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Carrying Capacity of Pond – An Overview

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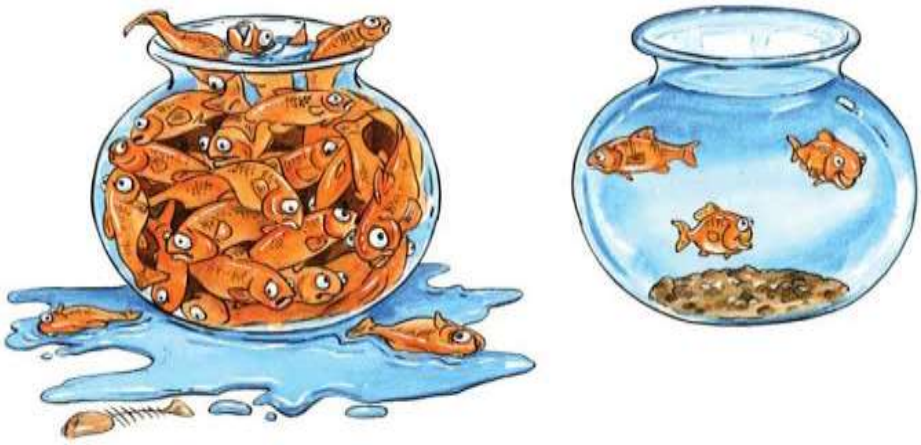
SUMMARY

Carrying capacity has become a fundamental concept within the context of environmental management. Carrying capacity for aquaculture has been studied since the 1960s and has attracted a dedicated literature focused on measuring the environmental and production limits of aquaculture developments. Nevertheless, management and policy face emerging challenges across environmental and social aspects and the growing need to manage multiple objectives in increasingly crowded aquatic ecosystems. Therefore, promoting more sustainable aquaculture development should consider how the tools, methods and research used to support management and decision-making should advance to meet such challenges. Here, the conceptual and practical applications of carrying capacity are reviewed and future prospects discussed. Carrying capacity for aquaculture has developed a range of models, indicators and approaches to study the relationships between aquaculture and ecosystem components. Carrying capacity supports diverse management objectives to support physical, production, ecological and social goals, although greater emphasis has focused on ecological and production capacities.

