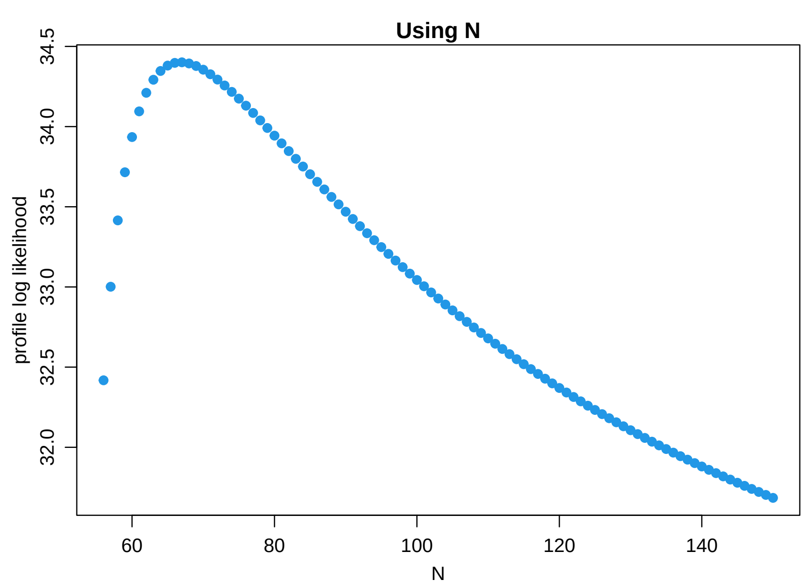
1. 40 points. Deer mice - practice with likelihoods and profile likelihoods
   (a) M0: $\hat{N} = 115.40$, se = 23.98
   (b) Mt: $\hat{N} = 113.90$, se = 23.54
   (c) Mb: $\hat{N} = 66.80$, se = 9.45
   (d) Using AIC, Mb is the best model (AIC = -62.80).
   (e) No. The AIC doesn't provide a measure of how well a model fits the data. It only helps you compare models and do model assessment and selection. The AIC only identifies the best of the models you consider. The best of the lot might still be a poor model.
   (f) MA estimate of N: 79.78
   se: 23.21 (usingBuckland formula), 26.04 (using the Revised formula)
   Details and components of the calculations:

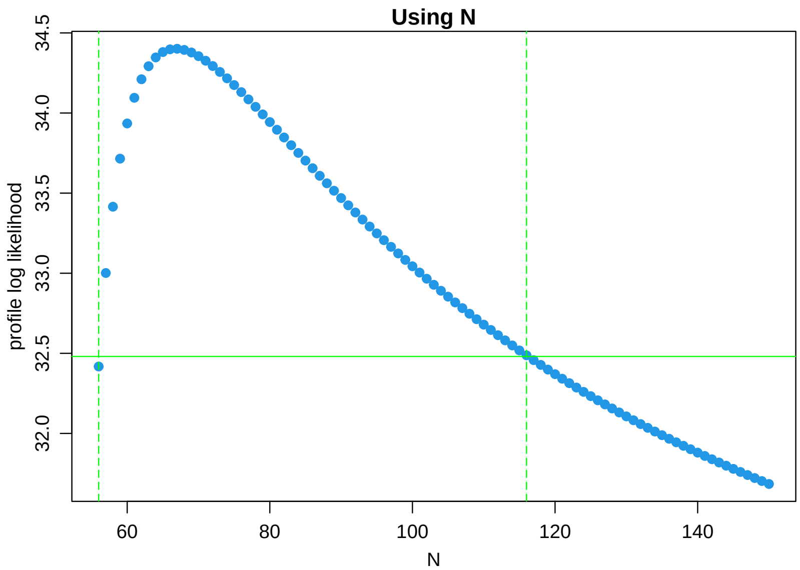
	M0	Mt	Mb
$\hat{N}$	115.40	113.90	66.80
se $\hat{N}$	23.98	23.54	9.45
AIC	-60.48	-56.95	-62.80
Δ AIC	2.32	5.85	0.00
$\exp(-\Delta/2)$ AIC	0.313	0.0536	1.000
weight	0.229	0.039	0.732

