Methods

In order to evaluate the feasibility of an obligate scavenging adult tyrannosaurus we use estimates of tyrannosaurs searching rate, energy balance and a range of carcasses distributions. To these estimates we also explore the affect of both inter and intra competition and exclusive access to bone derived energy on the possibility of obligate scavenging.

Following the approach of Ruxton et al (2003) that scavengers are constraint by their ability to find food we define a scavenger searching for a fraction (α)of their time according to a distribution (*f*). When active the scavenger searches out an area at a rate of *V* hence having an energy input at the rate α*fVE* where *E* is the amount of energy from each food item. The cost of such searching is given by α*S* while the rate of energy expenditor at rest is given by *R*. This gives the equation

*E*net = *E*in – *E*out = **α**(*fVE*) – **(α***S* + R)

Following Ruxton et al (2003) and Carbone et al (2011) we assume a 12 hour daily searching period, similar to the behaviour of brown hyenas (Mills). For the ectoterm model we used resting metabolic scaling relationships Rect = 0.11M0.76 as calculated from reptiles (White et al 2006 this is an OLS model though not a PGLs) were M, the mass of the T.rex in kg, is taken to be 6 tonnes (does this match Hutchinson?). To calculate the cost of searching we used the equations in Ruxtons et al (2003).

For the endotherm model the allometric equation Rend = 4.12M0.69 was used as calculated from mammalian resting metabolic rate (White et al 2006) (who said this was the best group to use?). To calculate the cost of searching we used the slow walking speed (v) of 2.5 meters per seconds as calculated for a 6 ton Tyrannosaurs rex in Pontz? et al (2007). The cost of transport (COT) of 1 kg per meter was then calculated using COT = 90.284Hip-0.77 for an adult with a hip height of 264cm (Pontz? et al 2007). This was then multipyied by the mass and walking speed (v) to give the cost of searching per second.

Based on the speed (v) for each model the search rate was calculated using Searched area = v(detection distance x2).

Estimating the energy input of food items. To estimate the energy available to a scavenger from carcasses we used the estimated density of carcasses density from the Serengeti of 4.38 kg/km2/day (ref)(was there a problem with this?). Using the body size distributions of both Carbone et al (2011) and Horn et al (2012?) the amount of bone available was calculated using the scaling relationship Bone mass = 0.065M1.071 from Prange et al (1979) for birds (mammals is very similar). An energy content of 6.7kJ/g was used for bone as calculated using the average calculated energy density calculated from vulture carcasses by Who et al ???().

We follow previous studies on T.rex scavenging energetics and assume a carcasses density based on modern day Serengeti environments which yield 4.38 kg/km^2/d of carcasses. To estimate the average distance between carcasses of different body sizes we partition the above figure across body size bins of the herbivorous dinosaurs according to the % of the community made up from each body size bin as in Carbone et al (2011). Hence if all carcasses consistent of 70kg individuals on average each km would produce a carcass every 16 days. The percentages of the above carcass production rate imparted by each body size group was determined by first of all basing it on densities of individuals calculated from scaling equations as used in Carbone et al. However as the densities of each of the groups is difficult to estimate with some studies suggesting a density distributions distinctly different then may be expected from scaling based on contemporary groups we select a range of possible body size proportionality in carcass development.

Results

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Detect  range | | Search rate  (km2/d) | | | Dist.ref | | | Time until each body size carcass (days) | | | | | | | | Days until full sat | | |
|  |  | | | |  | | 75 | | 216 | 700 | 2500 | 5000 | 8500 | 25000 |  | | Bo. | c.50 |
| 80m | | | 2.9 | Carbone | | 6 | | | 17 | 55 | 197 | 394 | 669 | 1968 | | Inf | | 540.03 |
| 200m | | | 7.3 | Carbone | | 2 | | | 7 | 22 | 78 | 156 | 266 | 782 | | 156 | | 40.005 |
| 500m | | | 18.3 | Carbone | | 1 | | | 3 | 9 | 31 | 62 | 106 | 312 | | 320.02 | | 10 |
| 1000m | | | 36.6 | Carbone | | 0.5 | | | 1 | 4 | 16 | 31 | 53 | 156 | | 50.002 | | 10 |
|  | | |  |  | |  | | |  |  |  |  |  |  | |  | |  |
| 80m | | | 2.9 | %com | | 2 | | | 7 | 131 | 420 | 9372 | 23900 | 140585 | | Inf | | 70.005 |
| 200m | | | 7.3 | %com | | 0.7 | | | 3 | 52 | 167 | 3723 | 9494 | 55848 | | Inf | | 10 |
| 500m | | | 18.3 | %com | | 0.3 | | | 1 | 21 | 67 | 1485 | 3787 | 22279 | | 10.001 | | 10 |
| 1000m | | | 36.6 | %com | | 0.1 | | | 0.5 | 10 | 33 | 743 | 1894 | 11139 | | 10 | | 10 |
|  | | |  |  | | 2 | | | 24 | - | 36 | 2 | 73 |  | |  | |  |
| 80m | | | 2.9 | %dino.a | | 58 | | | 14 | - | 107 | 3852 | 180 | - | | Inf | | 1770.19 |
| 200m | | | 7.3 | %dino.a | | 23 | | | 5.5 | - | 43 | 1530 | 71 | - | | 720.07 | | 420.03 |
| 500m | | | 18.3 | %dino.a | | 9 | | | 2.2 | - | 17 | 610 | 28 | - | | 170.01 | | 40.005 |
| 1000m | | | 36.6 | %dino.a | | 4.6 | | | 1 | - | 8.5 | 305 | 14 | - | | 40.002 | | 10.002 |
|  | | |  |  | | 50 | | | 144 | - | 1667 | 3333 | 5667 | - | |  | |  |
| 80m | | | 2.9 | %dino.j | | 39 | | | 9 | - | 71 | 2566 | 120 | - | | Inf | | 710.09 |
| 200m | | | 7.3 | %dino.j | | 15 | | | 4 | - | 28 | 1019 | 48 | - | | 470.06 | | 110.007 |
| 500m | | | 18.3 | %dino.j | | 6 | | | 1.5 | - | 11 | 407 | 19 | - | | 120.01 | | 10.002 |
| 1000m | | | 36.6 | %dino.j | | 3 | | | 0.7 | - | 6 | 203 | 10 | - | | 60.001 | | 10 |
|  | | |  | |  | |  | |  |  |  |  |  |  | |  | |  |

All results assume carcass is around for 7 days (simply multiply to get encounter rate if only around for 7 days). Dino park formation excludes t.rex as a source of scavenging. Juvinial ones are simply 0.66 of adult mass.



Figure 1. Energetic budgets for adult t.rex consuming scavenged bones as according to a body mass distribution used in Carbone et al (i.e equivalence).



Fig 2. Energetic budgets for adult t.rex consuming scavenged carcasses asumming 50% is scavenged prior to t.rex feeding. Body mass distribution as used in Carbone et al (i.e equivalence).



Fig 3. Energetic budgets for adult T.rex consuming scavenged bones as according to a body mass distribution based on the numerical percentage of community found in Dinosaur Park (Hone et al).



Fig 4. Energetic budgets for adult T.rex consuming scavenged carcasses assuming 50% is scavenged prior to T.rex feeding. Body mass distribution as found in Dinosaur Park Hone et al (i.e equivalence).