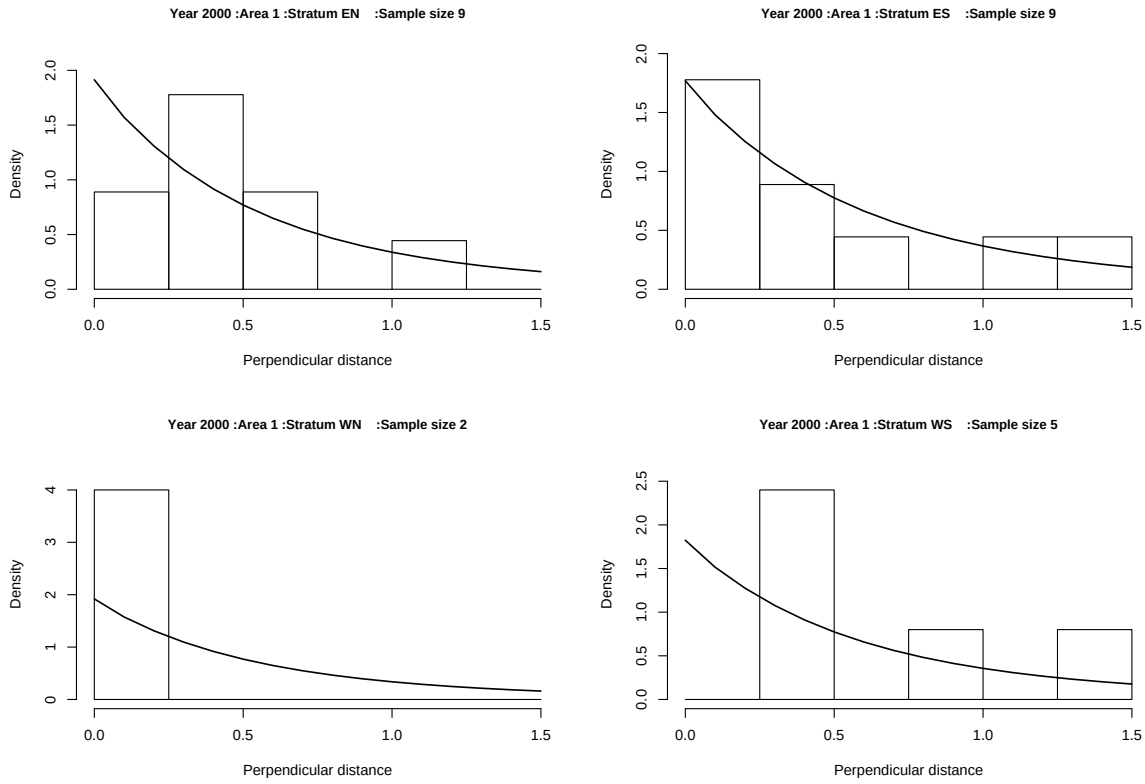


Figure 3. o) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 1999/2000. The histograms denote the observation and the solid lines denote the fitted values.

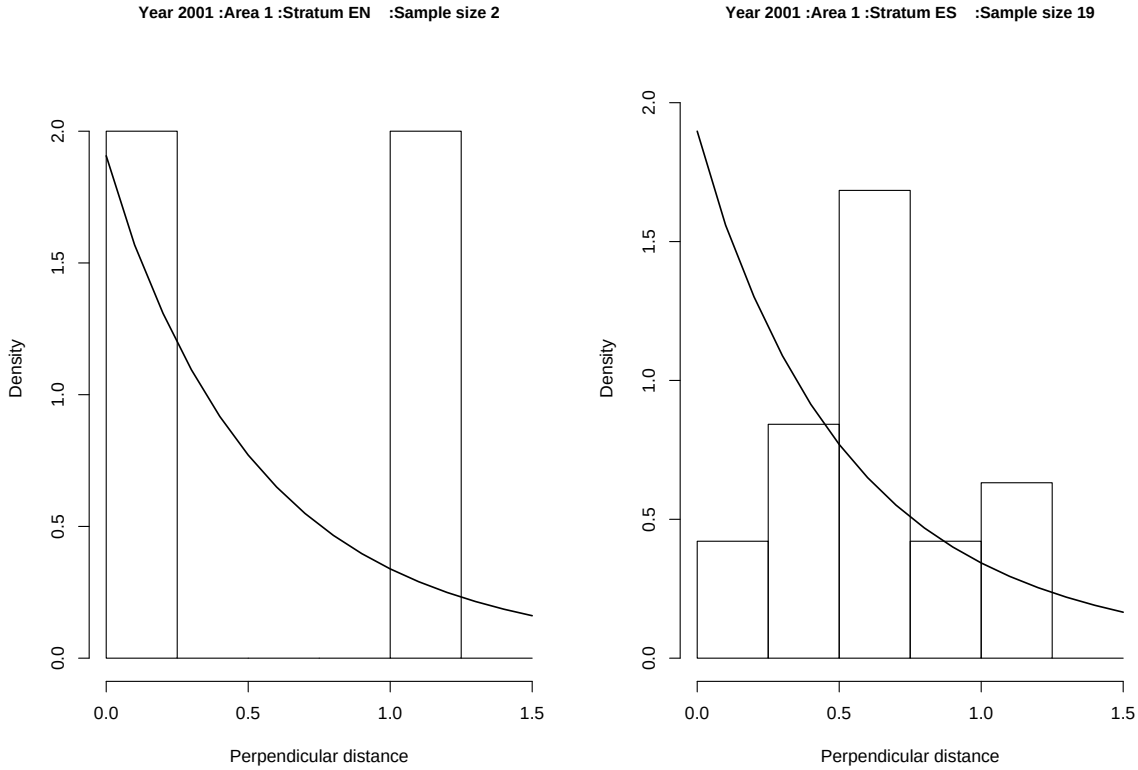


Figure 3. p) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 2000/01 (Area I). The histograms denote the observation and the solid lines denote the fitted values.

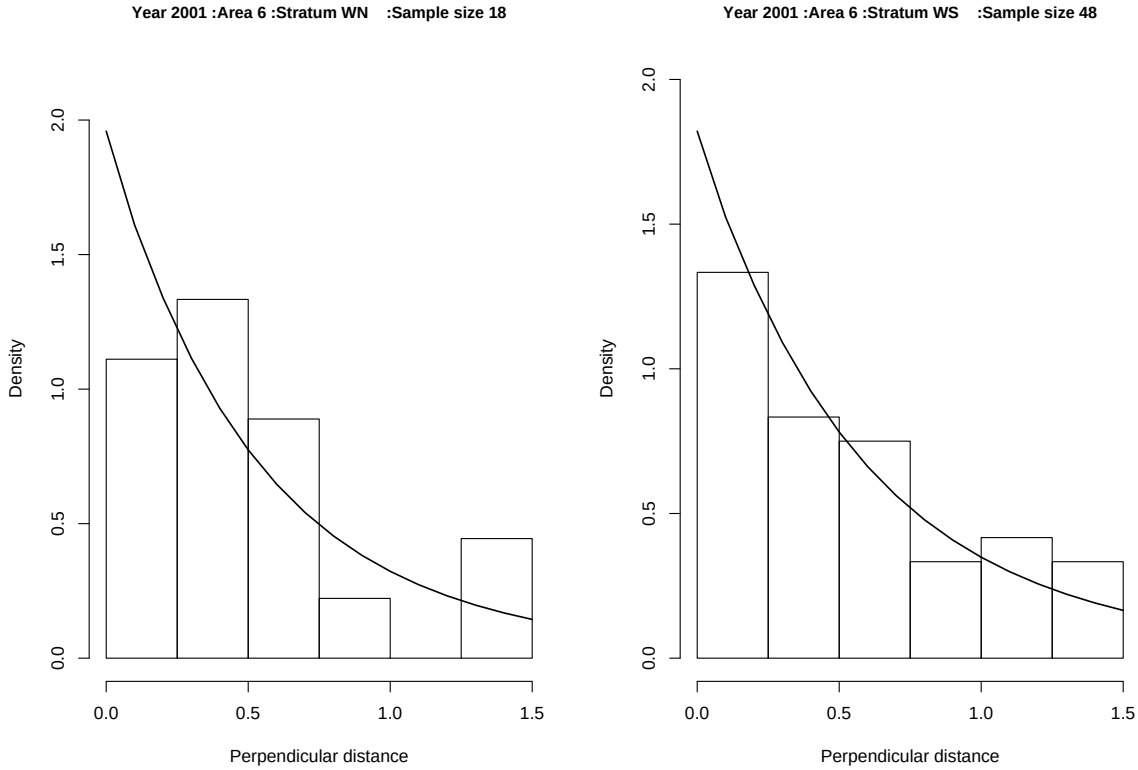


Figure 3. q) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 2000/01 (Area VI). The histograms denote the observation and the solid lines denote the fitted values.

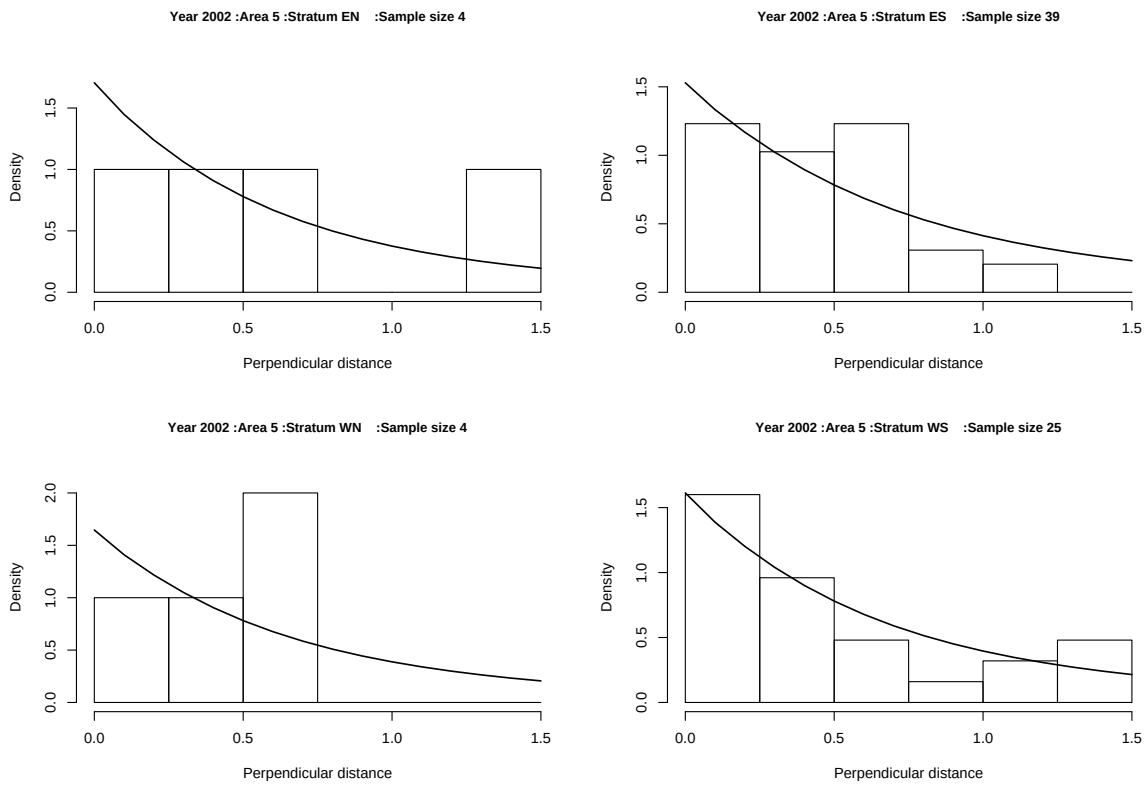


Figure 3. r) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 2001/02. The histograms denote the observation and the solid lines denote the fitted values.

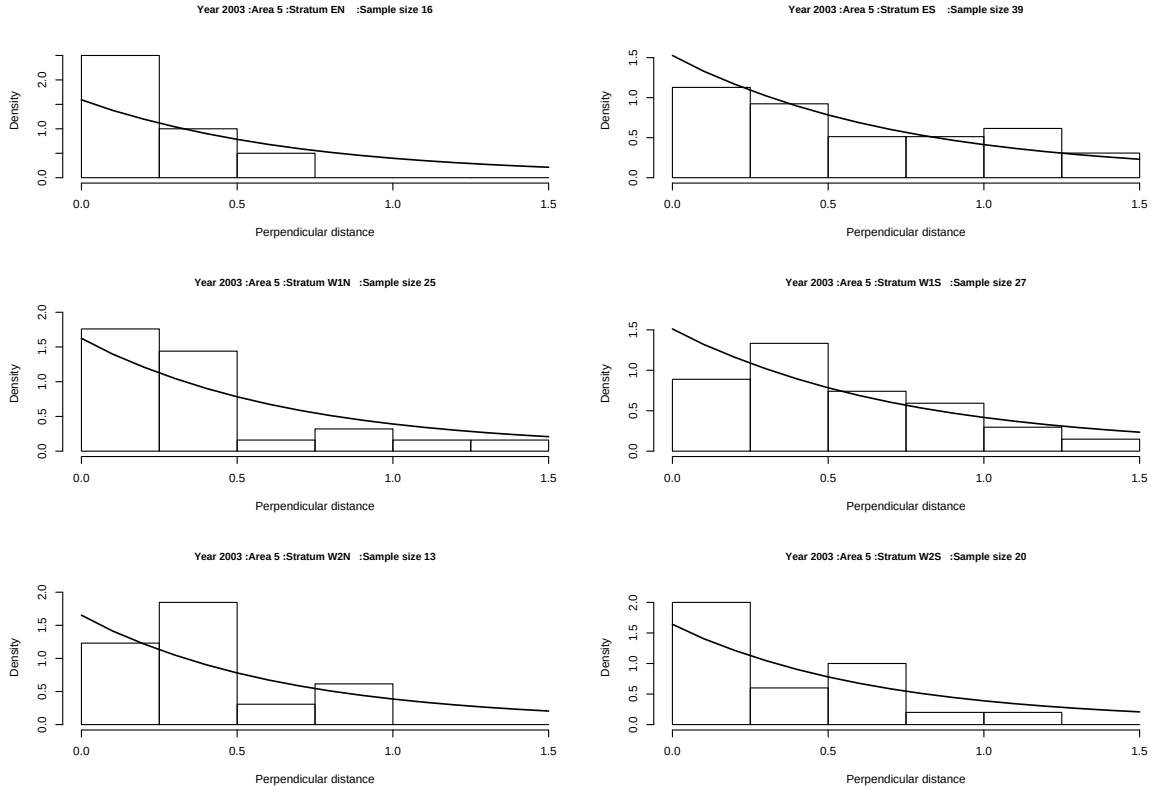


Figure 3. s) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 2002/03. The histograms denote the observation and the solid lines denote the fitted values.

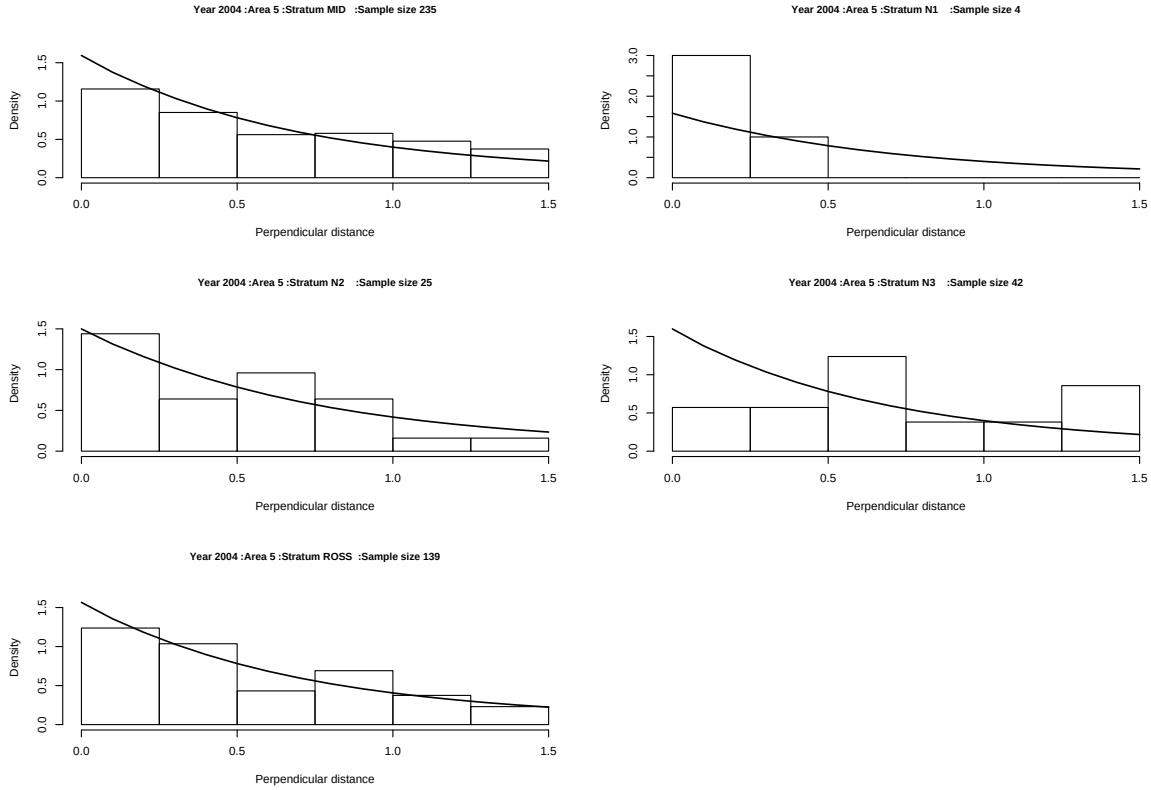


Figure 3. t) The plots of perpendicular distances (n.miles) in the Passing mode by survey stratum in 2003/04. The histograms denote the observation and the solid lines denote the fitted values.

