Pipers Load Factor (Flow Index)

Piper's loading index equation is one of the first attempts to mathematically calculate the juvenile salmon carrying capacity of a hatchery rearing tank. The equation Piper developed in 1970 also uses multiple factors in the equation that have are important to consider when filling a rearing tank with fish. These factors are water temperature, size of the fish (length) and the amount of water flowing into the tank.

- Water temperature is an important factor since the warmer the water the less oxygen, necessary for life, the water will hold and at the same time as water fish require more oxygen as they grow larger, so the F loading factor decreases as the water temperature increases
- **L** is the length of the fish and because as the fish get larger, the rearing tank will naturally hold fewer fish, so the amount of fish the tank will hold must be adjusted to account for size
- **I** is the constant flow rate of water into the tank. Increasing the volume of the flow in gallons per minute increases the amount of oxygen deliver and the tank can hold more fish than a lower volume flow rate. However, there is a limit as to how much flow should be provided as the speed of the water through the tank also increases with flow rate, resulting in the fish using more energy, and oxygen, in the process of swimming against the current

Considering all the factors that affect loading, a fine balance must be maintained to provide the best rearing environment. If the environment is imbalanced, the fish will be stressed, grow poorly, suffer disease, and mortalities will occur in the tank or upon release into the natural environment.

Let us move onto the Pipers equation, using the index table, and computing a loading example.

Pipers loading equation is:

$$Wf = F \times L \times I$$

Where: Wf = total weight of the fish in the pond (lbs)

F = load factor (lbs. fish/gpm/inchs of fish length
(From the table value below)

L = Length of the fish in inches

I = Water flow in gallons per minute (gmp)

Loading factor values by temperature in ^{o}F and at sea level (elevation = 0 ft)

Water temperature ^{o}F	Loading factor F	Water temperature ^{o}F	Loading factor F
40	2.70	52	1.67
41	2.61	53	1.61
42	2.52	54	1.55
43	3.43	55	1.50
44	2.34	56	1.45
45	2.25	57	1.41
46	2.16	58	1.36
47	2.07	59	1.32
48	1.98	60	1.29
49	1.89	61	1.25
50	1.80	62	1.22
51	1.73	63	1.18

Example problem:

Data:

- The fish tank I want to load has a water temperature of 44^{o}F.
- The length of the fish I want to load is 2 inches.
- The tank if flowing at 100 gallons per minute

What is the maximum loading in pound of fish this tank can hold?

Calculation:

- The F loading factor from the table at 44 ^{o}F is 2.34
- Gallons per minute flow is 100 gpm
- Length of the fish is 2 inches

Wf (total loading of fish in pounds) = 2.34 x 100 x 2 = 468 pounds of fish

Since the answer is the total loading capacity of the tank, and further grow is expected, you would actually load about 70% of the total loading capacity of 468 lbs =0.70 x 468 = 328 lbs.