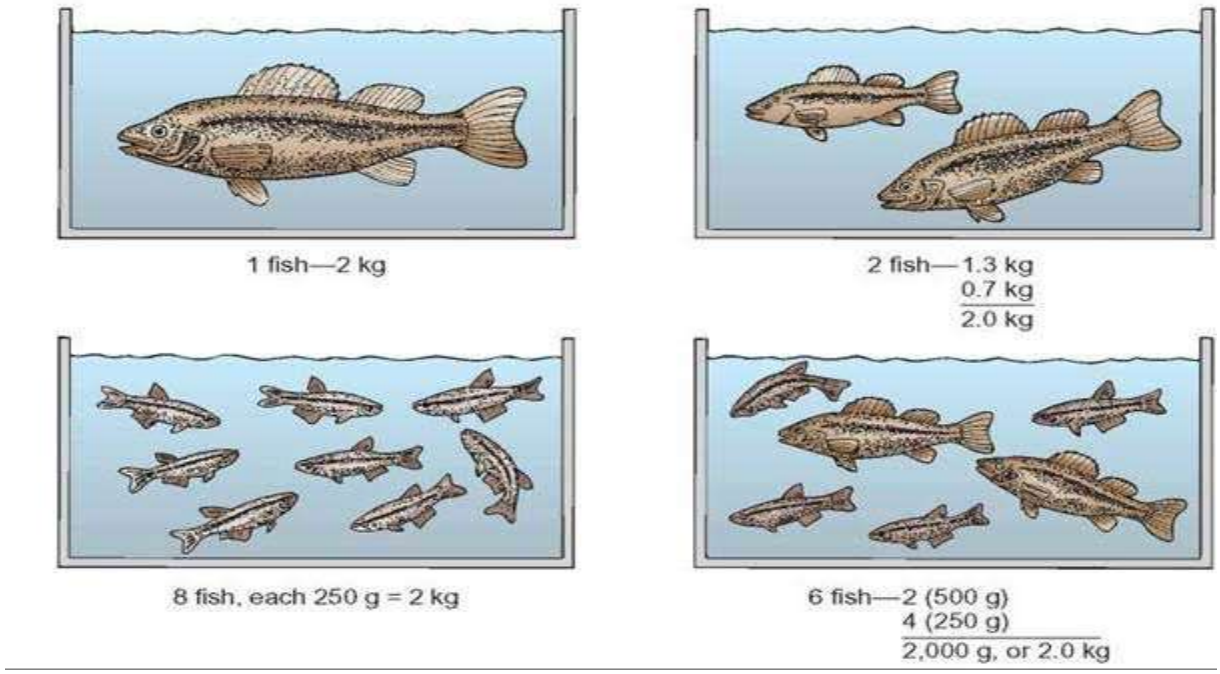
INTRODUCTION

Carrying capacity can be defined as the maximum biomass maintained by an ecosystem in a given period. It has become a fundamental concept in aquaculture management and is considered the basis and a tool for sustainable development. Carrying capacity was first applied in fish pond research in 1963, it has gradually developed from the individual level to the ecosystem level. In recent years, carrying capacity assessments based on ecosystem models have become a research hotspot in aquaculture. Carrying capacity refers to the maximum number of fish the pond can support without compromising their health or the overall ecosystem balance.



In fish farming, every fish pond has a carrying capacity, which is there is a maximum weight of fish a pond can carry. Anything exceeding this carrying capacity will cause the fish to stop growing as they should. In fish farming, every fish pond has a carrying capacity that is there is a maximum weight of fish a pond can carry. Anything exceeding this carrying capacity will cause the fish to stop growing as they should. If the weight of fish exceeds the carrying capacity, it means some of the fish have to die. This means the weight of the fish must not exceed the pond's carrying capacity. For instance, if a pond has a volume of 1000 litres of water, and we have a standard of 10 litres to 1 fish of 1kg, it means the pond can carry only 100kg fish or 100 fish. Carrying capacity

is not measured by the dimensions of a fish pond but by the volume of water, it can take which, in turn, determines the number of fish a pond can take.



Factors that influence the carrying capacity

- Availability of Food
- Space
- Shelter

Calculation of stocking density

- The quantity of fish a pond can take can be calculated and should be calculated.
- This is to ensure proper stocking or to avoid high stocking density.
- However, the calculation of stocking density varies, it depends on the type of pond used.
- Here is how to calculate the quantity of fish a pond can a pond can take (using the following calculation parameters).
- Concrete Pond: Length x Breadth x Height x 5/3 [Measurement done in Feet]
- Earthen Ponds: Length x Breadth x Height x 2/5 [Measurement in Feet]
- Mobile fish Pond: Length x Breadth x Height x 5/3 [Measurement done in Feet]
- Tanks: For tanks, I would advise you use use a standard of 50 litres per fish.

Several items need to be considered / remembered.

- The carrying capacity and fishery balance changes as ponds age.
- You are correct a few die, although the number is almost always more than a "few". Expect 10-35% maybe 40% early deaths depending on the source and handling. Often dead fish don't float.
- Once the pond reaches carrying capacity natural annual mortality is high usually 20%-30% of the older/adult fish. These annual deaths are not always apparent and usually go unnoticed. This is why annual harvest is wise, efficient use of the resource.
- In balanced communities or high predatory populations, few new fish survive long enough to be adult recruits.
- Your 450lbs/ac figure may not be remembered correctly or the source of the info may not have been accurate or can not be applied to every situation. Rarely is one carrying capacity figure all inclusive. "It always depends."
- In good poly culture, diverse communities where different species will utilize different niches, this allows less direct competition and ultimately higher carrying capacities.
- Different ponds (situations) can have higher natural and artificial carrying capacities depending on habitat and soil type.

Environmental management methods

1. **Water clarity/lack of suspended sediment**—Lack of suspended sediment allows for better sunlight penetration into the water column, which in turn increases simple and complex plant growth, which in turn enhances micro and macro-invertebrate populations, yielding more fish. Water clarity is composed of suspended micro algae, zooplankton, bacteria, and dead organic & inorganic solids aka detritus. Usually non-living detritus is more abundant than the other three categories. Just because your water has low visibility does not mean lots of living Plankton is present.