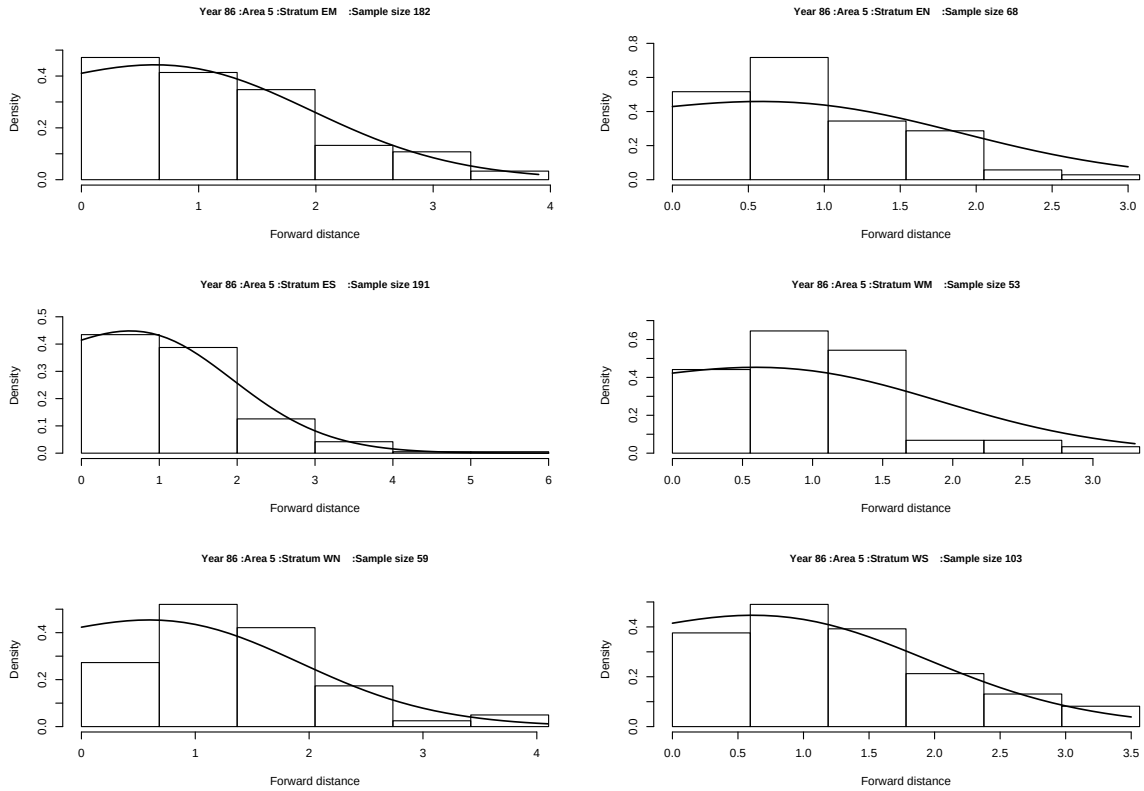
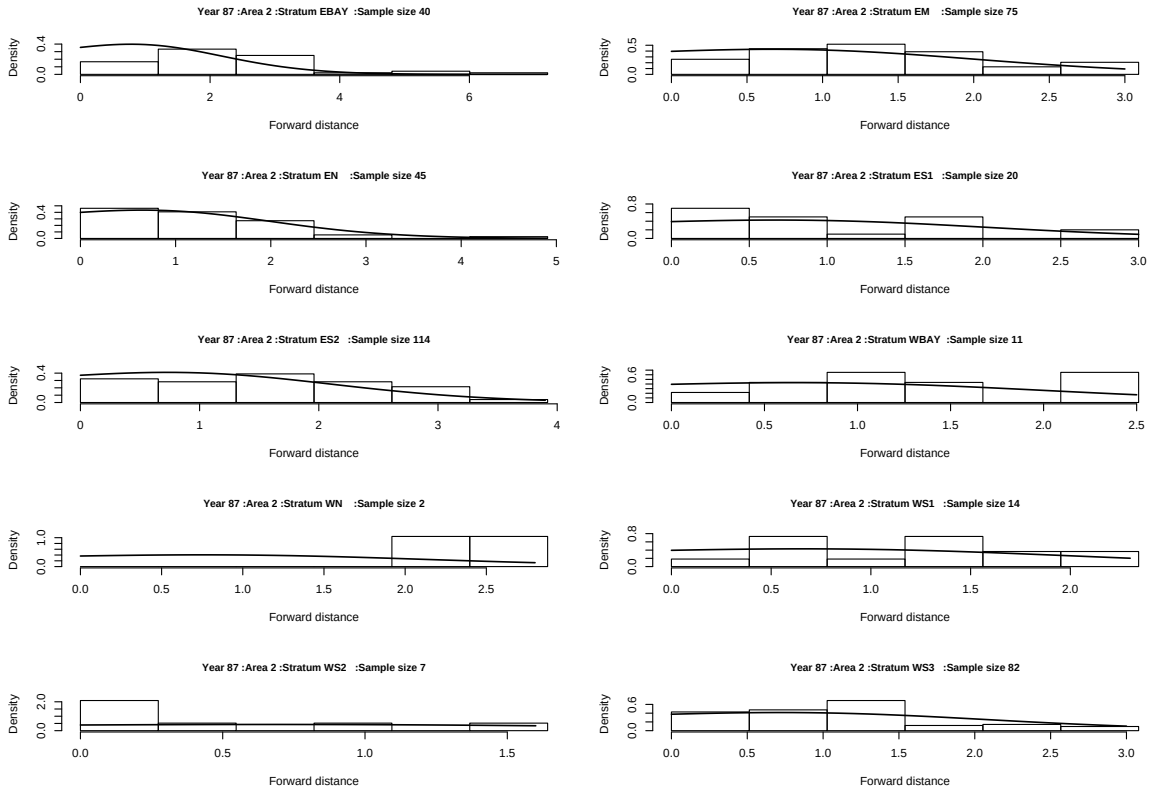


Figure 4. a) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 1985/86. The histograms denote the observation and the solid lines denote the fitted values.



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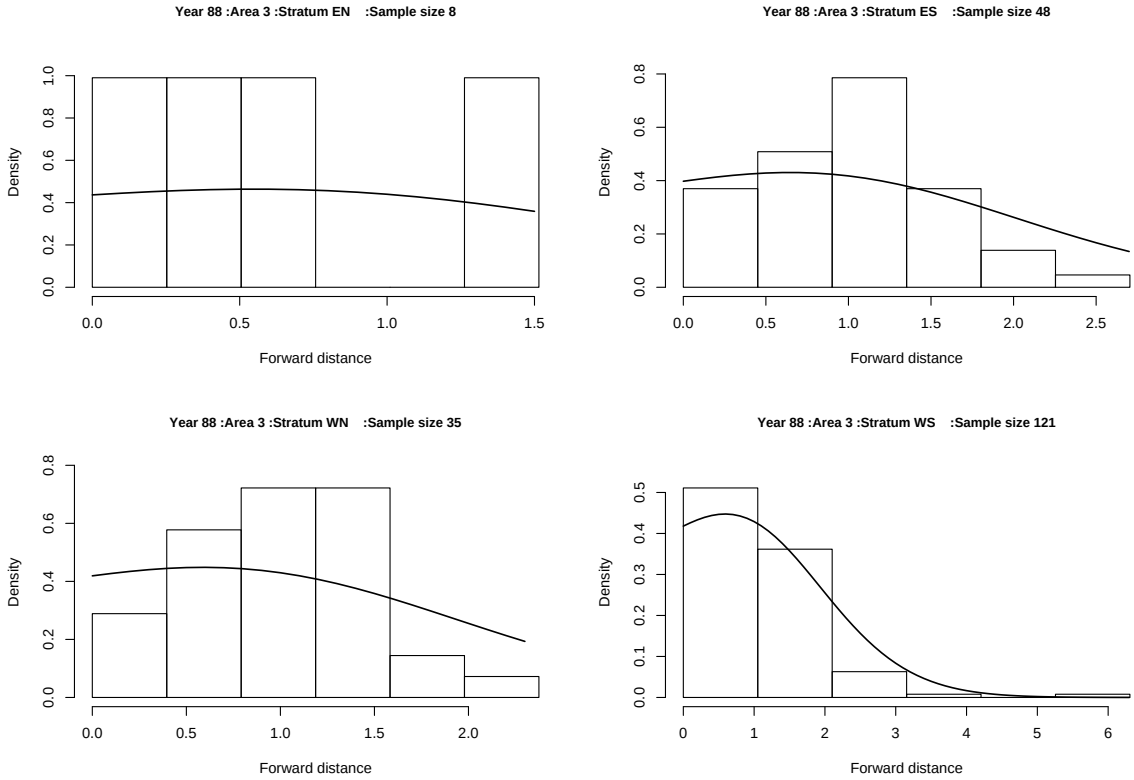

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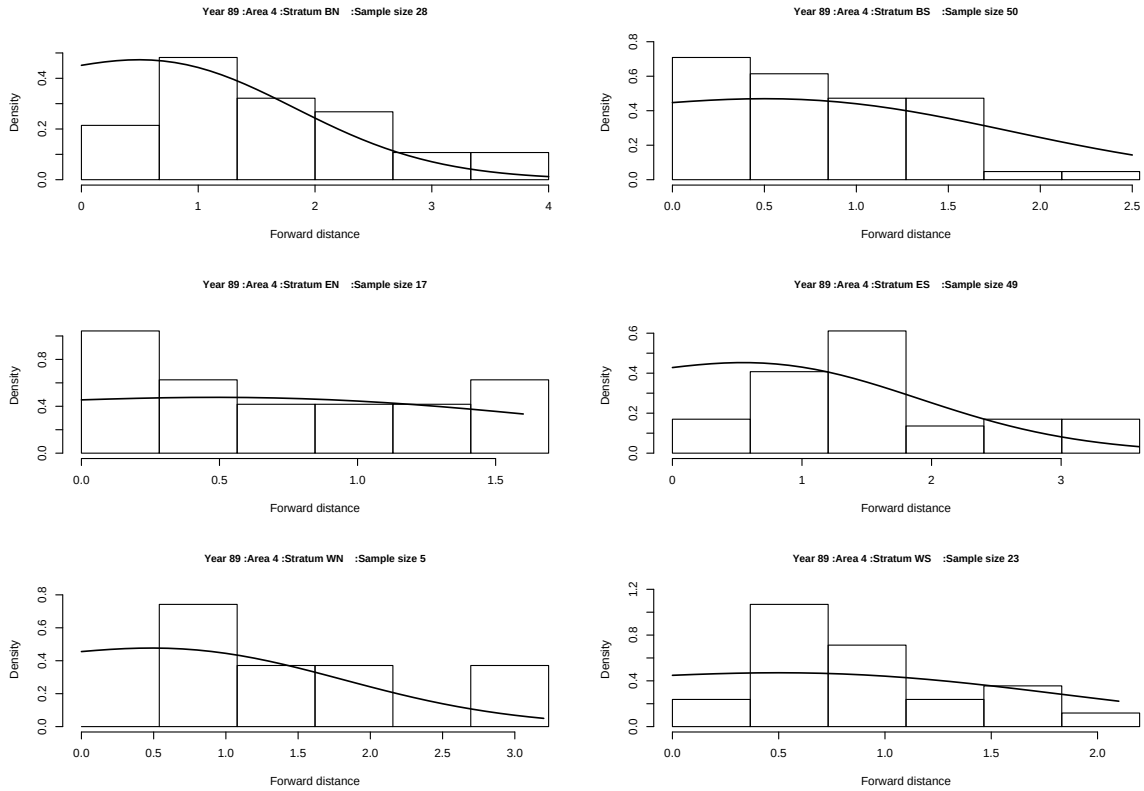

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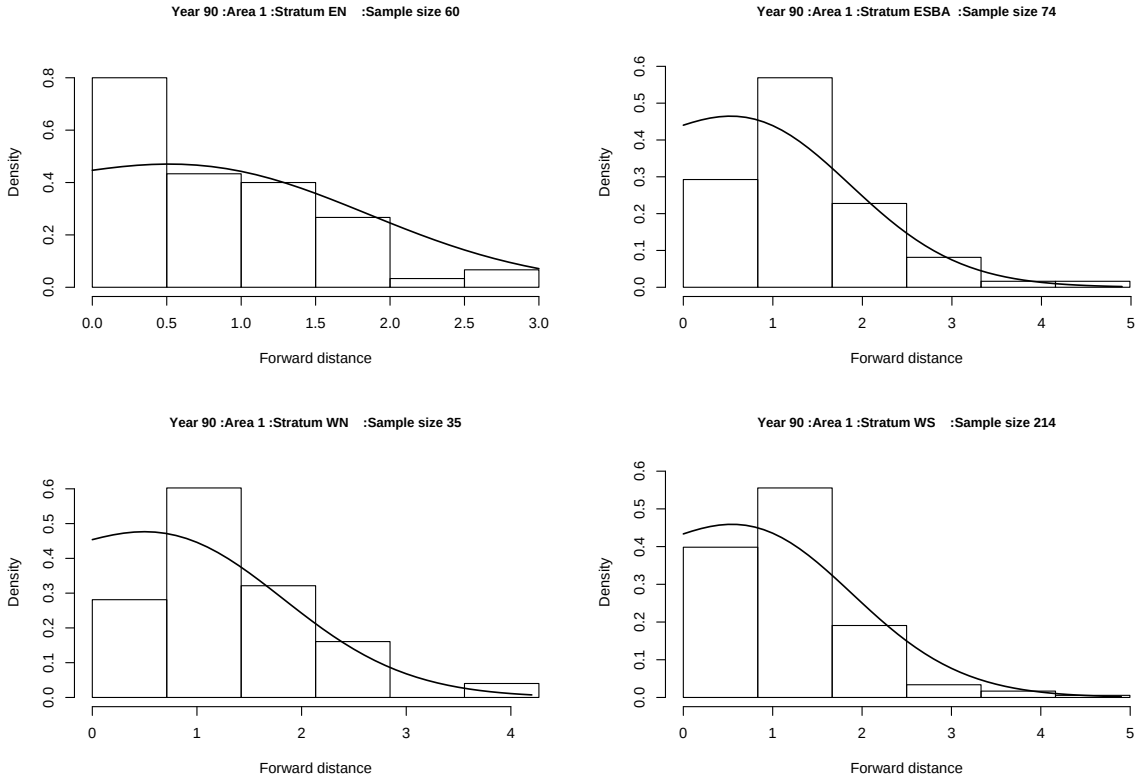

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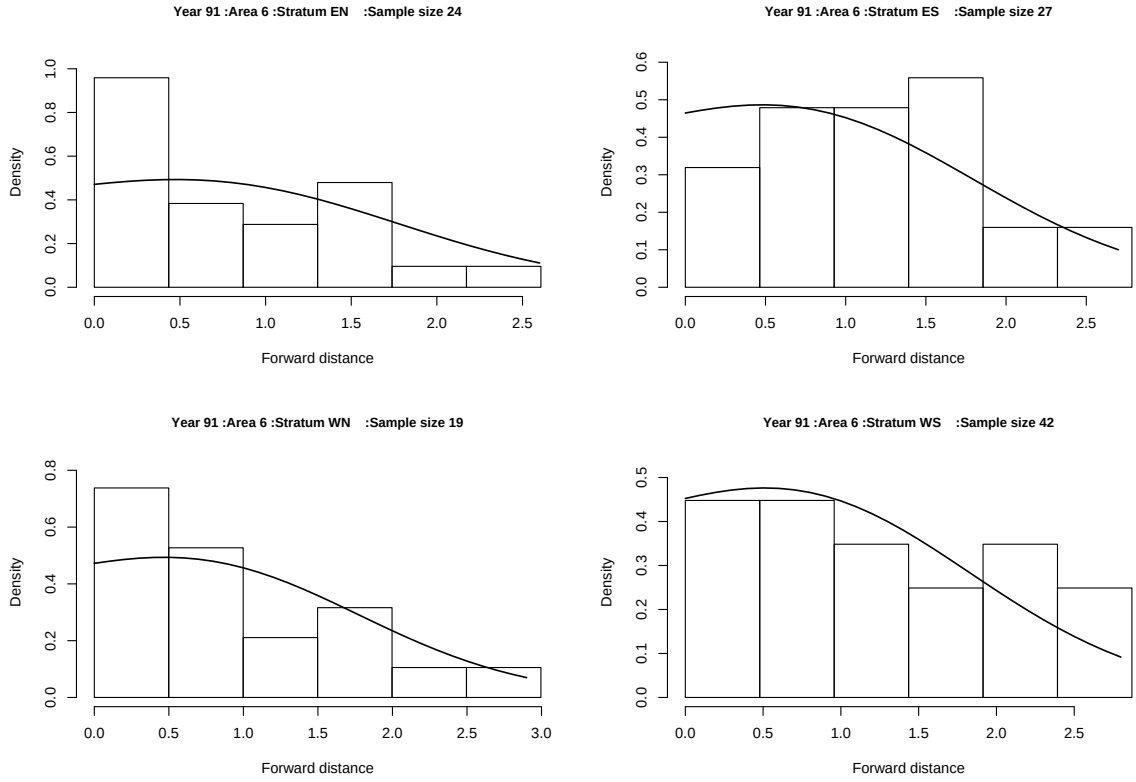

