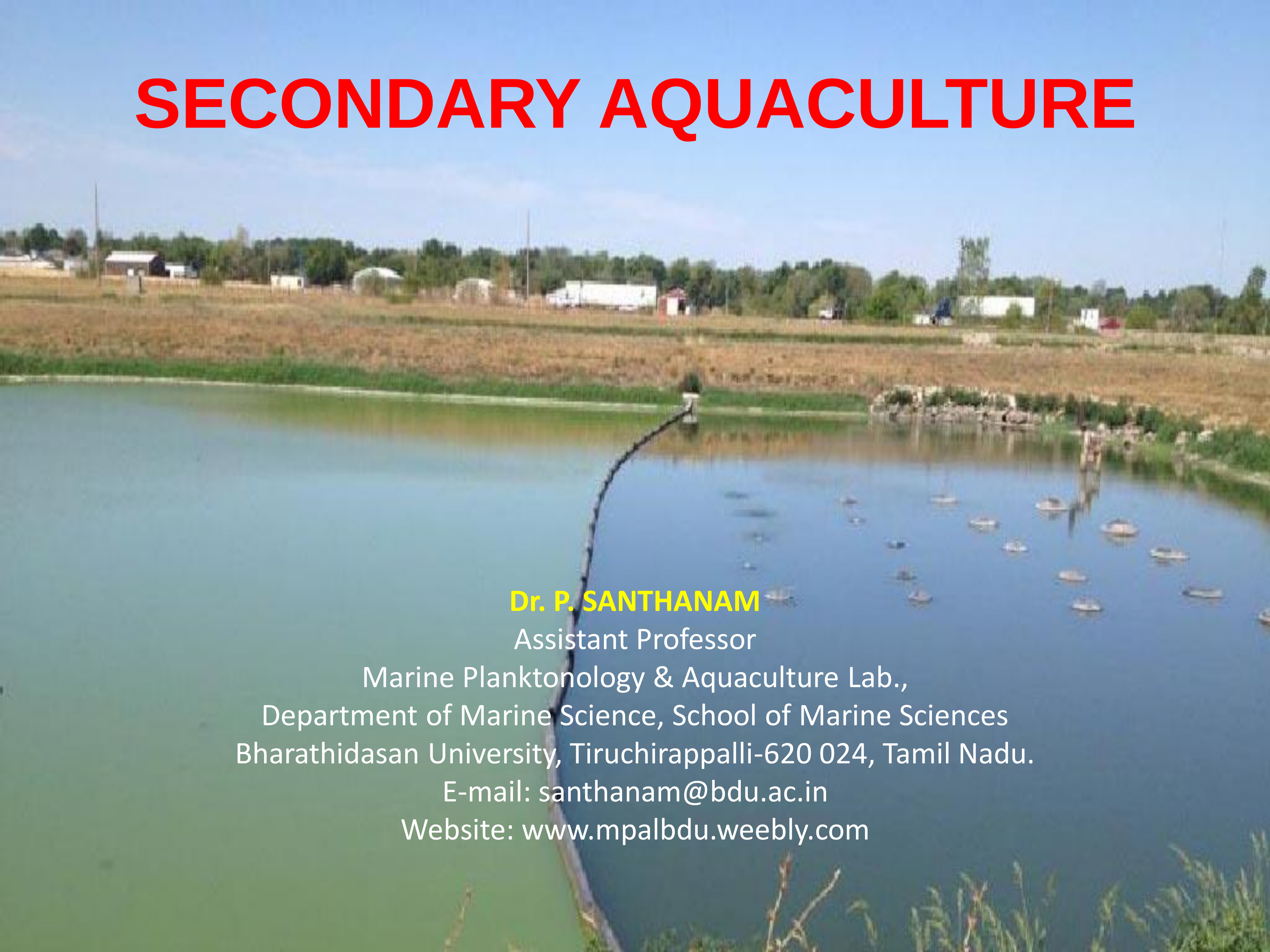
SECONDARY AQUACULTURE



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Cultivation of aquatic organisms in ponds receiving aquaculture waste water

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- A wide range of fish species has been cultivated in aquaculture ponds receiving aquaculture waste, including common carp *(Cyprinùs carpio),* Indian major carps (*Catla catla, Cirrhina mrigala and Labeo rohita),* Chinese silver carp *(Hypophthalmichthys molitrix),* bighead carp *(Aristichthys nobilis),* grass carp *(Ctenopharyngodon idella),* crucian carp (*Carassius auratus),* Nile carp *(Osteochilus hasseltii),* tilapia *(Oreochromis spp.),* milkfish *(Chanos chanos),* catfish *(Pangasius spp.),* kissing gouramy *(Helostoma temmincki),* giant gourami *(Osphronemus goramy),* silver barb *(Puntius gonionotus)* and freshwater prawn *(Macrobrachium lanchesterii).*

- The selection reflects local culture rather than fish optimally-suited to such environments. For example, Chinese carps and Indian major carps are the major species in excreta-fed systems in China and India, respectively.

