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Does the Float Whale Pokémon really float? How can Wailord avoid floating off into space?

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Abstract
Wailord, the biggest Pokémon in the franchise, has a mass that implies it is less dense than both water and air. This paper calculates that if Wailord eats approximately 55.36 kg of food, its average density will be sufficient such that it will remain in the water. An unfeasible amount of food would be needed to reach the density of water, however.

Introduction
The largest known creature in the Pokémon universe is Wailord, the Float Whale Pokémon. Were they to exist in real life, they would be the tenth largest organism on Earth, reaching 14.5 m from head tip to tail. They are supposedly capable of diving up to 3,000 m below sea level and are known to prey on smaller water type Pokémon [1].

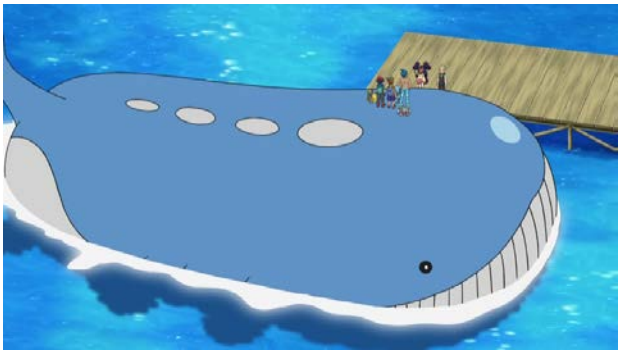

Figure 1 – The largest known creature in the Pokémon universe, but can it stay in the water? [2].

An odd quirk of this behemoth is its official weight. While it would be expected that such a gargantuan creature would have a mass to match, Wailord weighs just 398 kg [1]. Widely believed to be an uncorrected typo upon its introduction to the franchise, this value has led some fans to claim that Wailord is not only less dense than the water in which it resides, but also air [3].

This paper will calculate an approximate density of a Wailord, and compare this to the densities of air, seawater at sea level, and seawater at a depth of 3,000 m. Should Wailord not be sufficiently dense to reach this depth, calculations will then be made to work out how many other Pokémon it would have to ingest to achieve the required density.

Density of Wailord
The first step towards calculating a Wailord's density it to approximate its shape. In 2014, Melbourne devised two methods to devise this Pokémon's volume. After measuring an aspect ratio of 2.54, a height of 5.71 m was deduced [2].

A solid estimate is to model Wailord's body as a cylinder. While the body is not completely cylindrical, empty spaces in the model will be compensated by the large tail and fins that are not considered within the model. Thus, Wailord's volume can be approximated as 370.01 m^3. Dividing Wailord's mass by this volume gives the Pokémon a density of 1.08 kgm^{-3}.

The density of seawater, at 3,000 m has been calculated at 1,041.43 kgm^{-3}, while seawater at 0 m is 1,025.56 kgm^{-3}, and air approximately 1.23 kgm^{-3} [4, 5]. This means that Wailord will not only require a large physical effort to dive below the water's surface but is significantly less dense than air. Wailord would thus have to be tethered to the ocean floor in order to avoid floating into the air.

Gaining Mass
One method by which Wailord can acquire mass would be to consume food. Wailord's diet appears to consist of mainly Wishiwashi and Luvdisc, two much

smaller aquatic Pokémon found in the same areas [1, 6].

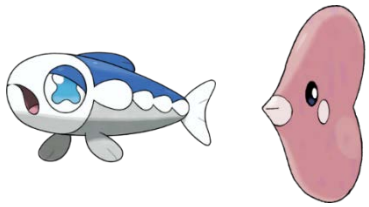

Figure 2 – Wishiwashi (left) and Luvdisc (right) are consumed by Wailord [7, 8].

Wishiwashi appear to have a similar aspect ratio to Wailord but have a cone-shaped body. As their length is officially listed as 0.2 m, we determine the radius of their 'conical' body to be 0.0039 m. This gives a volume of 3.2×10^{-4} m^3 which, when combined with a mass of 0.3 kg, provides a density of 924.12 kgm^{-3} [7].

Luvdisc, meanwhile, are heart-shaped. In this paper, the shape is approximated as a square with two semi-circles attached. The area of this shape was determined to be $(\pi + 4)r^2$, as shown in figure 3. Luvdiscs have a height of 0.6 m, giving a radius r of 0.3 m and an area of 0.643 m^2. Assuming a width of 5 cm, a Luvdisc will have a volume of 0.0321 m^3. With a mass of 8.7 kg, the density will be 270.71 kgm^{-3} [8].

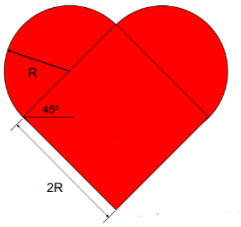

Figure 3 – Approximation of the surface area of a heart [9].

Achieving the Required Density

From the above data, it is possible to calculate the volume, and then number, of each type of prey in order to make Wailord sufficiently dense to:

- Not float away into the sky (>1.23 kgm^{-3})
- Dive below the water's surface without effort (>1,025.56 kgm^{-3})
- Reach 3,000 m without exerting itself (>1,041,43 kgm^{-3})

The following equations provide an example calculation for the amount of Wishiwashi consumed to become denser than air, while table 1 contains the amount of both prey to reach the different densities listed.

$$m_{Wailord}(new) = \rho V = 1.23 \times 370.01 = 453.26\ kg$$

$$m_{Prey} = m_{Wailord}(new) - m_{Wailord}(unfed) = 453.36 - 398 = 55.36\ kg$$

$$V_{Prey} = \frac{m_{Prey}}{\rho_{Wishiwashi}} = \frac{55.36}{925.12} = 0.0577\ m^3$$

$$Number\ consumed = \frac{V_{Total}}{V_{Wishiwashi}} = \frac{0.0577}{3.25 \times 10^{-4}} = 177.47$$

Prey	Target Density (kgm^{-3})	Volume Required (m^3)	Number Consumed
Wishiwashi	1.23	0.0577	178
	1,025.56	410.12	1261908
	1,041.43	417.69	1285200
Luvdisc	1.23	0.204	7
	1,025.56	1400.02	43615
	1,041.43	1425.88	44420

Table 1 – The number of prey required to achieve different densities. 'Number Consumed' is reported as an integer, as it is assumed all prey is whole.

Discussion

As can be seen in table 1, Wailord would need to consume 178 Wishiwashi or 7 Luvdisc to become denser than air and not rise out of the water. The volumes taken up by both of these quantities (0.0577 m^3 and 0.204 m^3 respectively) seem feasible quantities for Wailord to have stored in its stomach.

On the other hand, the volume of prey that would have to be consumed in order to sink below the surface without physical effort would not only be bigger than its stomach, but bigger than Wailord itself. However, this seems somewhat reasonable, as in the real world whales are less dense than the water surrounding them and expend energy while diving for food and other activities [10]. Furthermore, reaching this density would mean that Wailord would have to make a concerted effort to breach the water and breath. It is also assumed that all mass consumed is transferred to Wailord, where in reality mass would be lost through excretion and conversion to energy.

Conclusion

By ensuring it has at least 55.36 kg of food in its stomach, Wailord could maintain a sufficient density to avoid floating up into the sky. It would also be possible for Wailord to reach 3,000 m by consciously diving to that depth, much like real life whales.

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