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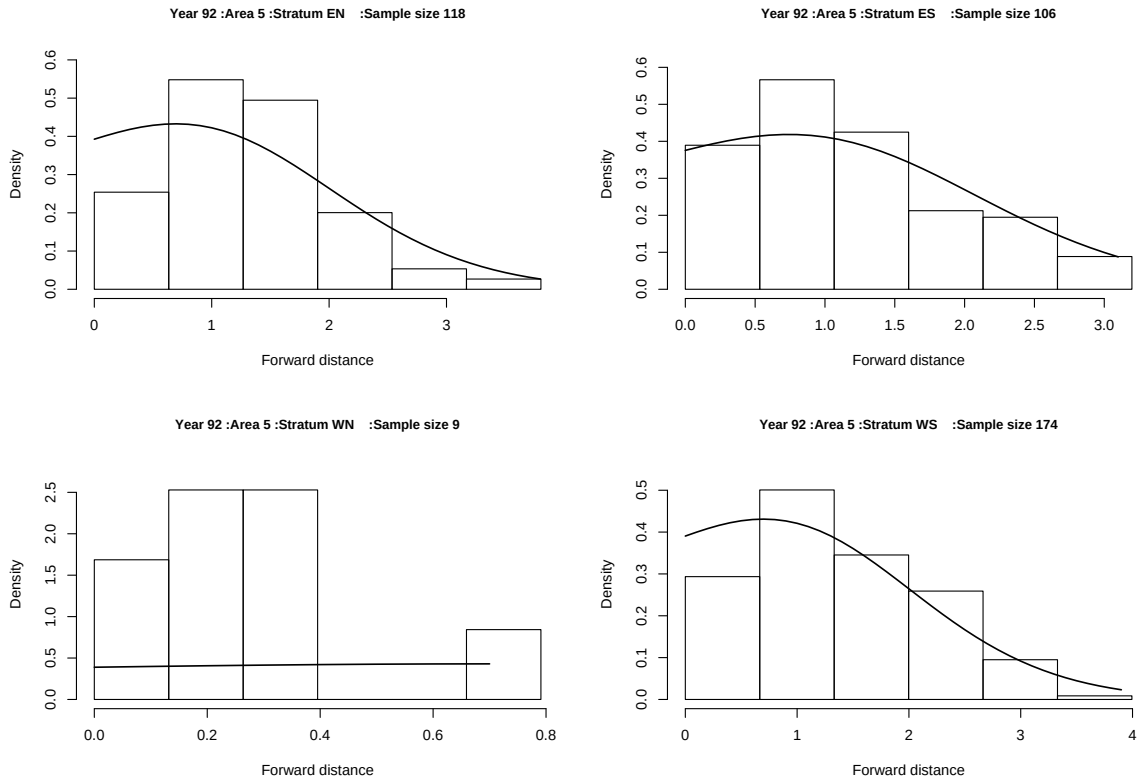

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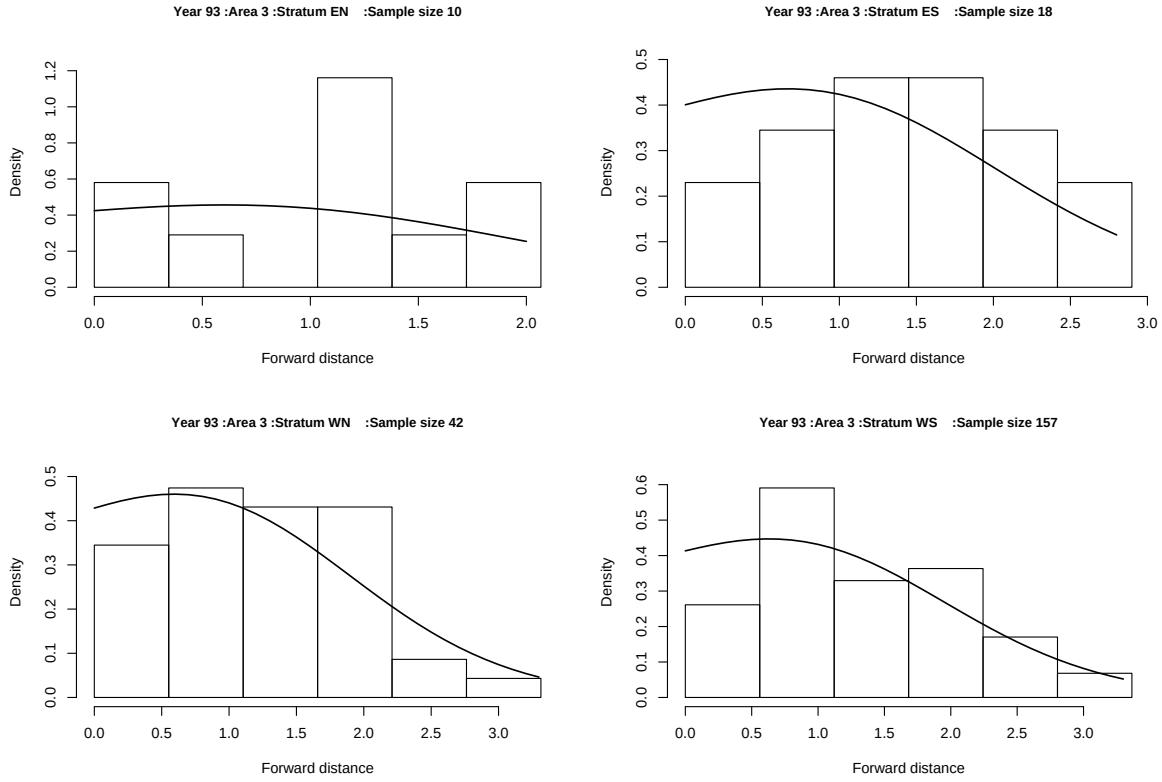

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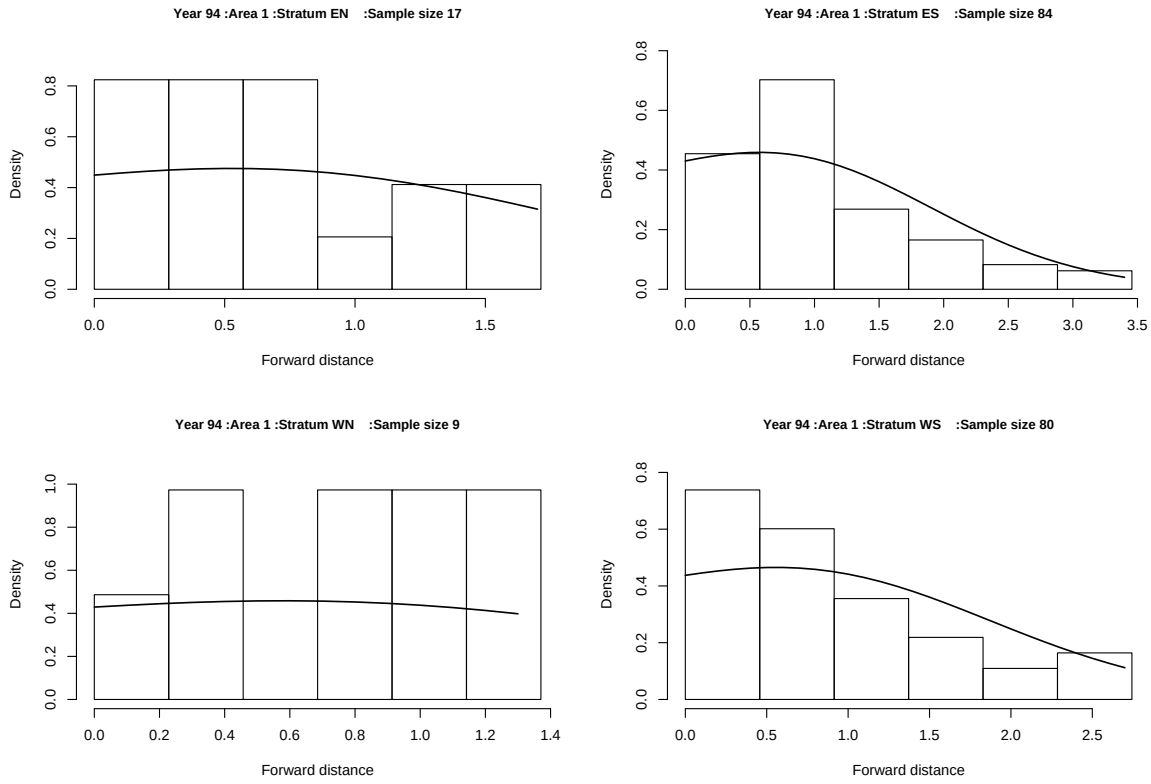

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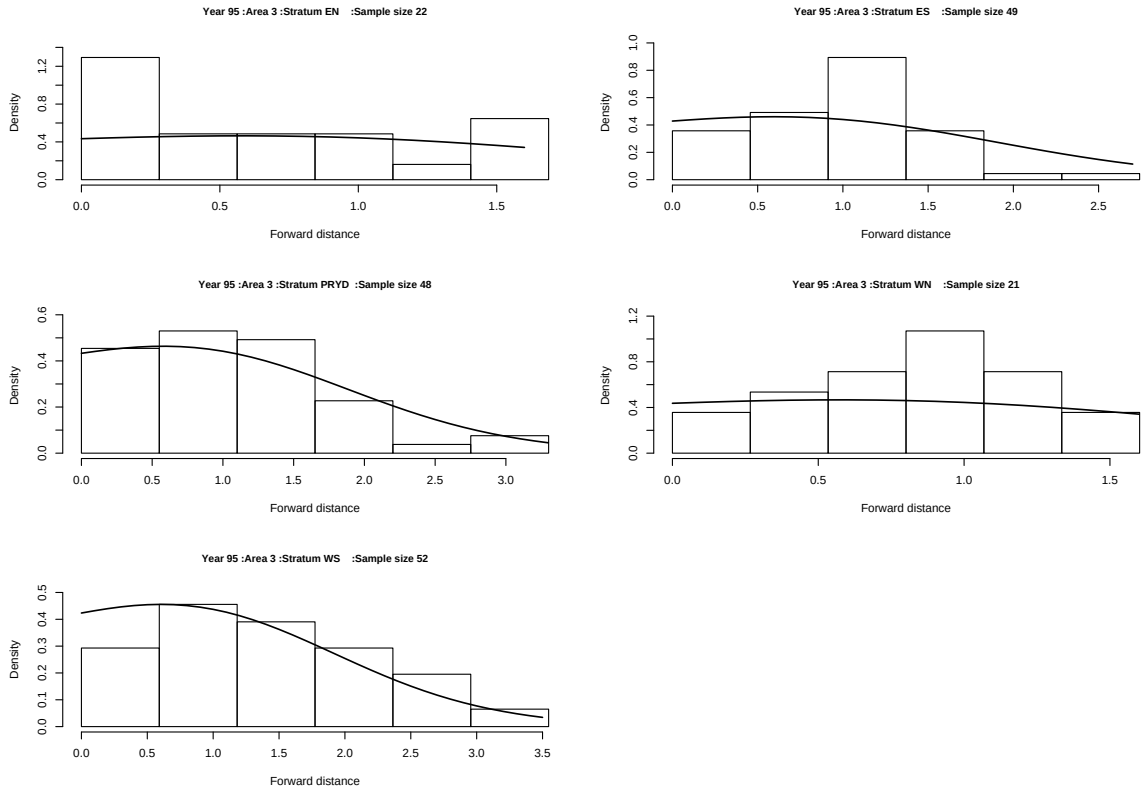

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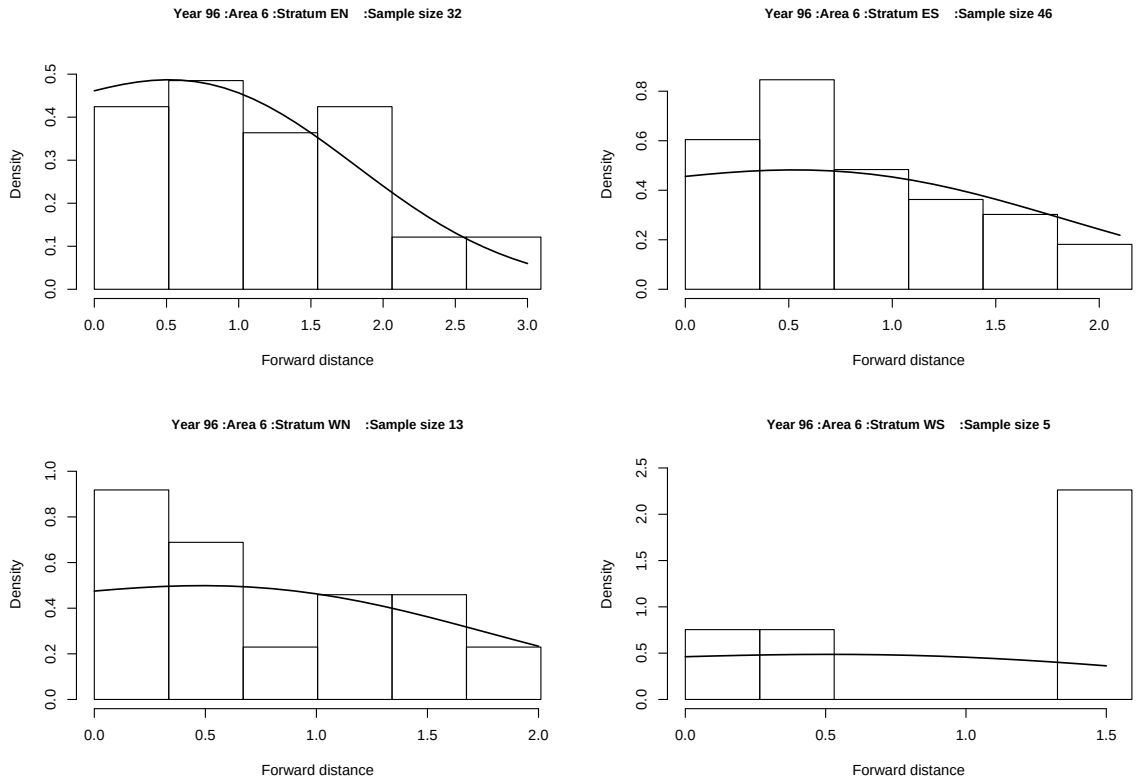

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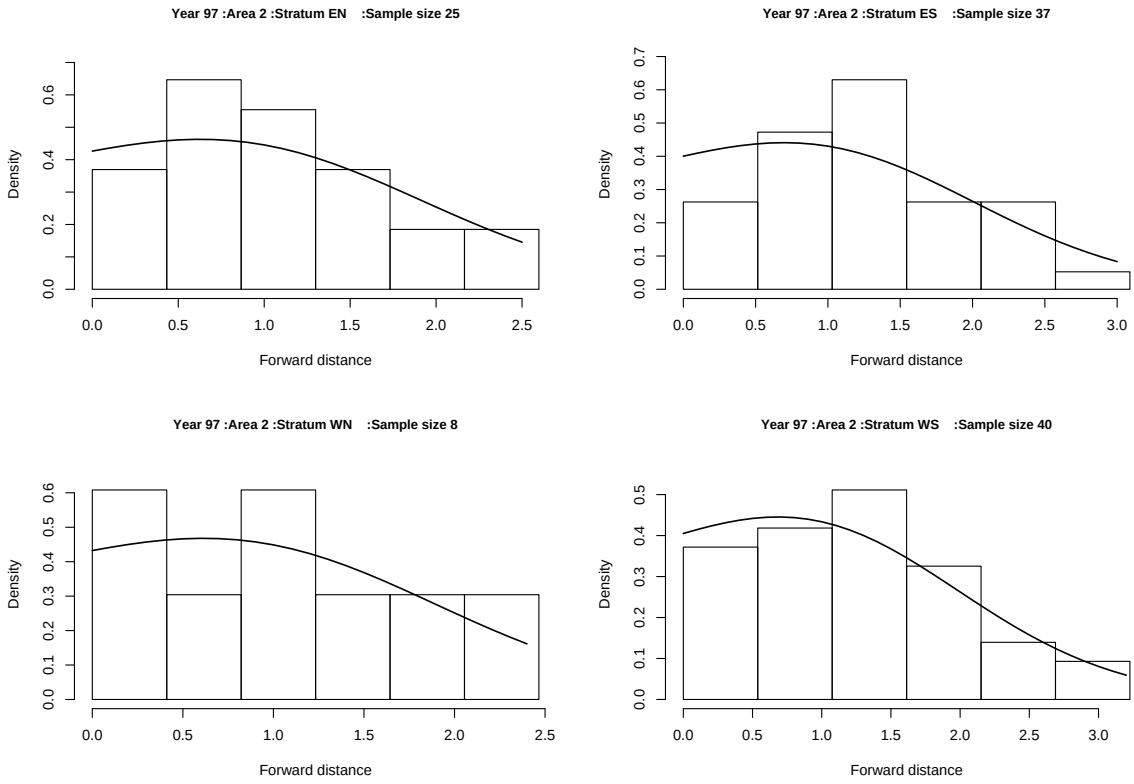