- In some countries, a polyculture of several fish species is used. Tilapia are generally cultured to a lesser extent than carps in excreta-fed systems although, technically, they are more suitable for this environment because they are better able to tolerate adverse environmental conditions than carp species.

- Milkfish have been found to have poorer growth and survival statistics compared with Indian major carps and Chinese carps in ponds fed with stabilization pond effluent in India.

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- The various fish species which can be cultured in ponds fed with waste.

- It would appear that considerable confusion still exists with regard to fish feeding on natural food.

- Although fish are generally divided into types according to their natural nutritional habits-those that feed on phytoplankton, or zooplankton or benthic animals - several species are known to feed on whatever particles are suspended in the water.

- There is also uncertainty about the types of phytoplankton fed upon by filter-feeding fish. For example, although blue-green algae are thought to be indigestible to fish, Tilapia have been shown to readily digest these algae and there is evidence that silver carp can do the same.

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Environmental factors

- In a successful aquaculture system there must be both an organismic balance, to produce an optimal supply of natural food at all levels, and a chemical balance, to ensure sufficient oxygen supply for the growth of fish and their natural food organisms and to minimize the build-up of toxic metabolic products.

- Chemical balance is usually achieved through organismic balance in waste-fed ponds because the most important chemical transformations are biologically mediated.

- It is now recognized that depletion of dissolved oxygen in fertilized fish ponds is due primarily to the high rates of respiration at night of dense concentrations of phytoplankton.

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Environmental factors

Phytoplankton photosynthesis is the major source of oxygen during daylight hours and, during the night, the major cause of oxygen depletion is respiration.

It has been estimated that respiration of plankton (bacterioplankton, phytoplankton and zooplankton) can lower pond DO by 8-10 mg/l overnight. By far the greatest proportion of the DO depletion overnight is caused by the respiration of the phytoplankton that develop as a result of the nutrients contained in the waste.

Phytoplankton provide feed for the largest percentage of fish farmed. They also exhibit a positive net primary productivity on a 24-hour basis and are net oxygen contributors to a fish pond.

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Environmental factors

Fish mortality in a waste-fed pond can result from at least three possible causes. First, the depletion of oxygen due to bacterial oxygen demand caused by an increase in organic load. Second, the depletion of oxygen overnight due to the respiratory demand of too large a concentration of phytoplankton, having grown in response to an increase in inorganic nutrients, caused by an organismic imbalance. The third possible cause is high ammonia concentration in the waste feed.

Fish cultured in waste-fed ponds appear to be able to tolerate very low DO concentrations, for at least short periods of time, with air-breathing fish (such as walking catfish *(Clarias batrachus)* being the most tolerant, followed in decreasing order of tolerance by tilapia, carps, channel catfish and trout.

A wastewater fertilized aquaculture system might occasionally require a stand-by mechanical oxygenation system for use during periods when DO would otherwise be very low. However, if the system is well managed to avoid overloading, this expense can be avoided.

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Fish yields and population management

A wide range of yields has been reported from waste-fed aquaculture systems, for example: 2-6 tons/ha yr in Indonesia, 2.7 - 9.3 tons/ha yr in China and 3.5 - 7.8 tons/ha yr in Taiwan. Although the majority of waste-fed fish ponds stocks carps, research in Peru and Thailand has demonstrated the potential of tilapia for such systems. Management of fish ponds can have a significant effect on fish yields but the maximum attainable yield in practice is of the order of 10 - 12 tons/ha yr (Edwards 1990).

The first phase of growth is slow, so a high stocking density can be adopted to better utilize the spatial and nutritional resources of the pond. Alternatively, this can be achieved by stocking with larger fish having a higher initial weight, following growth in nursery ponds.

In South China, tilapia are stocked once a year at rates of either 30g fish and 0.15/m^2 or 1.3g fish at 2.3 - 3.0/m^2 stocking density. An increase in weight of fish in a pond leads initially to an increase in yield or production but there is subsequently a reduction in the growth rate of individual fish because of the limitation of natural food production in the system.

The high yields of tilapia reported in South China sewage-fed ponds are due to high stocking density and frequent harvesting.

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