2. Fertility—Nutrients are necessary for the above mentioned phytoplankton growth to occur.Increased fertility can occur naturally or be helped along artificially when necessary by fertilization or fish manure from feeding the fish. Just adding nutrients or fertilizer is not the answer if the pond water chemistry is not alkaline enough for the plankton to utilize the nutrients. Adding fertilizer to a clear water pond with weeds or filamentous algae usually just results in those two "weeds" blooming instead of the plankton. Learn about and know how to do it right.

3. Competition—Predator carrying capacity is directly impacted by competition from other predators, even in the form of so called "prey" species early in life, i.e. carnivore need abundant zooplankton for several weeks before they can prey on larval fish. Carrying capacity for any one species needs to account for other species in the fish community.

4. Weather/Environment—Does warm water have a greater "carrying capacity" than cool water? I'm not so sure. Fish in a cooler pond require less oxygen, and may therefore be able to push the envelope, so to speak, as far as pounds per acre. I would guess that a warmer pond may get to carrying capacity quicker, but may not ultimately support more weight of fish. I'd be interested in comments in regards to this.

5. Feeding—This may simply be a subgroup of fertility, but experience tells me that at least for short periods of time, I can support more pounds of fish per acre in a fed pond. In the long run, however, I may be more prone to crashes. Perhaps the fed pond has a higher "carrying capacity", but implies more risk. Higher carrying capacity always involves more risk. Be cautious and observant with high limit fisheries.

6. **Waste removal/flow through**—As nutrients build up in the form of waste products, a pond's carrying capacity decreases if it is unable to rid itself of waste. Ponds with efficient bacterial communities process waste better, thereby probably have higher "carrying capacity". Ponds with high natural flow through, such as those with a large watershed/volume ratio, have better ability to support more fish per acre due to the 'flushing' factor.

7. Aeration—Maybe a subgroup of #6, enhance a pond's ability to rid itself of waste, thereby increasing carrying capacity. Perhaps more importantly, aeration makes "usable" water more plentiful within a pond by bringing oxygen throughout the water column. Obviously a pond that only has oxygen in the top five feet, but below, has seven feet of anoxic oxygen (no DO) deficient water has less net carrying capacity per acre

8. Forage diversity— If a pond has species diversity that is appropriate to the goals of that particular ecosystem, it allows for more efficient movement of biomass up the food chain. In other words, if there is plentiful invertebrate life available that is utilizable by gizzard shad, then the presence of gizzard shad and or BG allows biomass to "flow" more efficiently up to a top end predator such as largemouth. This means a higher carrying capacity for the predator, although the carrying capacity could simultaneously decrease for species that would compete directly with the gizzard shad, such as bluegill or shiners.

9. pH —Another way that carrying capacity can be increased would be to have pH levels that minimize the presence of unionized ammonia. In water, ammonia occurs in two forms, which together are called the Total Ammonia Nitrogen, or TAN. Chemically, these two forms are represented as NH^{4+} and NH_3. NH^{4+} is called Ionized Ammonia because it has a positive electrical charge, and NH_3 is called Unionized Ammonia since it has no charge. This is important to know, since NH_3, unionized ammonia (abbreviated as UIA), is the form which is toxic to fish. Water temperature and pH will affect which form of ammonia is predominant at any given time in an aquatic system. At high pH there is more UIA because of the OH- groups readily available in basic water. The OH- groups attract the H+ ion to form water (H_2O). By stripping this ion away from NH^{4+} it leaves the unionized, or toxic form in the water. Toxic water means fewer fish, and less carrying capacity.