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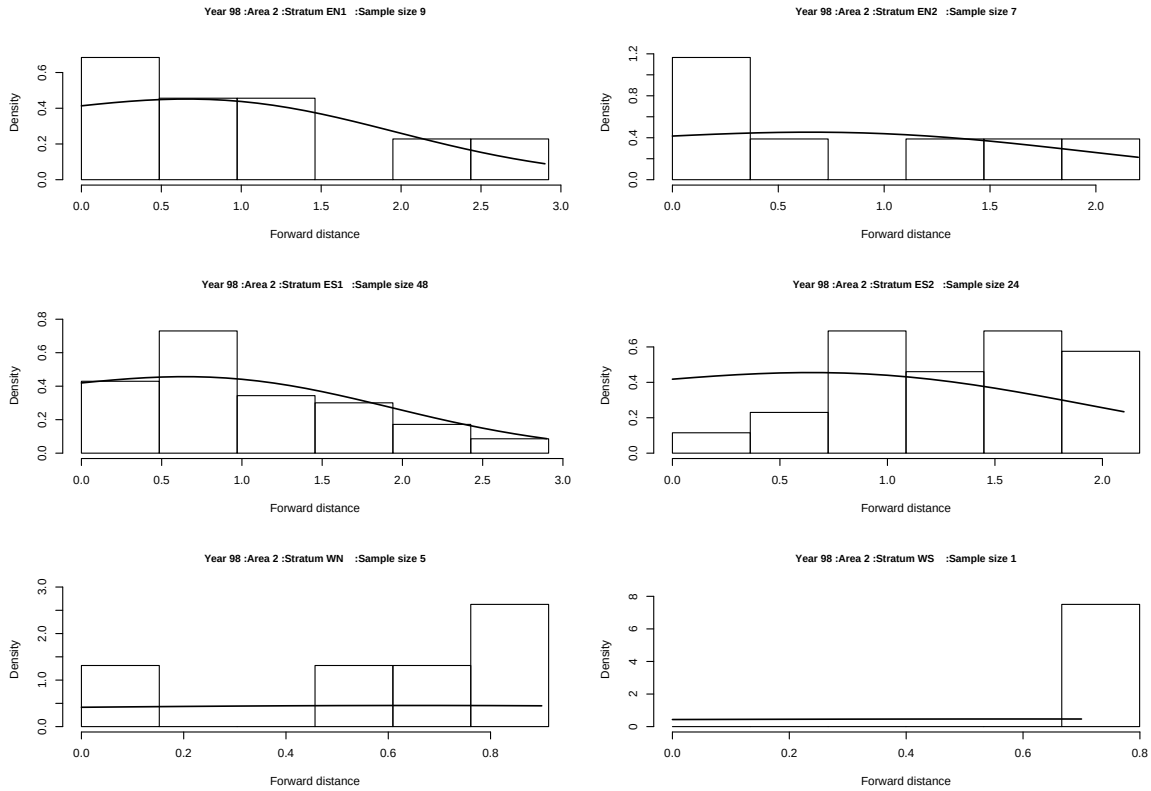

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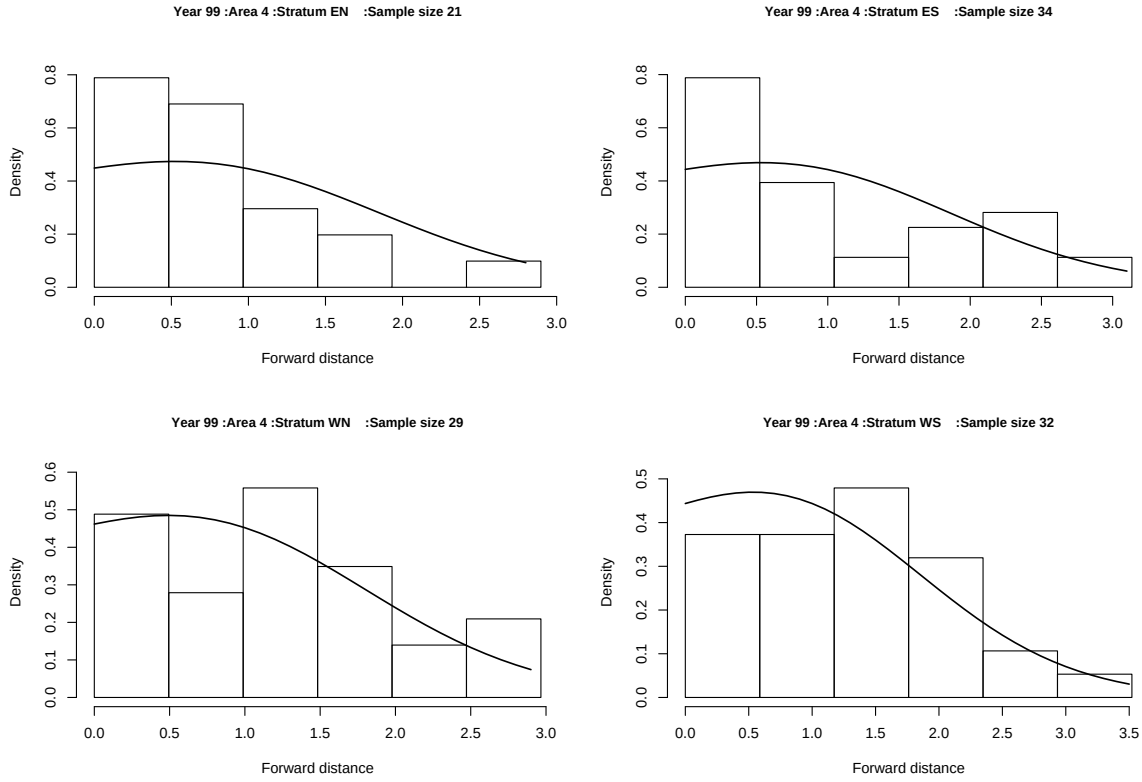

Figure 4. n) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 1998/99. The histograms denote the observation and the solid lines denote the fitted values.

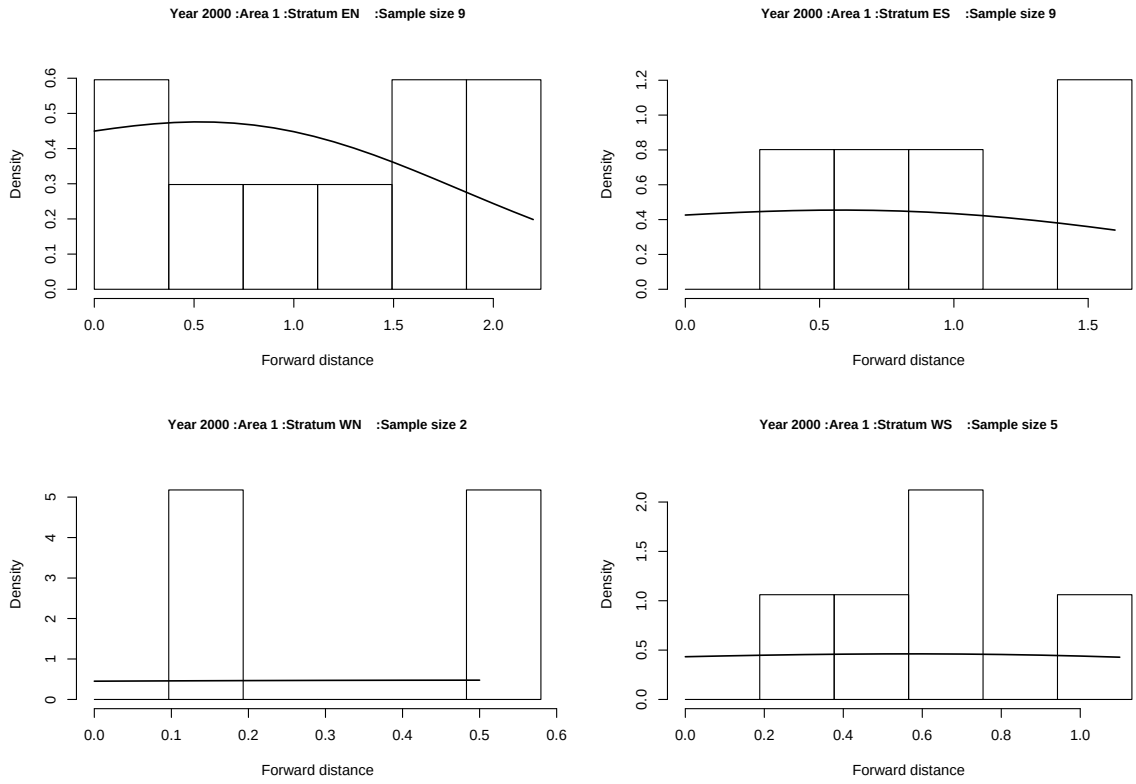

Figure 4. o) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 1999/2000. The histograms denote the observation and the solid lines denote the fitted values.

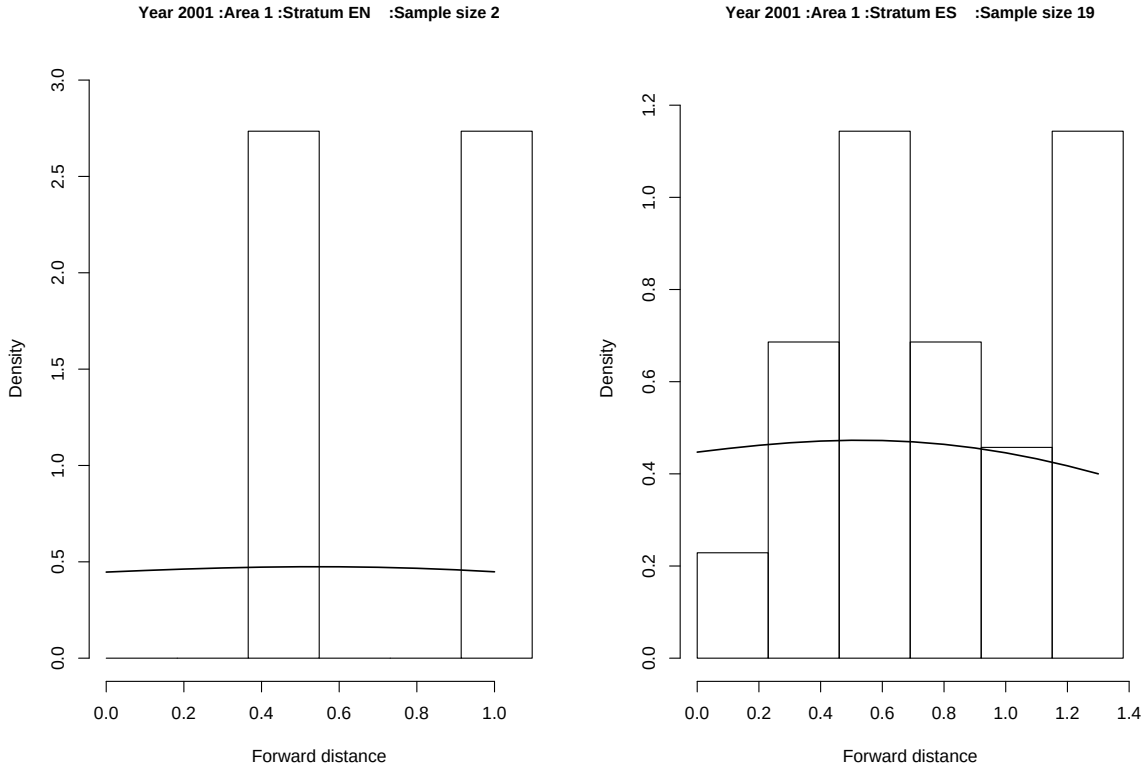

Figure 4. p) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 2000/01 (Area I). The histograms denote the observation and the solid lines denote the fitted values.

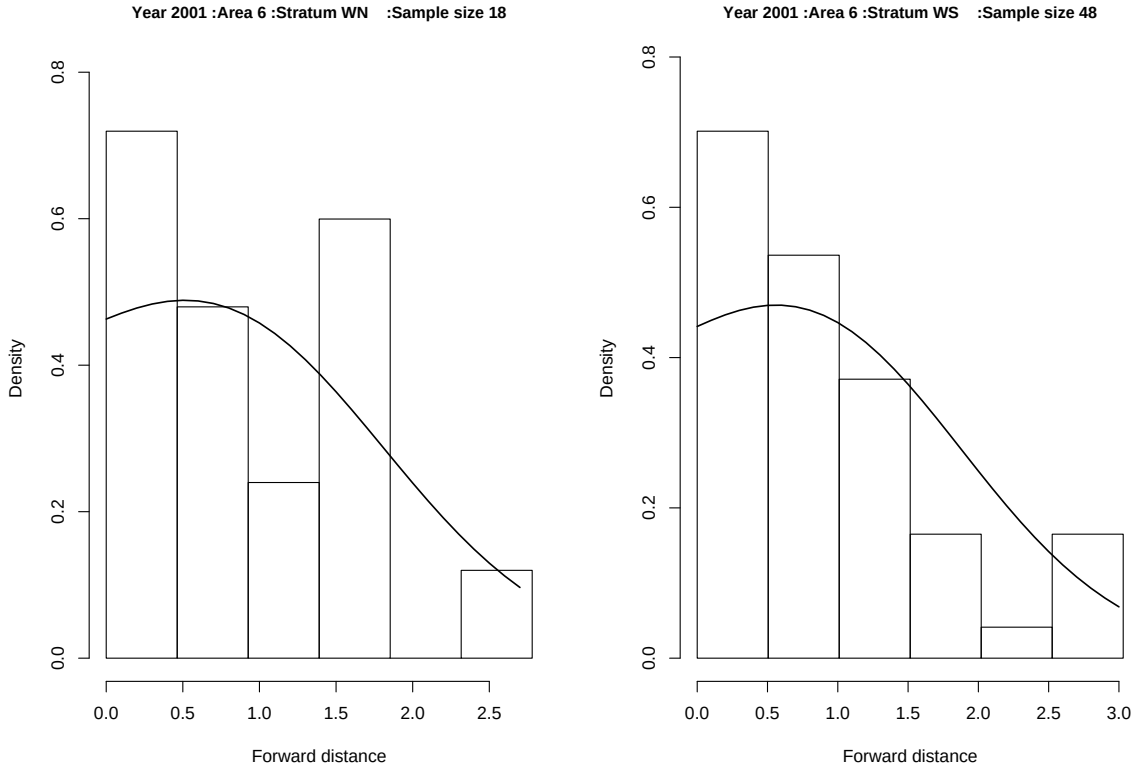

Figure 4. q) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 2000/01 (Area VI). The histograms denote the observation and the solid lines denote the fitted values.

