Derivation of C. S. Holling's Disc equation as an example of a theoretical model

Holling, C. S. 1959. Some characteristics of simple types of predation and parasitism. Canadian Entomologist 91:385-398.

1. γ = time required to consume one captured prey (time)

2. α = successful search rate = area searched per unit time multiplied by the probability that an encountered prey is captured $\left(\frac{\text{area}}{\text{time}}\right)$

3. V = prey density $\left(\frac{1}{\text{area}}\right)$

4. αV = prey capture rate $\left(\frac{\text{area}}{\text{time}} \times \frac{1}{\text{area}} = \frac{1}{\text{time}}\right)$

5. $\frac{1}{\alpha V}$ = time required to capture one prey (time)

6. Assuming that handling and search are mutually exclusive processes, prey capture rate is

$$z = \frac{1}{\gamma + \frac{1}{\alpha V}}.$$

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7. Checking units:

$$z = \frac{1}{\text{time} + \frac{1}{\frac{\text{area}}{\text{time}} \times \frac{1}{\text{area}}}} = \frac{1}{\text{time}}$$

8. Rearranging:

$$z = \frac{1}{\gamma + \frac{1}{\alpha V}} = \frac{\alpha V}{1 + \alpha V}$$