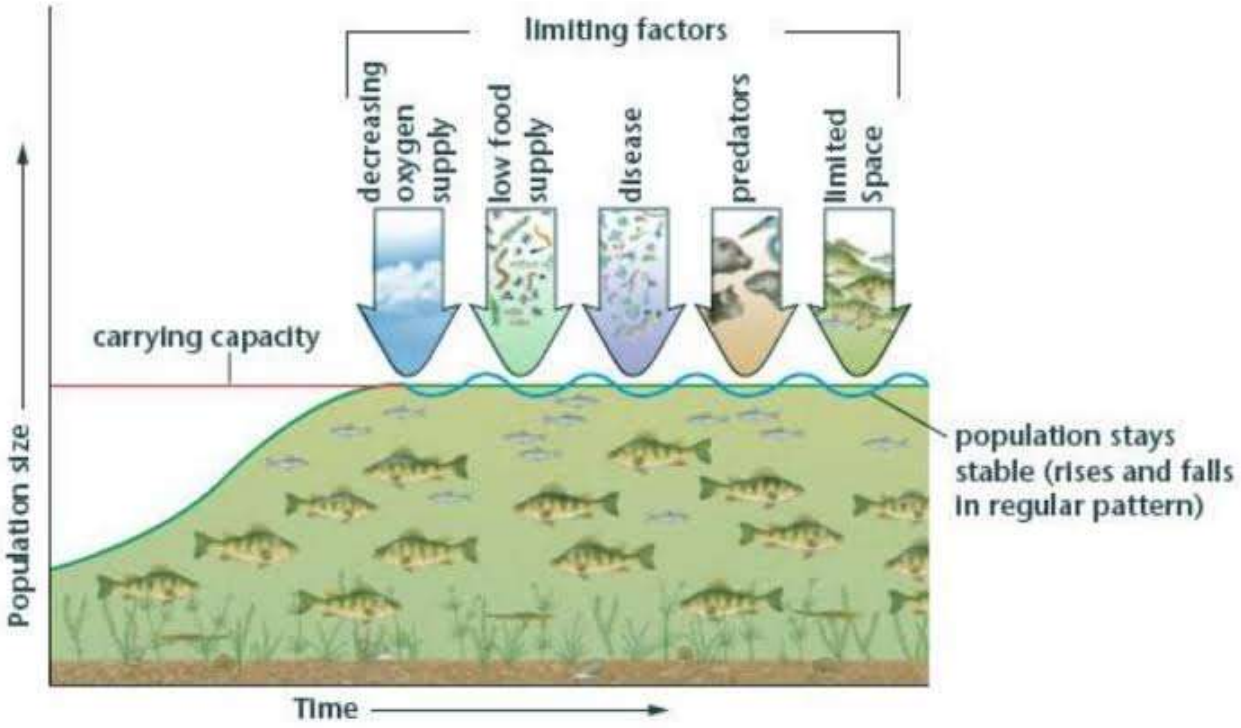
10. Social interaction— The carrying capacity is lower in a pond amongst species that spend large amounts of energy fighting over cover territory, and spawning substrate. A limited example would be an aquarium that might be able to hold three pounds of green sunfish biomass, but ultimately never reaches that carrying capacity because the GS spend most of their time attacking and killing each other. Pond ecosystems can behave in a similar manner if a particularly aggressive species, like bluegill fight over territory during late spring and summer.

11. Alkalinity -Alkalinity as dissolved carbonates stimulates or allows the phytoplankton to do their thing and thrive and move the nutrients up to zooplankton and the rest of the food chain that is actually a part of the pond's whole Food Web. Alkalinity can be increased by adding lime in the proper amounts. Alkalinity for good phytoplankton growth should be at least 20 mg/L or ppm. Fertilization without proper alkalinity will not stimulate good phytoplankton and resultant good zooplankton growth.

12. Suspended Dirt – High amounts of suspended silt decreases carrying capacity because it interferes with or reduces plankton production

Effects :

In nature, overpopulation is bad, it gives rise to all sorts of problems with disastrous consequences. Imagine



having 20 grown-up men in a small one-room apartment. There will be an extreme situation of survival of the fittest. Everything will be a competition or battle, and the weakest will suffer or even die off. The same applied to overstocking a pond with fish, there will be a struggle for survival and only the biggest and strongest will feed well and thrive. This will cause you to run at a loss, and possibly put you out of business. You shouldn't just use instincts or try to maximise space, it can lead to unfavourable consequences that will cost you your profit if not your farm.

CONCLUSION:

In conclusion, all of these factors need to be considered to evaluate "carrying capacity". It might also be more useful to think of this in terms of pounds of fish per unit of water volume instead of surface area, since one surface acre could mean anywhere from one to twenty acre feet of water. Being conscious of the quantity of fish a pond can take and strictly adhering will greatly help fish farming venture and save from loss. One of the reasons fish farms fail is due to overstocking or excessive stocking density.

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