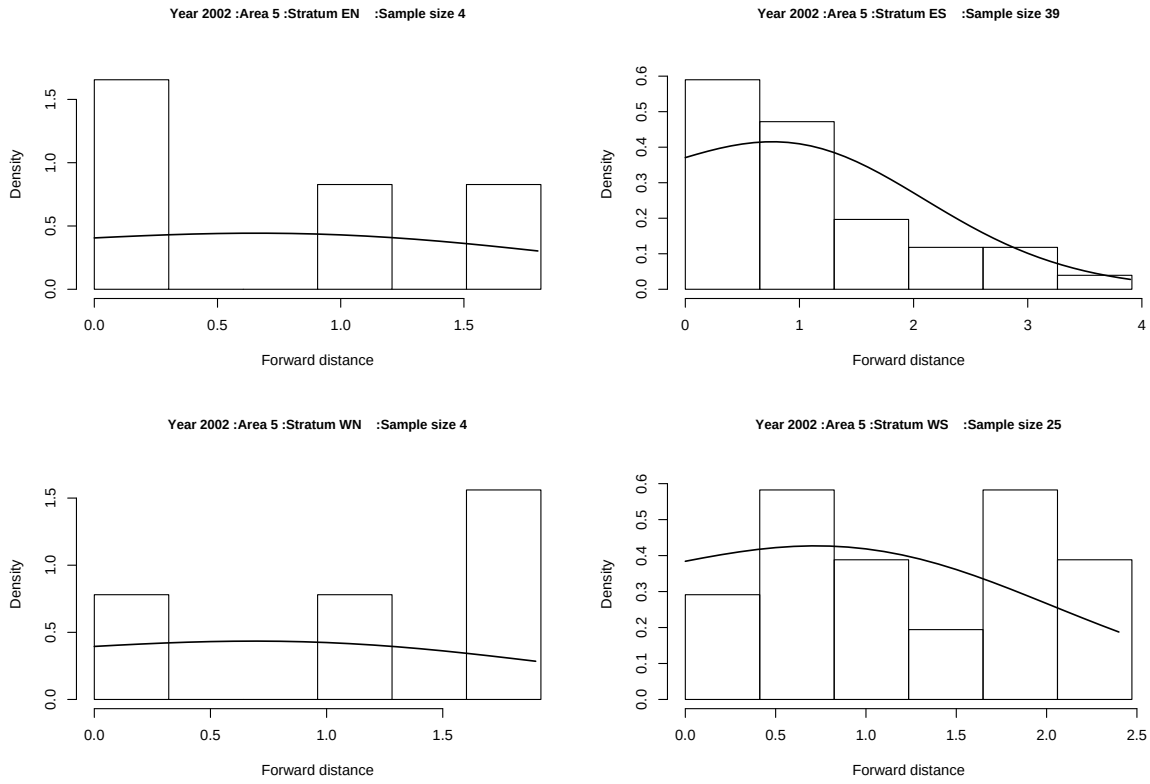

Figure 4. r) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 2001/02. The histograms denote the observation and the solid lines denote the fitted values.

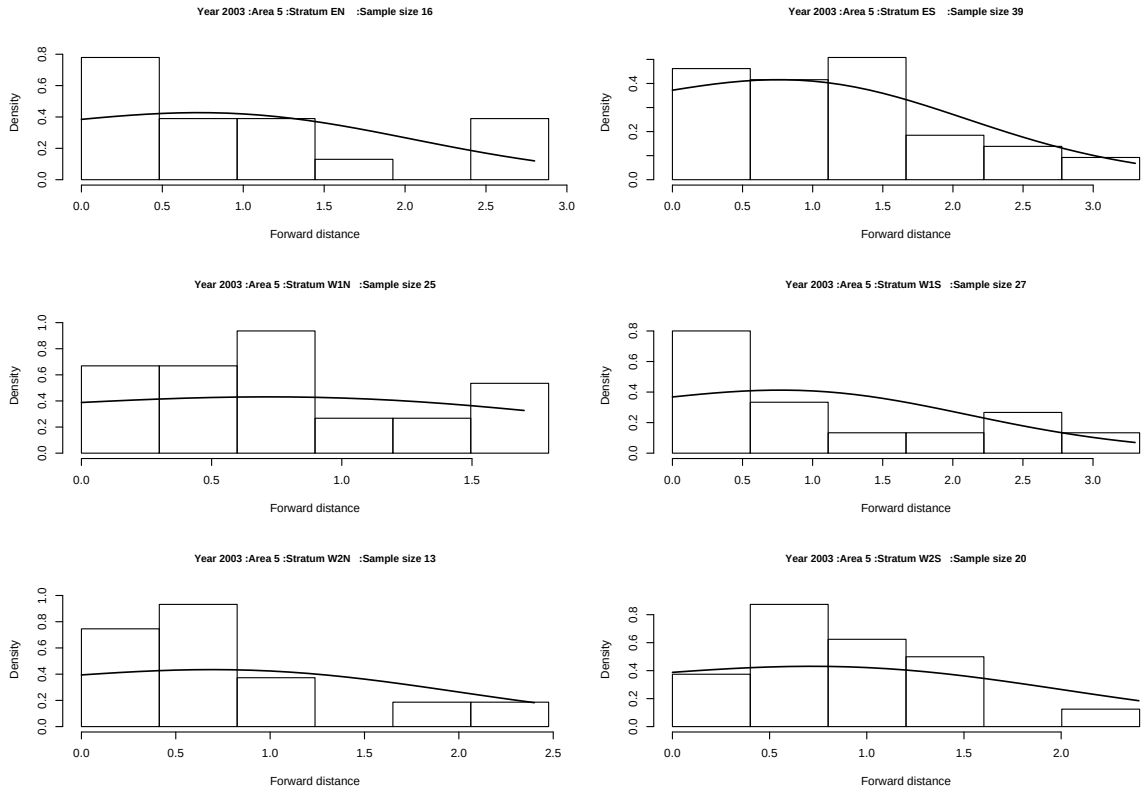

Figure 4. s) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 2002/03. The histograms denote the observation and the solid lines denote the fitted values.

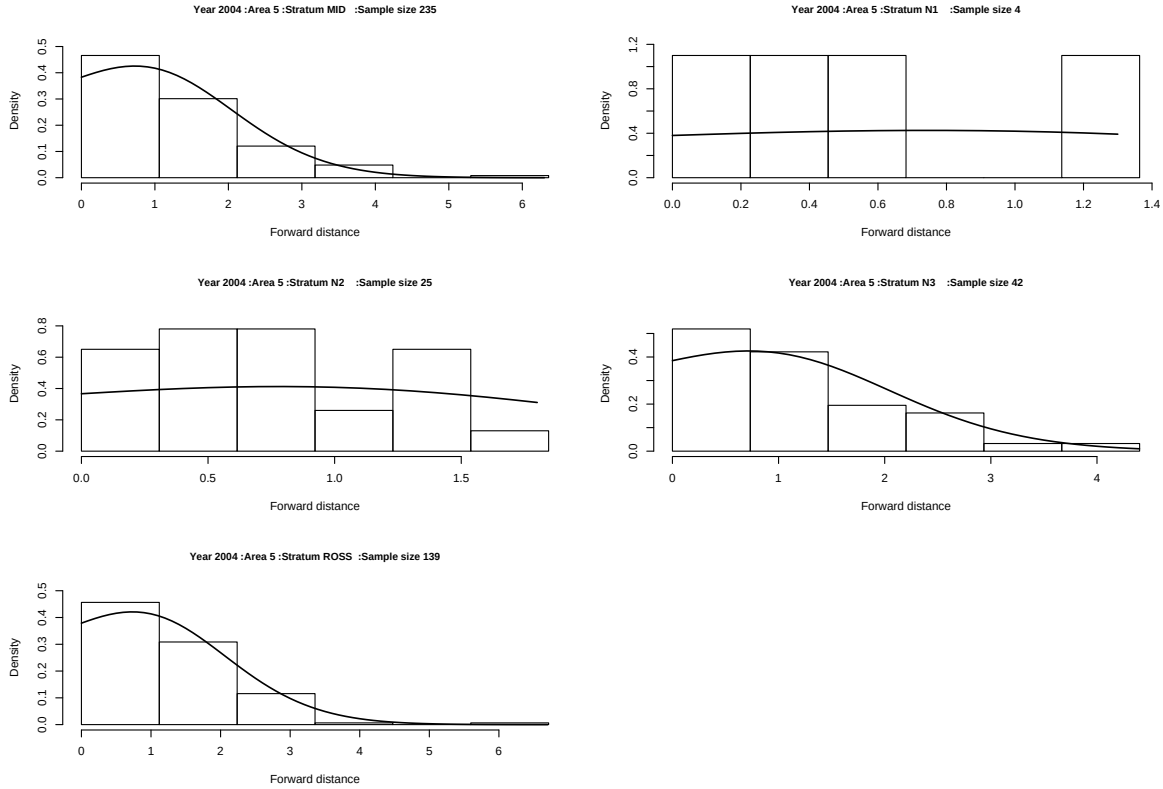

Figure 4. t) The plots of forward distances (n.miles) in the Passing mode by survey stratum in 2003/04. The histograms denote the observation and the solid lines denote the fitted values.

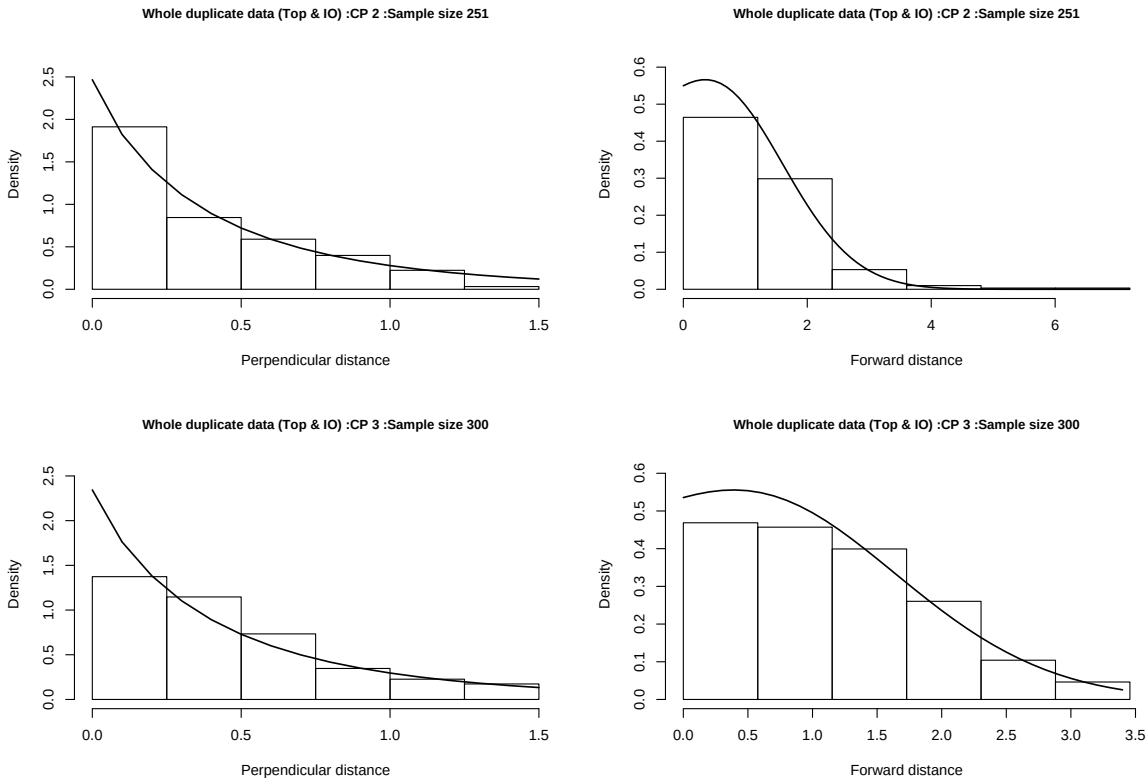

Figure 5. The plots of perpendicular and forward distances (n.miles) for the duplicate data (Topman and IO person) in the Passing mode in CPII and CPIII. The histograms denote the observation and the solid lines denote the fitted values.

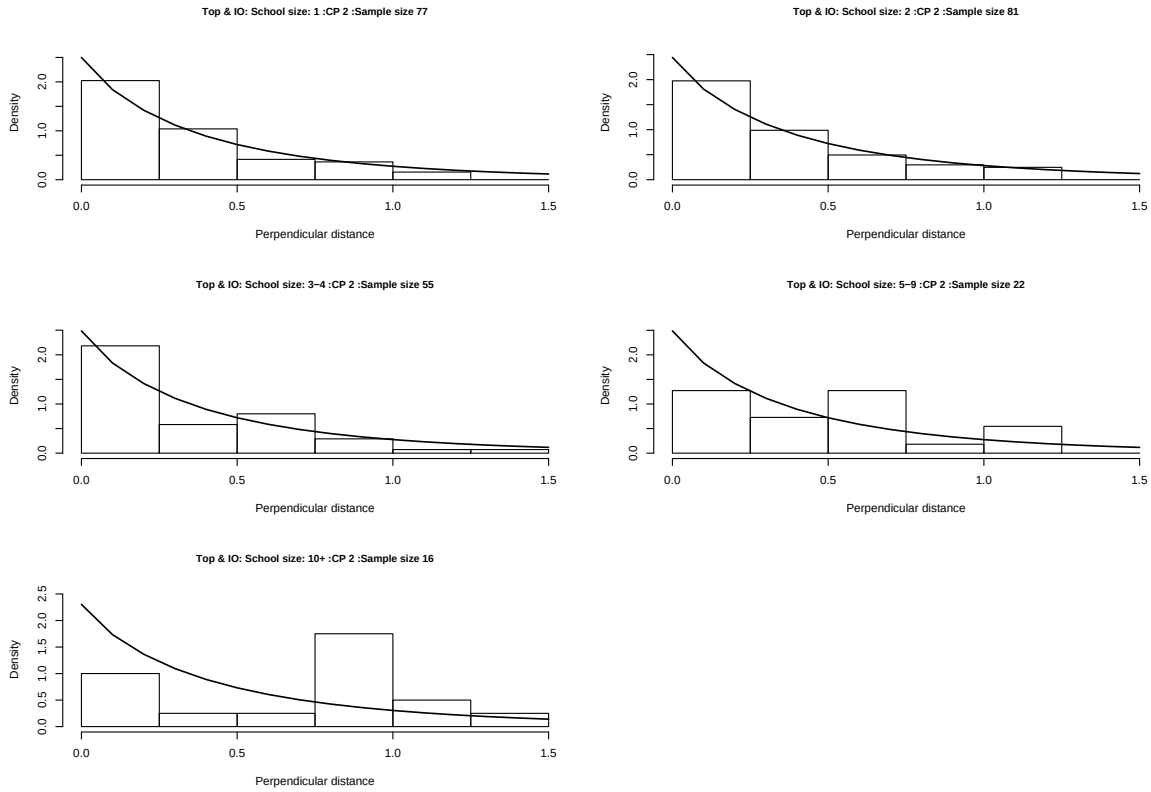

Figure 6. a) The plots of perpendicular distances (n.miles) for the duplicate data (Topman and IO person) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

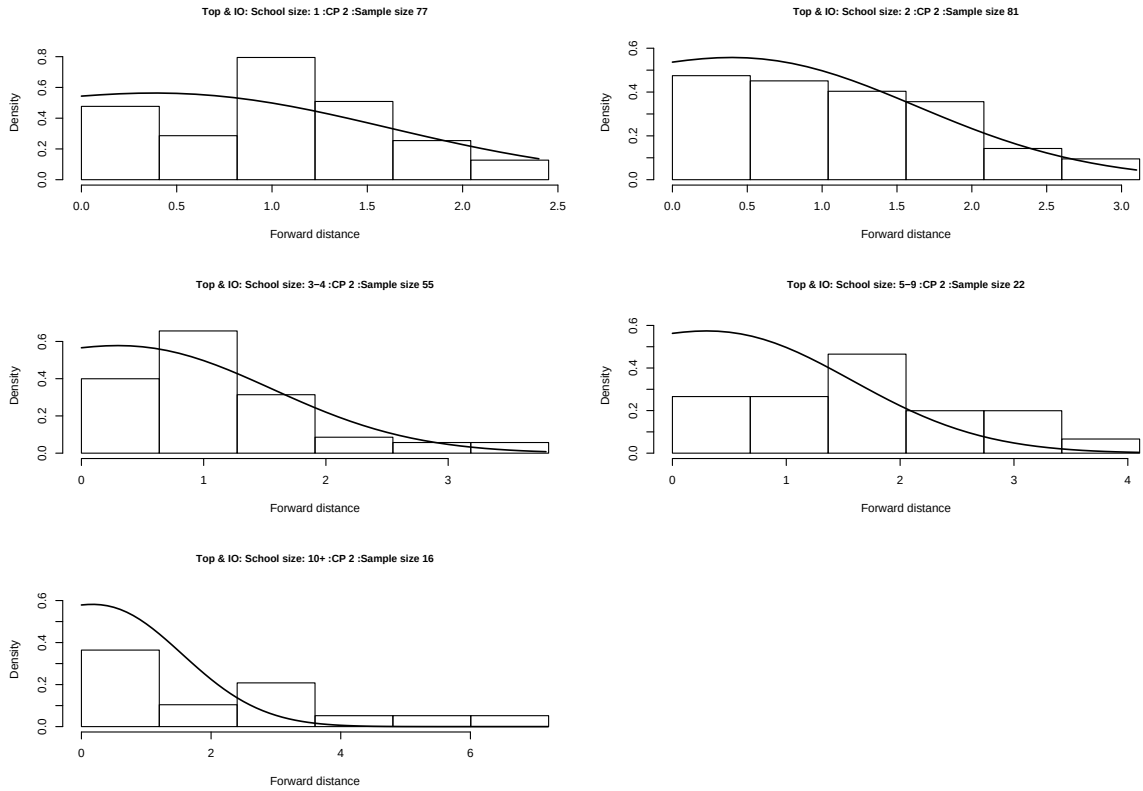

Figure 6. b) The plots of forward distances (n.miles) for the duplicate data (Topman and IO person) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