   (g) same equation with N replaced by $M_{t+1} + f_0$:
   $lnL(f_0, p, c|t, M_{t+1}, M., m.) = log[(M_{t+1}+f_0)!] - log(f_0!) - constant + M_{t+1} logp + [t(M_{t+1} + f_0) - M_{t+1} - M.]log(1-p) + m.logc + (M. - m.)log(1-c)$
   (h) We should get the same value of the log likelihood for these two models. Translation of the parameter values does not change the shape of the distribution, so the log likelihood does not change either.
   (i) 95% CI: (48.28, 85.32).
   (j) The se of $\widehat{log f_0}$ is 0.7383. The 95% CI for the $log f_0$ is (1.102, 3.996). Backtransform the log scale, the 95% CI for f_0 is (3.011, 54.395). Then plus M_{t+1} gives the 95% CI for N (57.011, 108.395).
   Common mistakes: -1 point if you $exp(\widehat{log f_0}) + 54 + 1.96 * sd(\widehat{log f_0})$
   (k) see figure below:

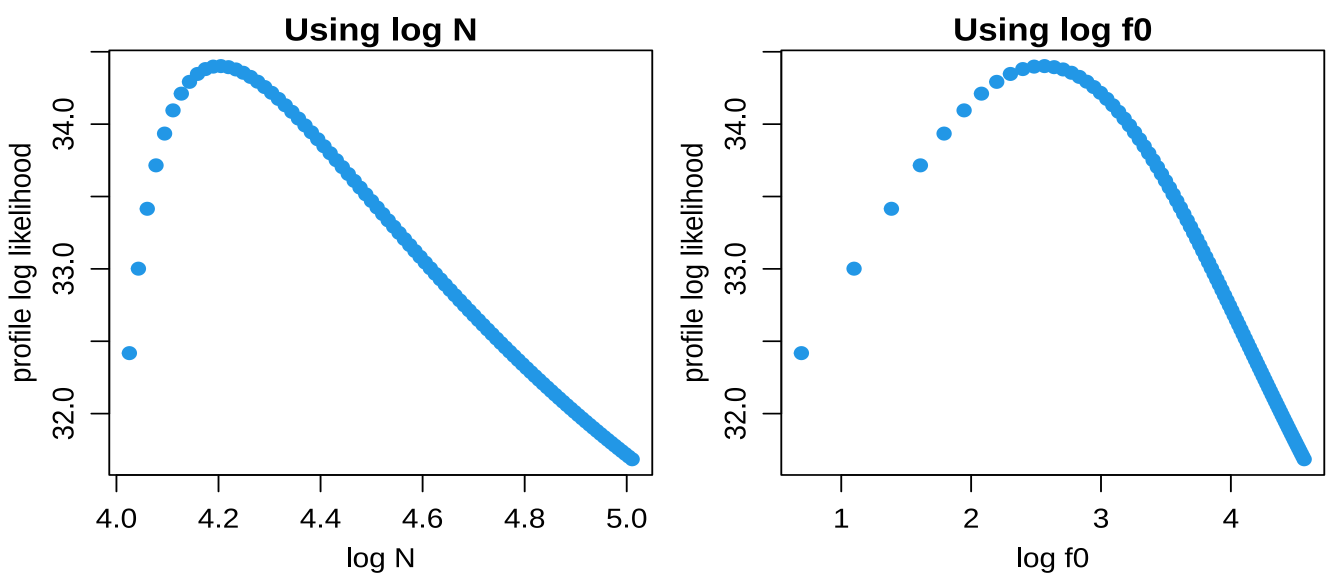


(l) From the graph, the 95% profile CI for N is (56, 116).

Common mistakes: The question asked is using the plot to get the CI. But the majority of people use the profileCI function to calculate the CI directly.

