Petersen Capture-Recapture Method Mark Scheme

Q1.

Question	Answer	Additional guidance	Mark
(a)	M1 $\frac{2}{10}$ or 20% are tagged oe OR $\frac{25}{x} = \frac{2}{10}$ oe A1 25/0.2 or $x = \frac{25 \times 10}{2}$ oe	M1 for identifying proportion which are tagged A1 for a complete correct calculation that leads to 125	(2)
(b)	B1B1B1 for three correct points from • Unreliable/poor (estimate) due to ... • Small sample • Sample not random / rabbits may not have mixed between samples • Long gap between samples / may have been a change in the population (e.g. may be births/deaths) • Tags may have come off between samples	B1 for each of three correct comments from the list assessing the appropriateness of Richard's method to achieve reliable results. Accept equivalent statements. Allow each bullet point once only. Ignore excess statements if not contradictory.	(3)

Q2.

Question number	Answer	Additional guidance	Mark
	B2 for not reliable with a correct reason e.g. samples too small or time interval between samples too long (as population may have changed between samples)	B2 for a correct comment assessing the appropriateness of the conclusion OR if B2 not earned B1 for an incomplete attempt to assess the appropriateness of the conclusion	(2)

Q3.

Question number	Answer	Additional guidance	Mark
	M1 • <u>Using Percentages</u> $\frac{5}{98}\times 100$ (= 5.1%) of sample are tagged **AND** Giovanni's estimate is $\left(\frac{250}{5000}\times 100 =\right) 5\%$ • <u>Finding the numerical estimate</u> For $N=\frac{250\times 98}{5}(=4900)$ or $\frac{98}{5}=\frac{N}{250}\Rightarrow N\ldots$ A1 for finding 5.1% are tagged (**and** Giovanni's estimate is 5%) or finds the value 4900 depB1ft **Provided M1 is scored.** Giovani's conclusion is likely to be reliable because 4900 is close to 5000 **OR** 5.1% is close to 5% The method is good or appropriate because..... B2 for any **two** correct points from • Tags unlikely to come off [in 3 days] • Population unlikely to change [in 3 days] /no new reindeer are likely to have entered or left the herd in [3 days]. • Sample likely to be random/should have had a chance to mix between samples. • The sample size is large enough to be representative **Special Case** They give **NO** judgement and give any **two of the above** assumptions (but not the converse of the assumptions), award B1	M1 • <u>Using percentages</u> Attempts to find that 5.1% of the sample are tagged **and** finds that Giovanni's estimate is 5% • <u>Using Numerical estimate</u> Attempts to find an estimate for the population $N=\frac{250\times 98}{5}(=4900)$ oe calc A1 – Finds 5.1% **OR** finds 4900 dep B1ft for a correct comment assessing the appropriateness of Giovani's conclusion. There must be a **comparison** of the **two** values. Their '4900' **and** 5000 only. Allow ft on their 4900 or 5.1% [but not 5% - that must be correct] for this mark, provided M1 has been scored. Use the guide, $4750 \le N \le 5250$ as a good estimate. Must state the method is good or appropriate **and** B1 for each of the correct comments from the list assessing the appropriateness of Giovani's method to a maximum of 2 marks. B1 for only one reason. **Any statement suggesting the method is inappropriate is B0B0** Converse of the assumption means for example, the population **is** likely to change or tags **are** likely to come off. These are B0	(5)

Q4.

Question	Answer	Additional guidance	Mark
(a)	M1 for $\frac{100}{n}=\frac{12}{60}$ oe A1 for 500		(2)
(b)	B2 for reliable/not reliable with a correct supporting reason eg reliable and samples are a good size/reliable and time interval between samples is not too long/not reliable and may catch greater proportion of injured or ill turtles so not random OR if B2 not earned B1 for reliable/not reliable with an attempt at a reason OR for identifying a factor which would impact reliability without a conclusion	B2 for a correct comment assessing the reliability of the conclusion OR if B2 not earned B1 for an incomplete attempt to assess the reliability of the conclusion	(2)

Q5.

Question	Scheme	Marks
(a)	$20 \div 4 \times 30$ $= 150$ cao	M1 A1 (2)
(b)	Any two from: • No fish were born/died/arrived/left the canal. (i.e. population unchanged / proportion of marked fish unchanged) • Marked fish mixed in between samples OR all fish have same chance of being caught / samples are random. (i.e. idea of randomness) • Markings remain in place / unchanged.	B1 B1 (2) [4]
	Notes	
(a)	M1 for attempt correct full method accept any of: $\frac{4}{20}=\frac{30}{N}$ (o.e.) OR $4:20 = 30:N$ (allow '?' for N) OR 30 fish is $\frac{1}{5}$ (or 20%) OR 20 fish is $\frac{4}{30}$ (or 13%) **NB: do not ISW here** - e.g. if they go on to add 30 then M0A0	
(b)	**Allow each bullet point once only.** Condone same proportion / 20%, of (all) the fish have marks on them (each time)	

Q6.

Question number	Answer	Additional guidance	Mark
(a)	M1 $\frac{48\times20}{240}$ or $\frac{48}{n}=\frac{240}{20}$ o.e. A1 $=4$	M1 for attempt at correct equivalent calculation or equation A1 4 cao	(2)
(b)	B1 B1 Any two correct assumptions from • 'closed' population (e.g. no pigeons leave/die/arrive) • random samples assumed (but unlikely) • tagged pigeons mixed well with untagged pigeons • tags remained in place B1dep e.g. estimate may not be reliable (as assumptions unlikely to hold)	1st/2nd B1 marks for any two correct assumptions from the list. Accept equivalent comments. 3rd B1 for appropriate assessment of reliability of estimate, dependent on at least B1 scored Do not award 3rd B1 for answers that state both reliable and unreliable.	(3)

Q7.

Question	Scheme	Marks
(a)	$18 \div 2 \times 45$ $= 405$	M1 A1 (2)
(b)	To allow the tagged geese to mix with the rest of the population.	B1 (1)
(c)	It would be unreliable to use this sample since…. • The population will have changed (births/deaths/flown away) • The tags may have fallen off	B1 B1 (2) **[5]**
	Notes	
(a)	M1 for any correct method e.g. $\frac{2}{18}=\frac{45}{N}$ or $2:18 = 45:N$	
(b)	Idea of mixing or allows for all geese to have same chance of selection (random) Allow comments which explain why waiting more than 1 day would be inappropriate	
(c)	1st B1 for it would be unreliable plus any reason 2nd B1 for a suitable supporting reason	

Q8.

Question number	Answer	Additional guidance	Mark
(a)	M1 for $\frac{114}{n} = \frac{69}{243}$ OR $\frac{114\times243}{69}$ *oe* A1 for 401 or 402	Must be an integer answer	(2)
(b)	B1 for reference to large sample size so it may be reliable B1 for reference to not knowing how the data was collected so may not be reliable	B1 for each of two correct reasons assessing the reliability of using this data Do not accept listing of individual assumptions of technique.	(2)
(c)	B1 answer in (a) is an overestimate/cause an increase in the estimate of the population size OR true population estimate would be lower oe		(1)