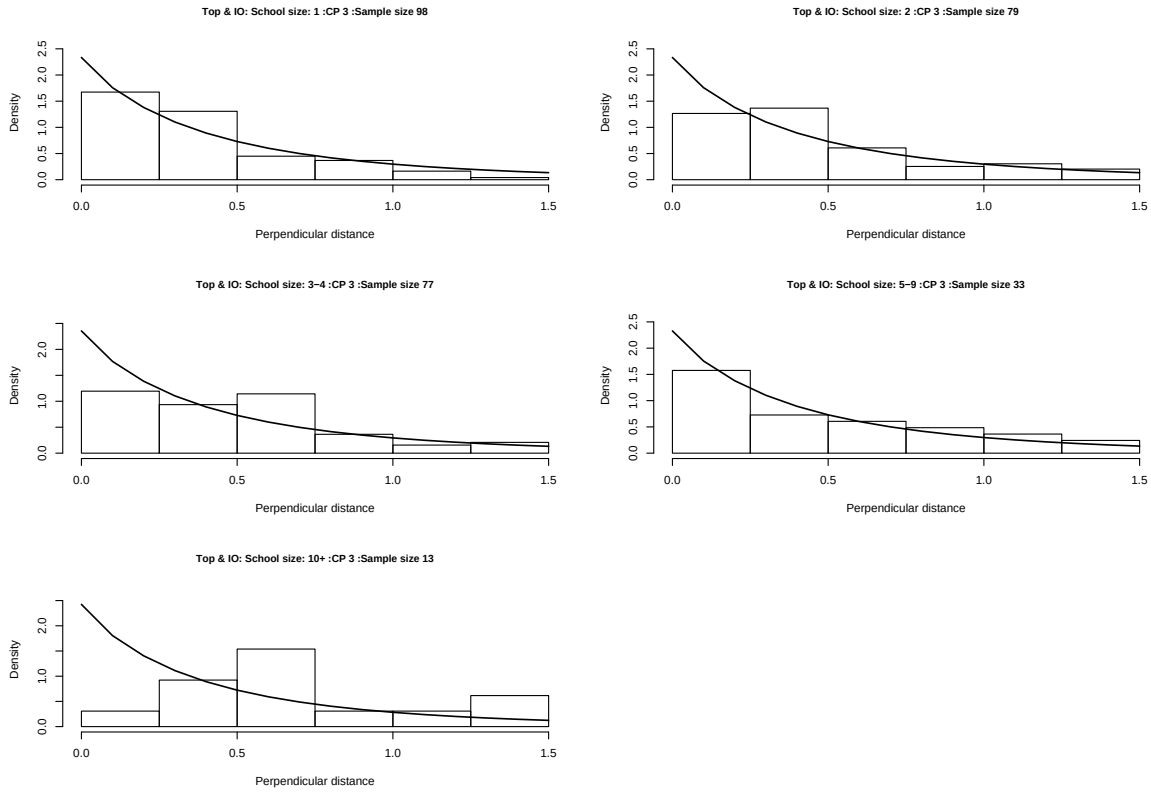

Figure 6. c) The plots of perpendicular distances (n.miles) for the duplicate data (Topman and IO person) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPIII. The histograms denote the observation and the solid lines denote the fitted values.

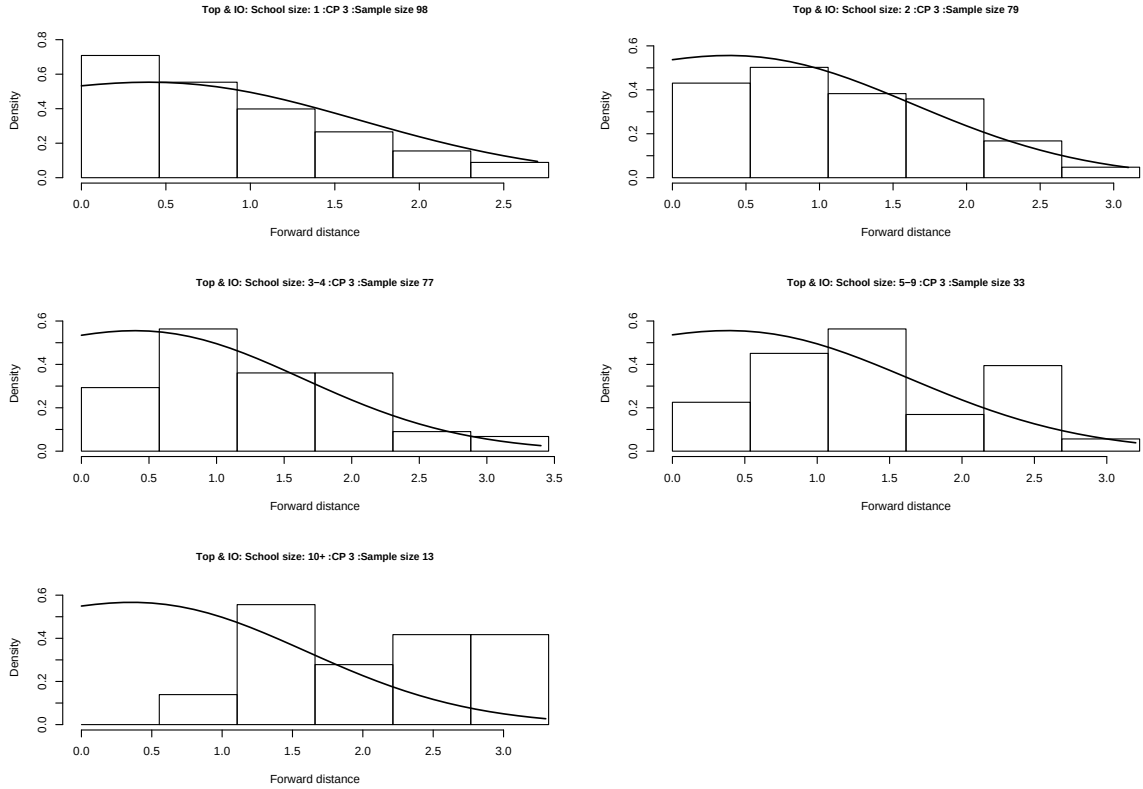

Figure 6. d) The plots of forward distances (n.miles) for the duplicate data (Topman and IO person) in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

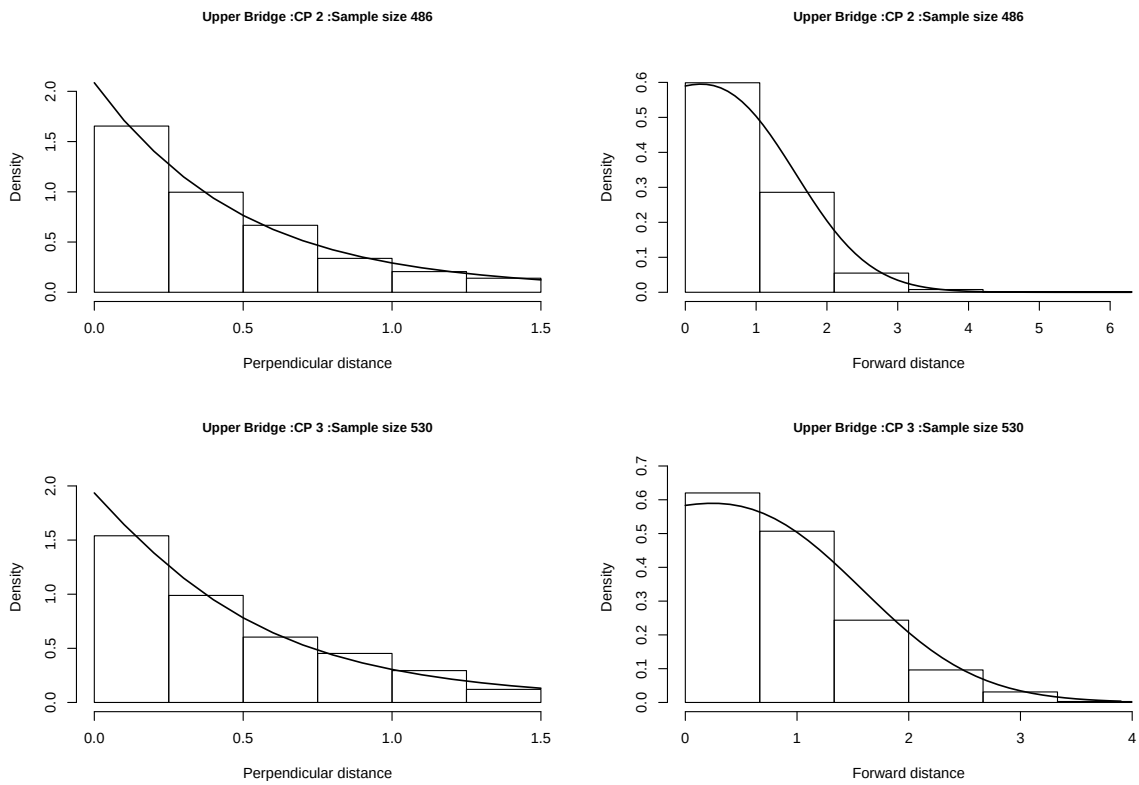

Figure 7. The plots of perpendicular and forward distances (n.miles) for the upper bridge platform in the Passing mode in CPII and CPIII. The histograms denote the observation and the solid lines denote the fitted values.

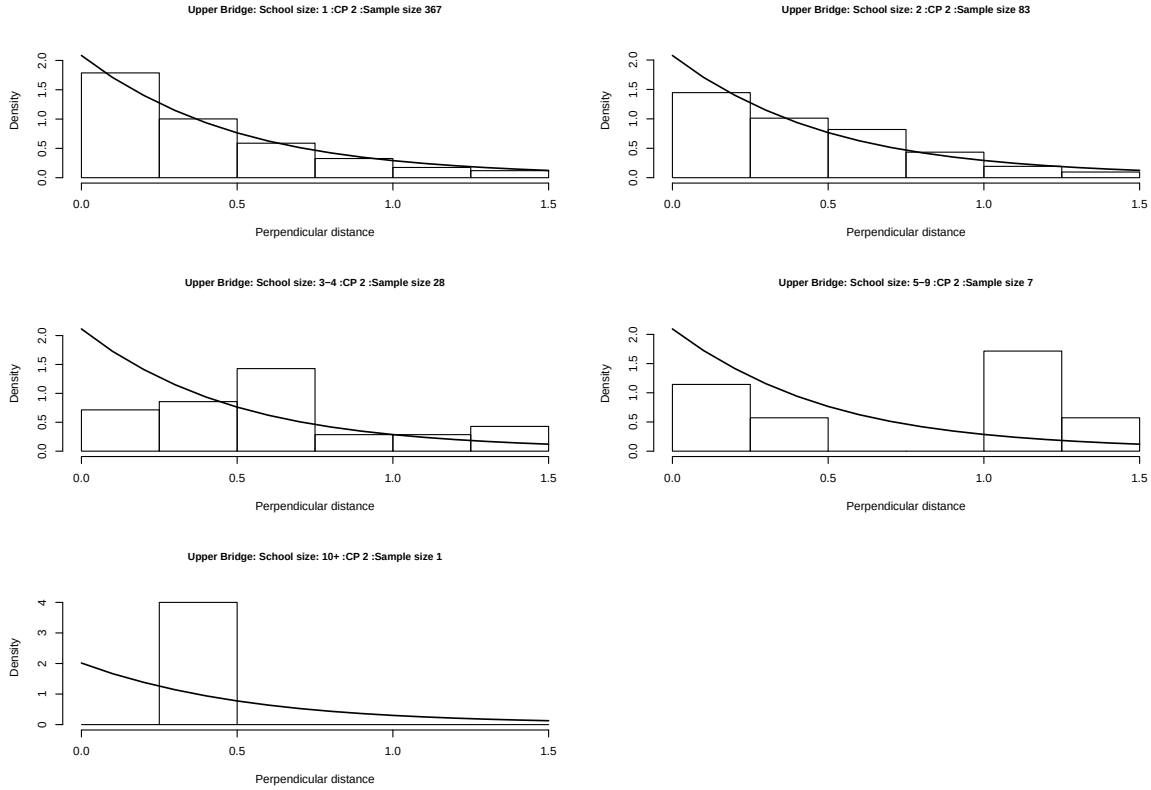

Figure 8. a) The plots of perpendicular distances (n.miles) for the upper bridge platform in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

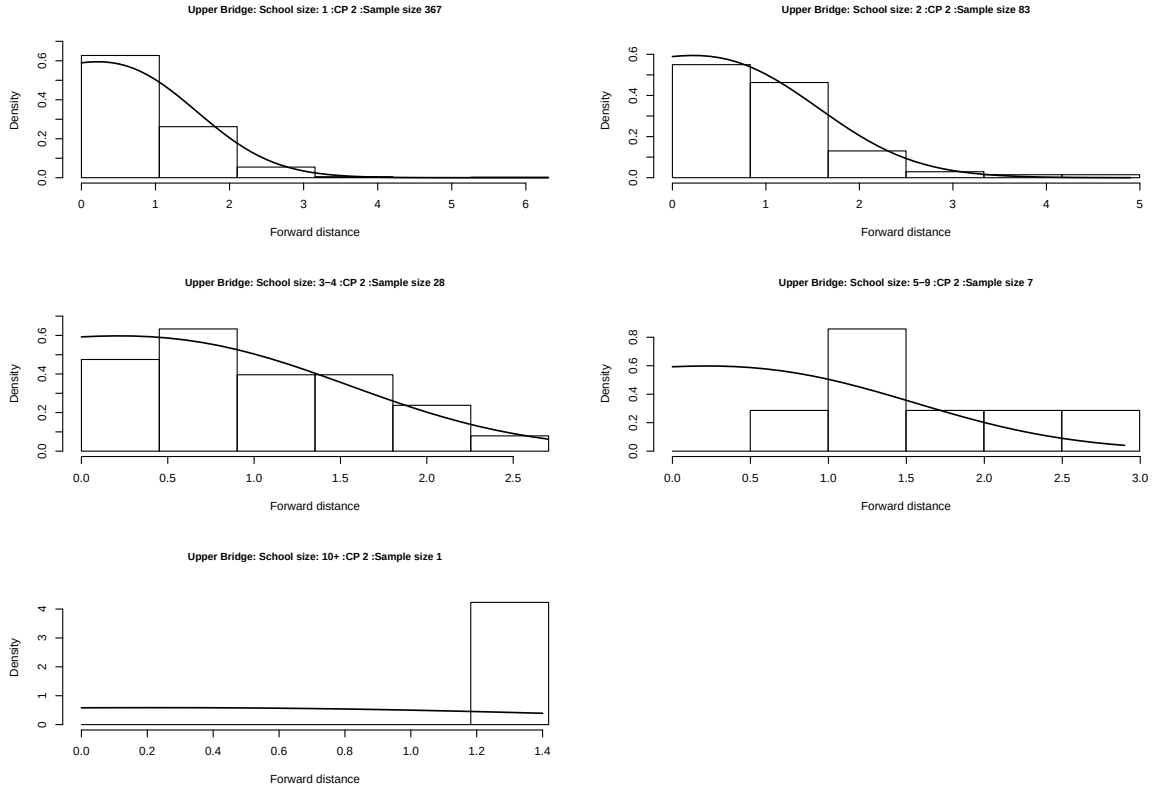

Figure 8. b) The plots of forward distances (n.miles) for the upper bridge platform in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPII. The histograms denote the observation and the solid lines denote the fitted values.

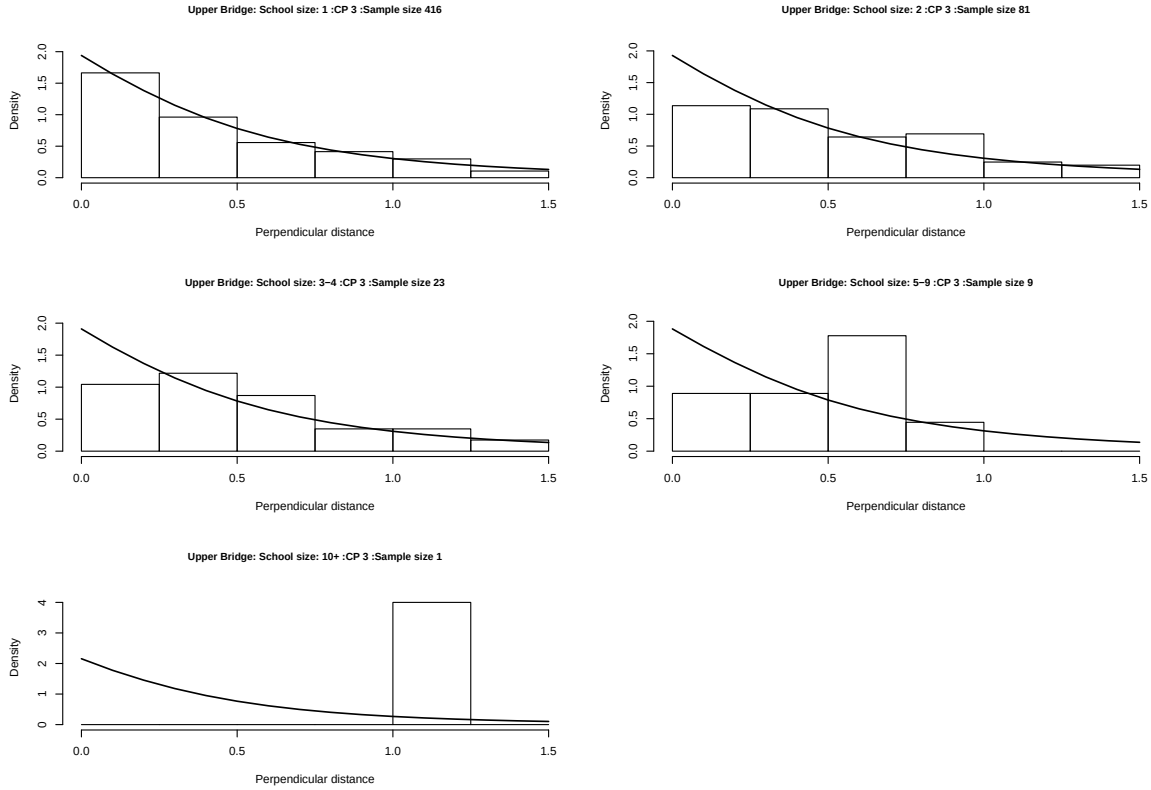

Figure 8. c) The plots of perpendicular distances (n.miles) for the upper bridge platform in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPIII. The histograms denote the observation and the solid lines denote the fitted values.