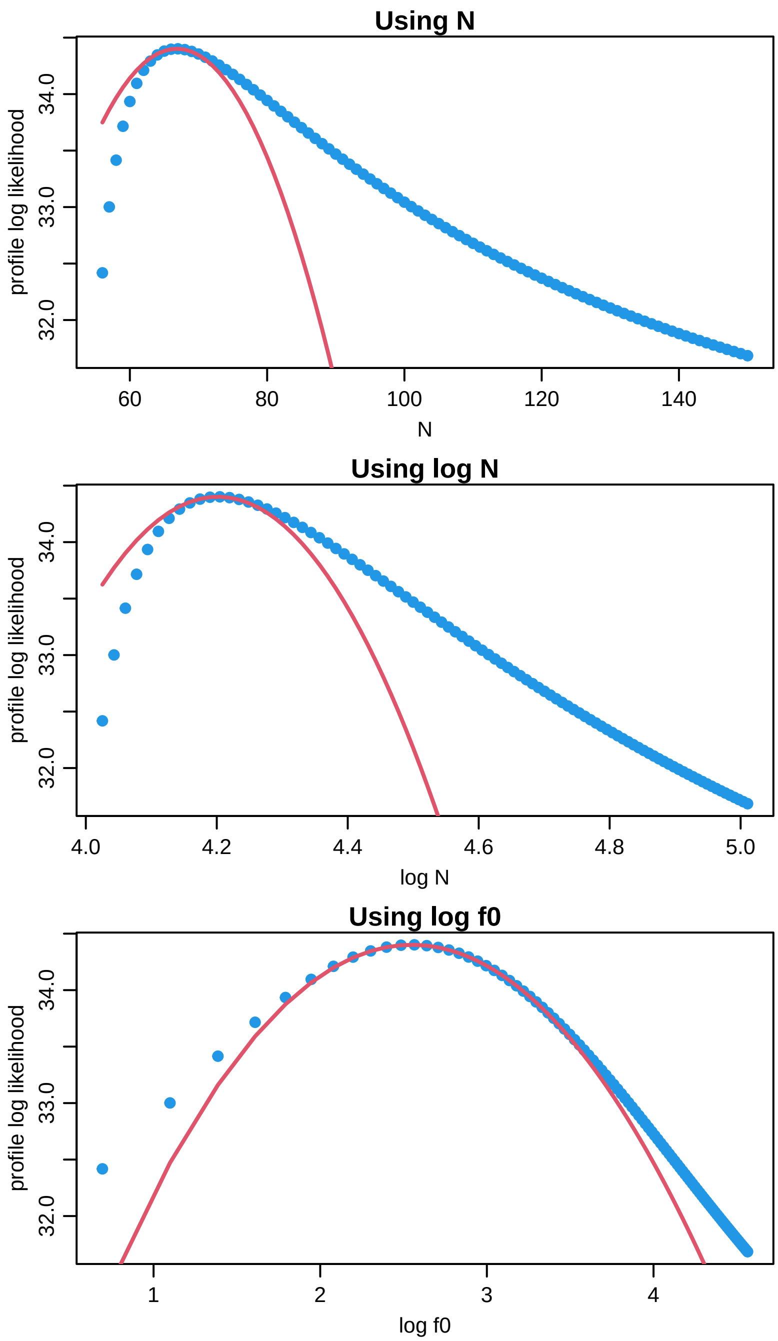


(m) see figure below:



Common mistakes: The value of N should be $\geq M_{t+1}$.
-0.5 point if you start N with 50, this will produce a -Inf value and the figure looks different from above.

(n) The profile likelihood plot using $log f_0$ is more appropriate to use a quadratic approximation in terms of $log f_0$. See figure below:



Common mistakes: -1 point if you don't use the addQuad() function to add the quadratic approximation.

Genaral comments: add warning = FALSE in the chunk header to prevent including too many warnings in the HW file.

(o) The Wald interval based on $\log f_0$ is recommended. The Wald interval is based on the asymptotic normality; in other words, that a quadratic approximation is reasonable. The profile likelihood plot using $log f_0$ is close to a quadratic curve. So we can assume $log f_0$ is normally distributed and calculate its Wald interval.

Take home message for users: If you have the option to get profile intervals, use it; they will always be better than Wald intervals. If you don't have that option, then use the Wald intervals computed on the most appropriate scale, based on experience (yours or others). For N in mark-recapture studies, that is to work on the $\log f_0$ scale.

2. 10 pts. Snouters

I considered 6 models same as in the "intro to RMark". The model with the smallest AIC value was overparameterized. So Mtb2 was the best for 6 years ago, and Mt was the best for last year. Using Mtb2, the estimated population size is 300 with se 15.77. Using Mt, the estimated population size is 333 with se 48.83. The se for last year is very large, so it isn't possible to make precise estimates of the change. The population is certainly not crashing. The low # seen last year is because the capture probability was much lower, 0.08 to 0.18, compared to 0.39 to 0.52 6 years ago.

Notes:

(a) This problem highlights a common issue and a sometimes heated discussion. The number seen is one of many sorts of indices of population size. Indices are easy to collect and analyze. Estimating the number is much harder. If detectability (or effort) doesn't change, then indices are proportional to population size. If detectability changes, indices are misleading or worse.

(b) This problem was on the assignment to make this point.

My grading rubric:

Section	Points	item
	3	has sufficient detail to reproduce the analysis without being excessively wordy, includes list of models that were considered
Methods	2	sufficient to reproduce the analysis but very wordy or omitted a list of models
	1	would not be able to reproduce the analysis
	0	missing or completely inappropriate content
		+1 if the overparameterized model is omitted, -1 on the contrary
	3	contains results in enough detail to support the conclusions, well formatted tables and/or well-chosen figures
Results	2	some missing results or unnecessary tables/figures
	1	didn't seem to understand what should be in a results section
	0	missing or completely inappropriate content
	3	states the conclusion and explains what actually happened
Conclusion	2	minor issues with the conclusion or explanation
	1	major problems with the conclusion