L2 Probability Practice #3

1. A scientist tests trout from a lake in an active geothermal region to see if they are being contaminated with methyl mercury (a poison that builds up in the body). The World Health Organisation's safe limit is considered to be 500 ppb (parts per billion).

   The scientist tests 20 fish and finds an mean methyl-mercury level of 378 ppb with a standard deviation of 127 ppb.

   a) What proportion of fish will be over the 500 ppb recommended limit?

   b) What range of methyl-mercury levels would include the middle 90% of all trout in the lake?

   c) A nearby lake recorded an mean methyl-mercury level of 392 ppb, with a standard deviation of 88 ppb. Describe the differences in the distribution of mercury in the fish compared to the first lake, and particularly how that relates to those with extremely high levels of mercury.

2. Scientists count fish in a stream returning upstream to mate and spawn.

   - in June they count 112 males and 95 females.
   - in July they count 147 males and 151 females
   - in August they count 63 males and 81 females.

   a) What is the probability a randomly selected fish returned in July?

   b) If a returning fish is male, what is the probability it returned in June?

   c) A scientist states that the relative rate of male arrivals is higher for early fish. Is this correct?

3. A scientist studies the effect pollution is having on the age at which fish reach maturity. Normally it would be expected that most fish would be mature after two years. He finds:

   - 82% of the fish are found to be fully mature after two years.
   - 52% of the fish that are mature after two years are male.
   - 39% of the fish that are not yet mature after two years are male.

   a) What is the probability a randomly selected fish is a mature female?

   b) What is risk that a female fish will not be mature after two years?

   c) What is the relative risk that a female will not mature after two years, compared to a male fish?

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Answers: L2 Probability Practice #3

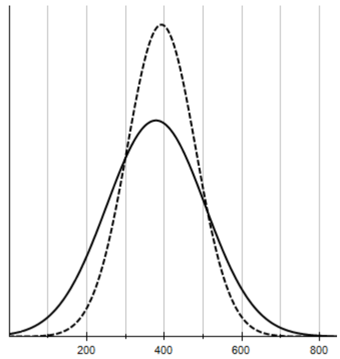
1.

a) Graphics normal distribution: Ncd: lower =500, upper = 99999, σ = 127, μ = 378
P(500 > x) = **0.168**

b) Graphics normal distribution: InvN: tail =centre, area = 0.90, σ = 127, μ = 378
(older calculators use InvN: area = 0.05 for low bound, then 0.95 for high bound)
range = **169.1 – 586.9 ppb**

c) The second graph (dotted) will be much steeper in general, falling away to near zero more quickly, because it has a smaller standard deviation.

Although in the second lake the maximum will be at the higher mean of 392, not 378, because it has less spread, due to a lower standard deviation, it will still have **fewer fish with extremely high values**.



2. Much easier to work out if you put the information into a table:

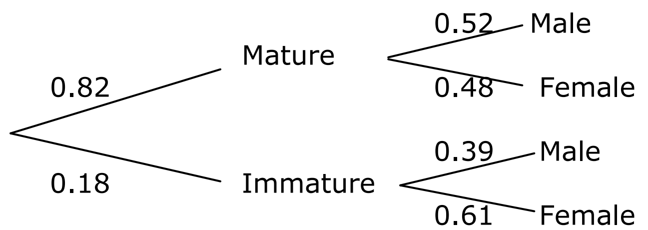
	June	July	August	**Total**
Males	112	147	63	**322**
Females	95	151	81	**327**
Total	**207**	**298**	**144**	**649**

a) 298 fish returned in July, out of 649 total, so the probability is 298 ÷ 649.
P(fish returned in July) = 0.459

b) There are 322 male fish, of which 112 return in June, so probability = 112 ÷ 322
P(male fish returned in June) = 0.348

c) % male fish in June = 112/207 = 54.1%; % of male fish in July = 147/298 = 49.3%
so relative percentage = 54.1/49.3 = **1.10** = 10% higher. Statement is **true**.
(% of male fish in August = 63/144 = 43.75% which is even lower.)

3.



0.82 × 0.52 = 0.4264
0.82 × 0.48 = 0.3936
0.18 × 0.39 = 0.0702
0.18 × 0.61 = 0.1098

a) P(mature female) = 0.82 × 0.48 = **0.3936**

b) "Risk" in this context just means the probability that a female will be immature.
P(immature and female) = 0.1098 and P(female) = 0.3936 + 1098 = 0.5034
P(not mature, given a female) = 0.1098 ÷ 0.5034 = **0.218**

c) Risk male will not be mature = 0.0702 out of (0.4264 + 0.0702) = 0.141 by same method as (b).
Use that male risk as a baseline for the female risk found in (b)
Relative risk that female will not be mature (cf male) = 0.218 ÷ 0.141 = **1.55**

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