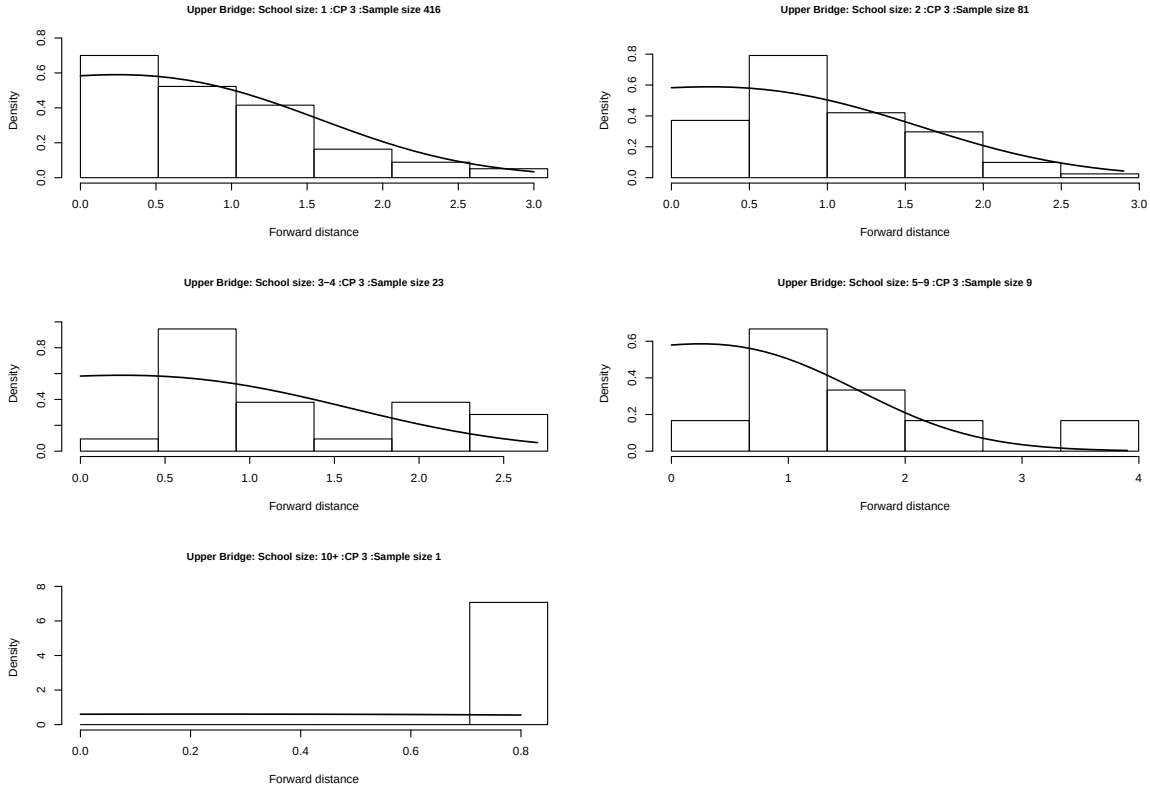

Figure 8. d) The plots of forward distances (n.miles) for the upper bridge platform in the Passing mode by observed school size classes (1, 2, 3-4, 5-9, 10+) in CPIII. The histograms denote the observation and the solid lines denote the fitted values.

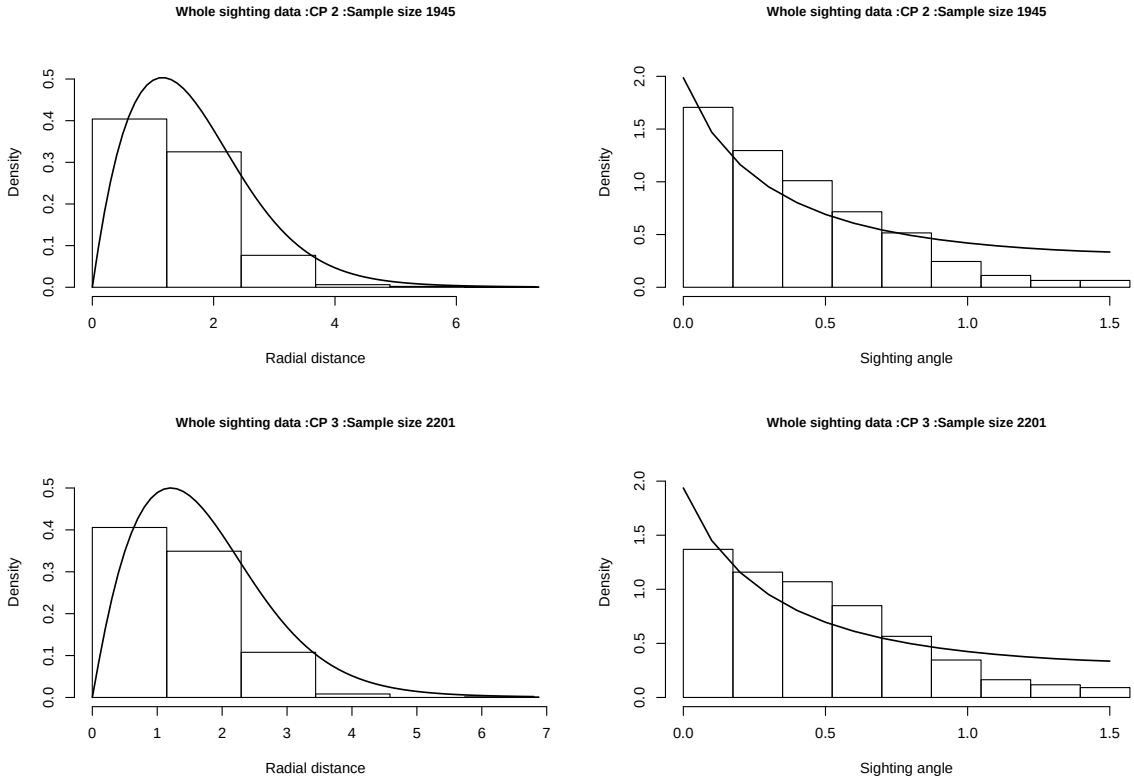

Figure 9. The plots of radial distances (n.miles) and sighting angles (radians) for the whole data in the Passing mode in CPII and CPIII. The histograms denote the observation and the solid lines denote the fitted values.

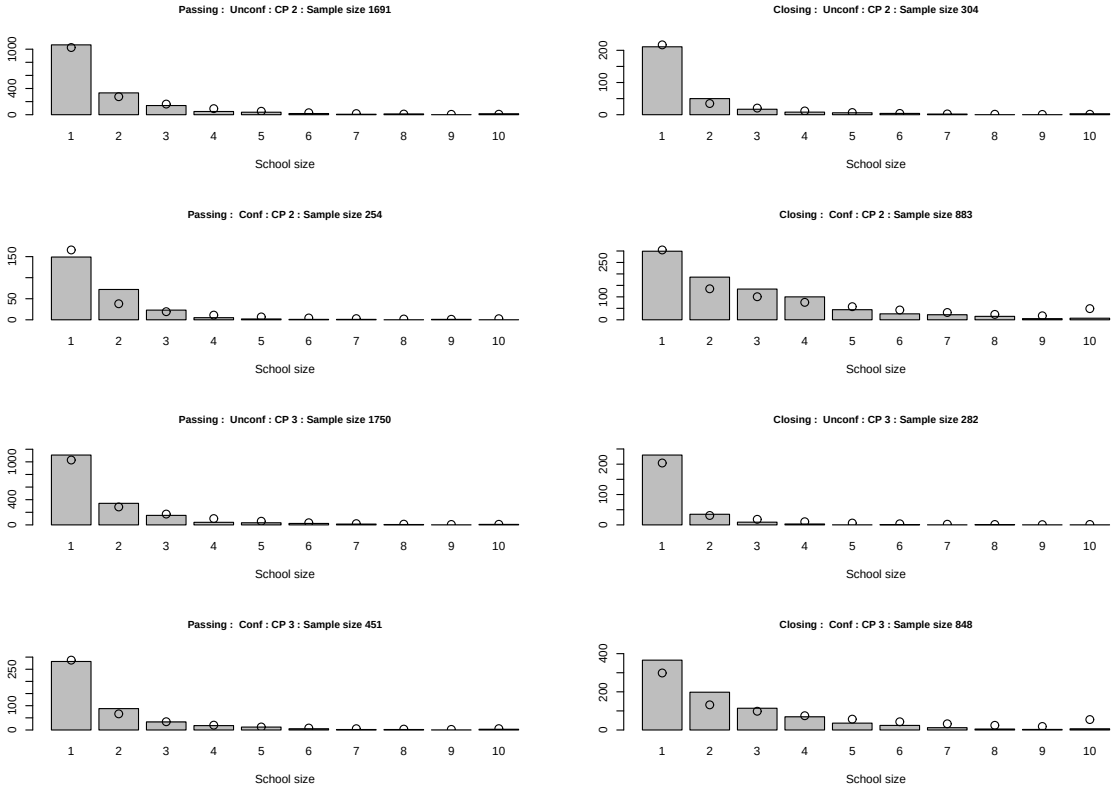

Figure 10. The plots of observed school sizes in CPII and CPIII. The histograms denote the observation and the open circles denote the fitted values.

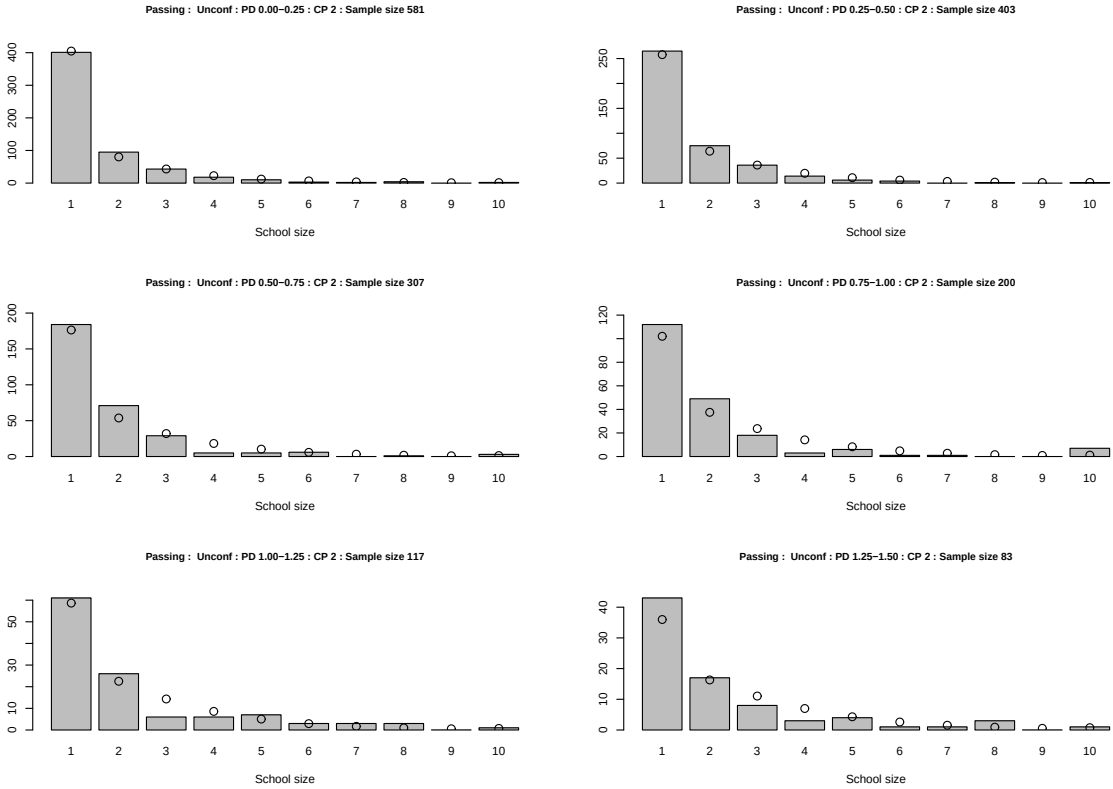

Figure 11. a) The plots of observed unconfirmed school sizes in the Passing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPII. The histograms denote the observation and the open circles denote the fitted values.

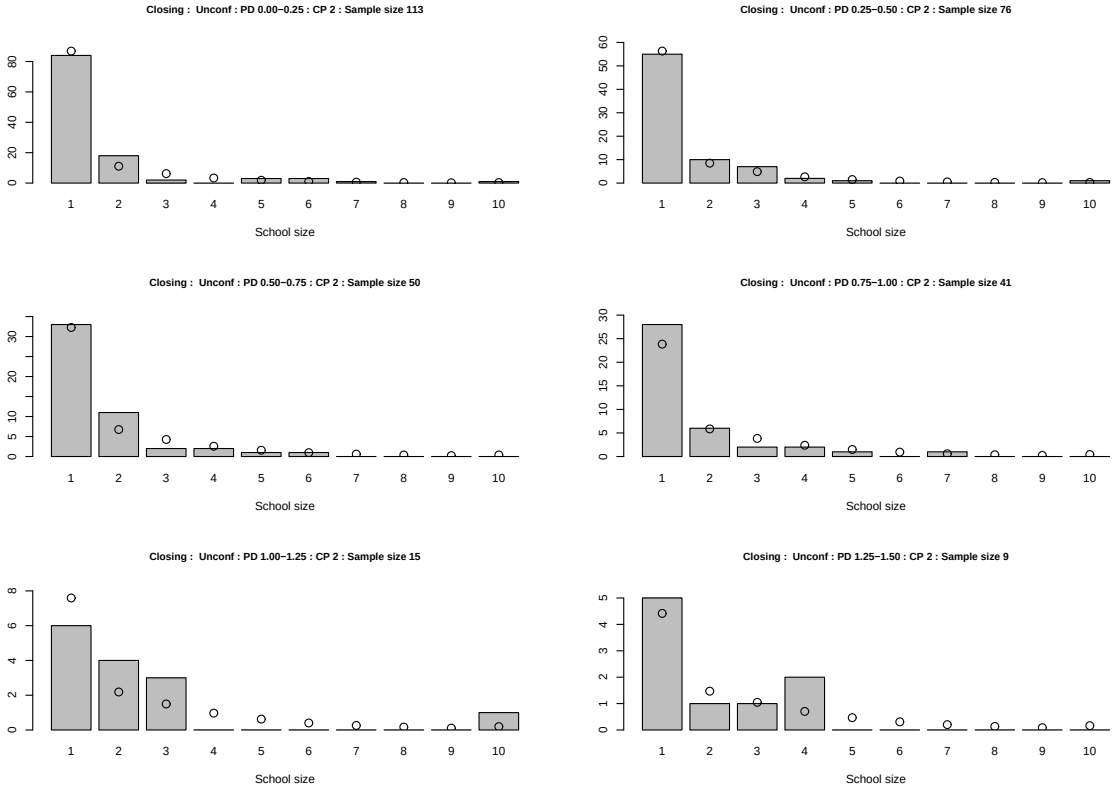

Figure 11. b) The plots of observed unconfirmed school sizes in the Closing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPII. The histograms denote the observation and the open circles denote the fitted values.

