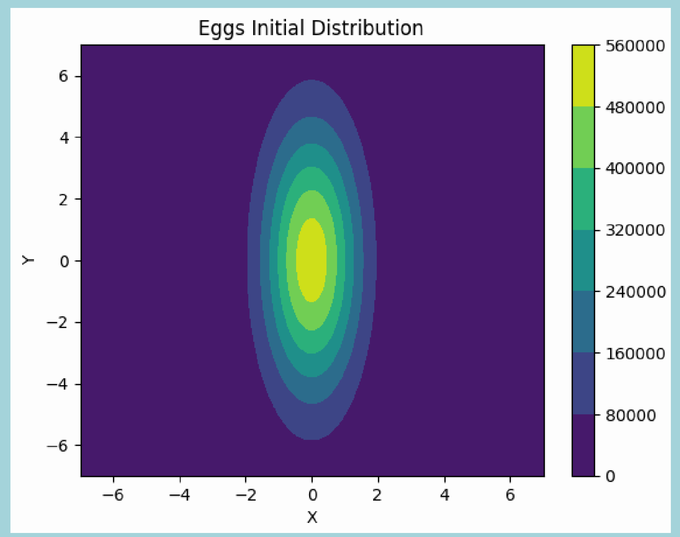
Fish Dispersal Model Post-Hatching

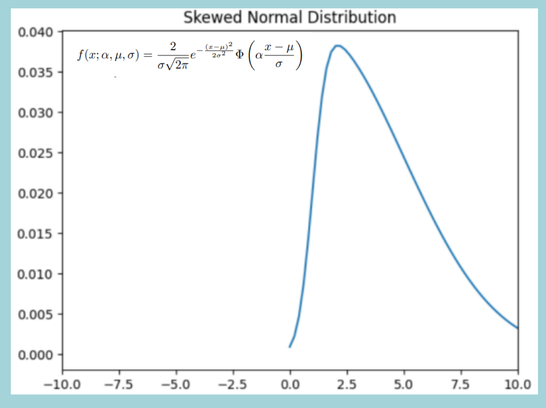
Based on Density Dependent Diffusion



Distribution of eggs at the migratory site for fish where the yearly mating occurs.

$$f(x,y) = A\exp\left(-\left(\frac{(x-x_0)^2}{2\sigma_X^2} + \frac{(y-y_0)^2}{2\sigma_Y^2}\right)\right).$$

The hatching process is influenced by the interplay of temperature and aeration at the ocean floor. This dynamic yields a skewed gaussian hatching behavior, characterized by a rapid peak followed by a slow decrease with time.



This graph indicates the proportion of eggs that have hatched at each discretized time interval.

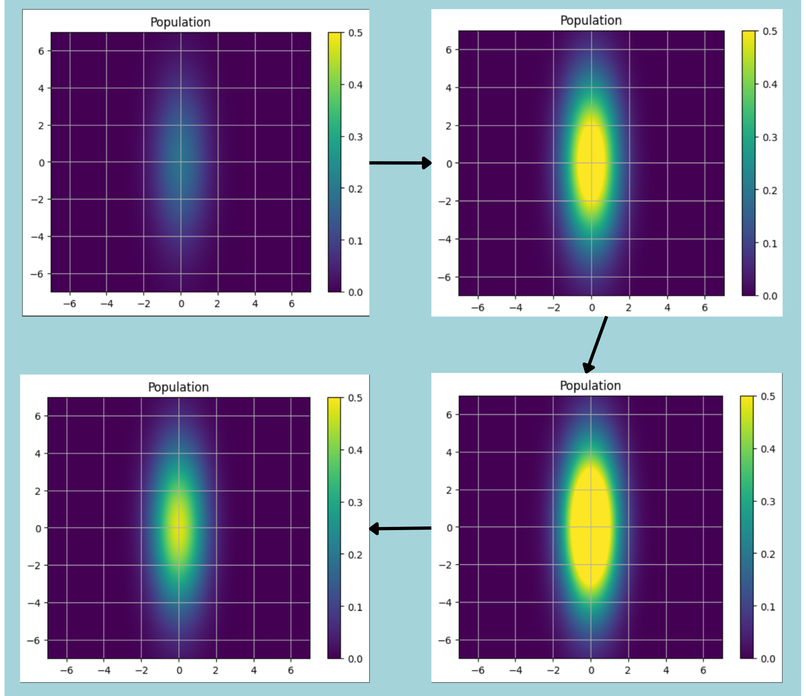
Post-Hatching, The population migration flux of the baby fish is characterized as a gradient that is dependent on population density.

$$J = -D(p)\left(\frac{\partial p}{\partial x}, \frac{\partial p}{\partial y}\right) \qquad D(p) = k_1 p$$

Thus, with the Divergence Theorem, we arrive at the following partial differential equation.

$$\frac{\partial P}{\partial t}(x,y,t) = K\left[\frac{\partial^2}{\partial x^2}\left[P^2(x,y,t)\right] + \frac{\partial^2}{\partial y^2}\left[P^2(x,y,t)\right]\right] + F(p)$$

Post-Hatching Migration Behaviour



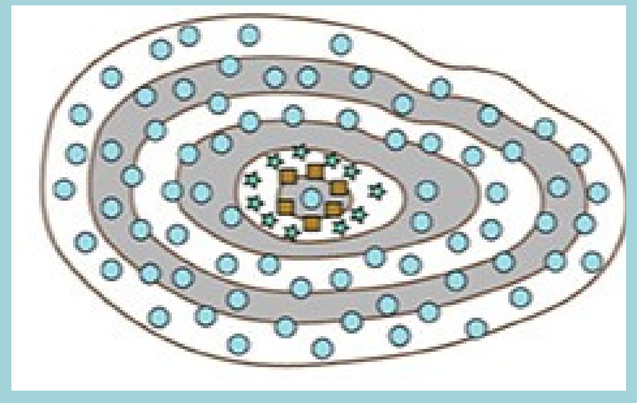
Using finite difference method, we solved the PDE by discretizing the spatial and temporal domains.

$$P_{i,j}^{n+1} = P_{i,j}^n + \frac{\Delta t}{\Delta x^2}(P_{i+1,j}^n - 2P_{i,j}^n + P_{i-1,j}^n) + \frac{\Delta t}{\Delta y^2}(P_{i,j+1}^n - 2P_{i,j}^n + P_{i,j-1}^n)$$

where $i = 1, 2, \ldots, \mathrm{N}x - 2$, $j = 1, 2, \ldots, \mathrm{N}y - 2$ and $\mathrm{n} = 0, 1, 2, \ldots, Nt$-1.

Conclusions

- Post-Hatching, The population migration flux of the baby fish is characterized as a gradient that is dependent on population density.
- The population first increases in the region till a point and then reduces as fish spread out.
- Young fry disperse in an efficient way to maximise their chances of finding food and chances of survival as this allows them to be less susceptible to large predator attacks. This is an important evolutionary trait.



Typical Migration behaviour from spawning area to the ocean