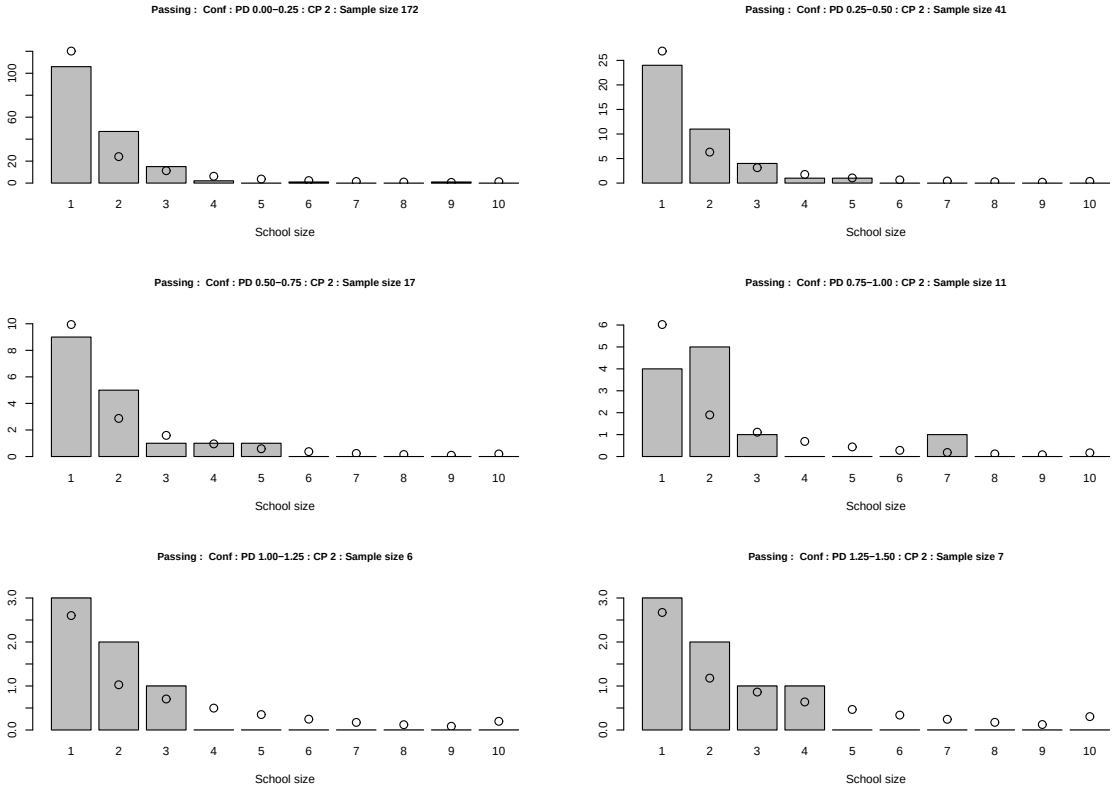

Figure 11. c) The plots of observed confirmed school sizes in the Passing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPII. The histograms denote the observation and the open circles denote the fitted values.

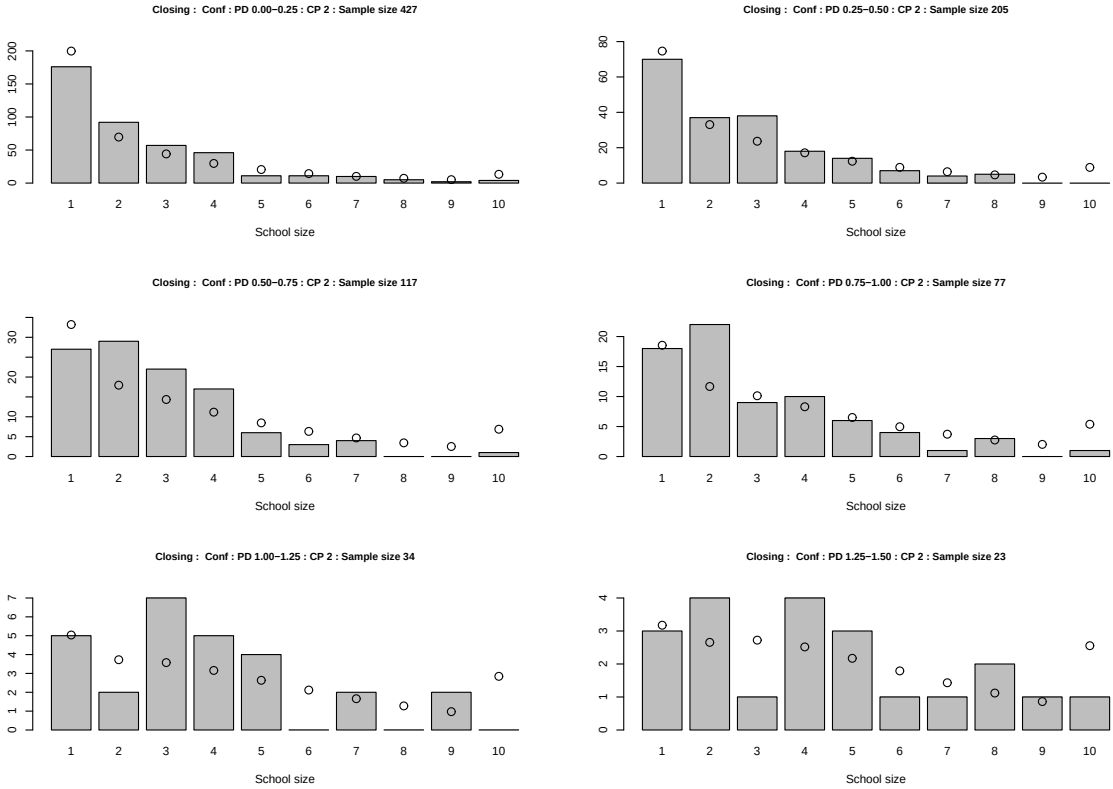

Figure 11. d) The plots of observed confirmed school sizes in the Closing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPII. The histograms denote the observation and the open circles denote the fitted values.

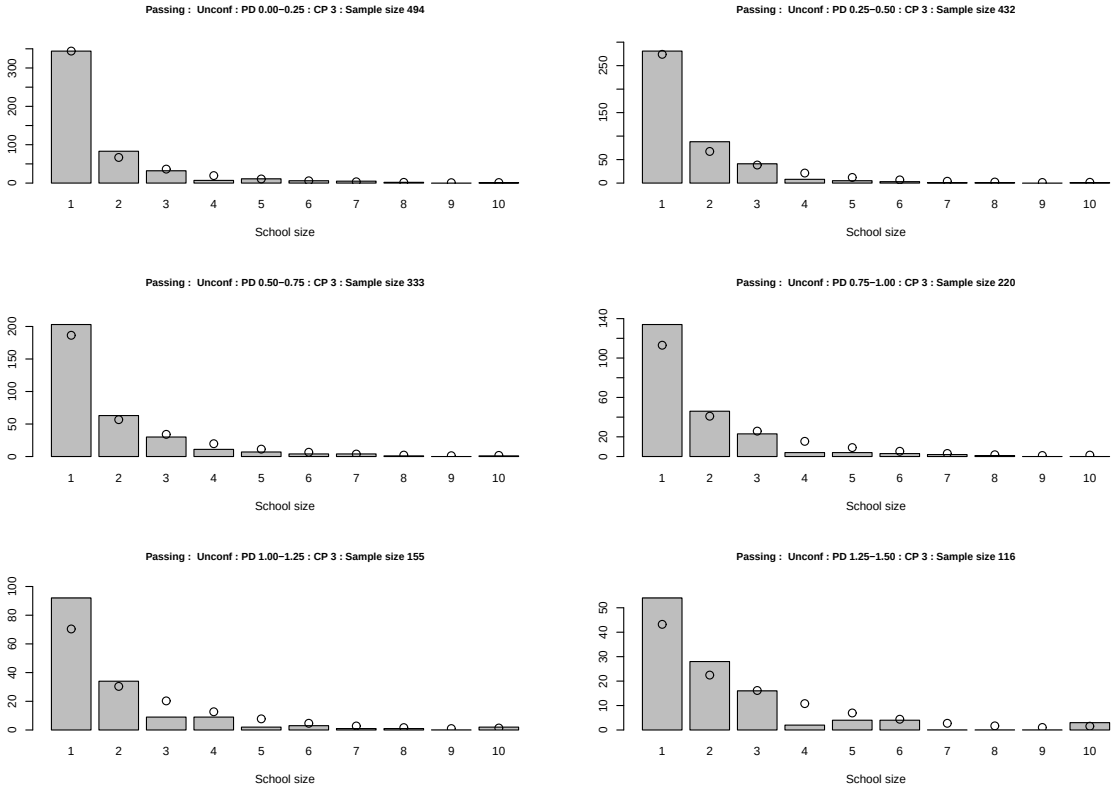

Figure 11. e) The plots of observed unconfirmed school sizes in the Passing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPIII. The histograms denote the observation and the open circles denote the fitted values.

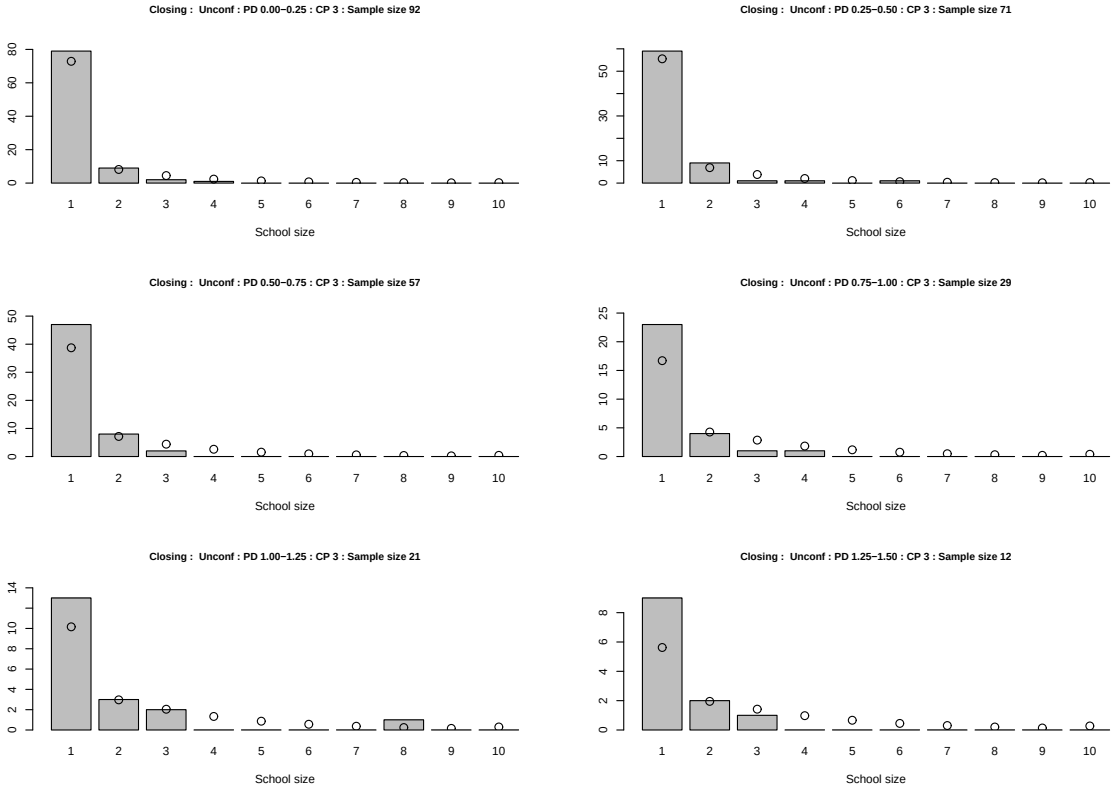

Figure 11. f) The plots of observed unconfirmed school sizes in the Closing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPIII. The histograms denote the observation and the open circles denote the fitted values.

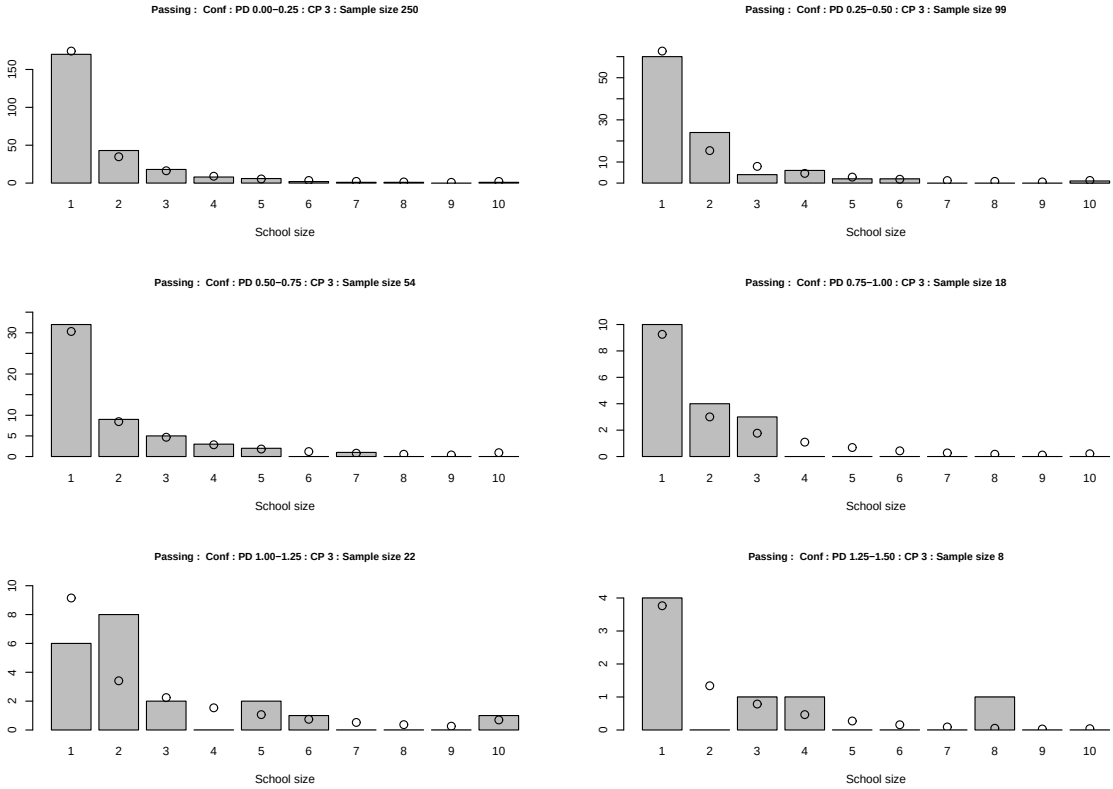

Figure 11. g) The plots of observed confirmed school sizes in the Passing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPIII. The histograms denote the observation and the open circles denote the fitted values.

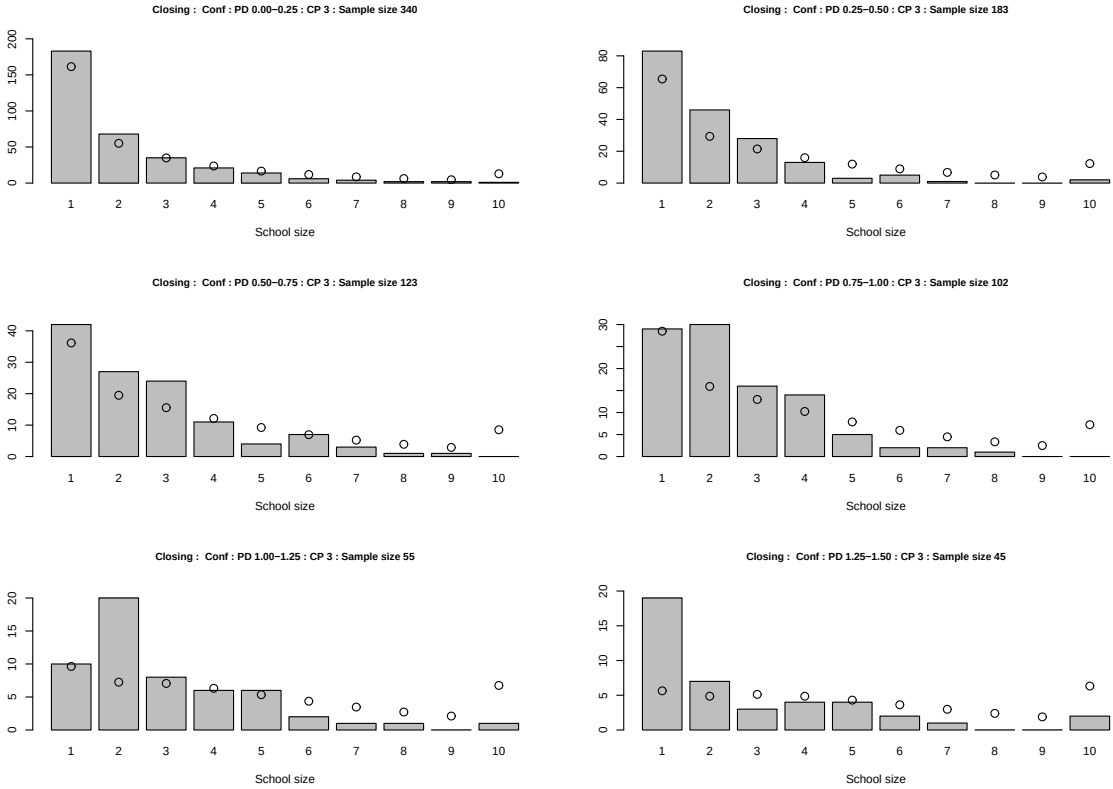

Figure 11. h) The plots of observed confirmed school sizes in the Closing mode by perpendicular distance classes (0-0.25, 0.25-0.5, ... , 0.125-0.15) in CPIII. The histograms denote the observation and the open circles denote the fitted values.