

## Impact of Biocides on Lakes

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### ABSTRACT

The surface water bodies have become very much susceptible to pollution by pesticides due to their increased application in agriculture. It also comes from industries and private households. Biocide contamination may disturb biological condition of Lake Ecosystem and be harmful for human, if they are transported to human food or drinking water. Percent impact of pesticides depending on animal species, genotype, life stage & size at birth. Pesticides may affect the population dynamics by controlling individual survival & reproduction and by altering the sex ratio. Still more manmade chemicals have been drawn into the field of interests as widespread pollutants and the geographical areas in which contamination takes places have become even larger. The paper review highlights about the sources of pesticides, its types & effects on Lake Ecosystem.

### INTRODUCTION

Water is one of the most abundant substances on the earth. It covers approximately 77 % of the globe. It is estimated that 97 % of the total quantity of water is in the oceans and 3% is fresh water, however only a small portion of the fresh water is available to humans, animals and plants. The term biocides cover wide ranges of compound including insecticides, fungicides, herbicides, molluscicides, nematocides, plant growth regulator and others (31). In India, currently 186 biocides are registered for use, 29 are banned for manufacture; import and use in India and 8 are restricted for use in agriculture and public health protection (13). Biocides are group of such hazardous material having potential to risk human health. Indiscriminant use of pesticides in agriculture to improve the protection of crop leads to the contamination of surface water by agricultural runoff (31).

Surface water bodies like lake are major sources of drinking water throughout the world (4). Biocides, in use for agriculture and public health programmes all over the world, have caused some of the most serious environmental problem(Edwards,1973) (30). biocides in water may have various effects on aquatic ecosystem . Due to their persistent and lipophilic nature, it tends to bioaccumulation in aquatic organisms such as fish (Schmitt et.al1990) and ultimately compounds can enter into human (Dearth et.al 1997) (30).

Aldrin is an organochlorine pesticide that is extremely persistent in the environment and can accumulate in living organisms, Although aldrin is included in the list of banned pesticides, it is one of the most widely occurring pesticides on surface water in India (13)

Organochlorine insecticides is also used successfully in controlling number of diseases, such as malaria and typhus, were banned or restricted after the 1960s in most of the technologically advanced countries (31).

Ideally pesticides must be lethal to targeted pests, but not to non targeted species, including man. Unfortunately this is not so the controversy of use & abuse of pesticides has surfaced. The rampant use of the chemicals under the adage, "if little is good, a lot will be better have played havoc with human & other life forms" (31).

## **BIOCIDES**

Biocide is chemical substance capable of killing living organisms, usually in selective way and commonly used in fields such as medicine, agriculture and forestry. Large quantities are also used in industrial applications preventing fouling in water and oil pipelines ([7]).

### **Biocides can be:-**

#### **1. Pesticides**

According to function it is divided into insecticides, fungicides, herbicides etc.

#### ***Fungicides-***

Fungicides used to kill or inhibit fungi or fungal spores .fungi are capable of causing serious damage in agriculture, resulting in critical losses of yield, quality and profit. Fungicide can either be contact or systemic. A contact fungicides kills fungi when sprayed on its surface, systemic fungicides has to be absorbed by the plants [8].

#### ***Herbicides***

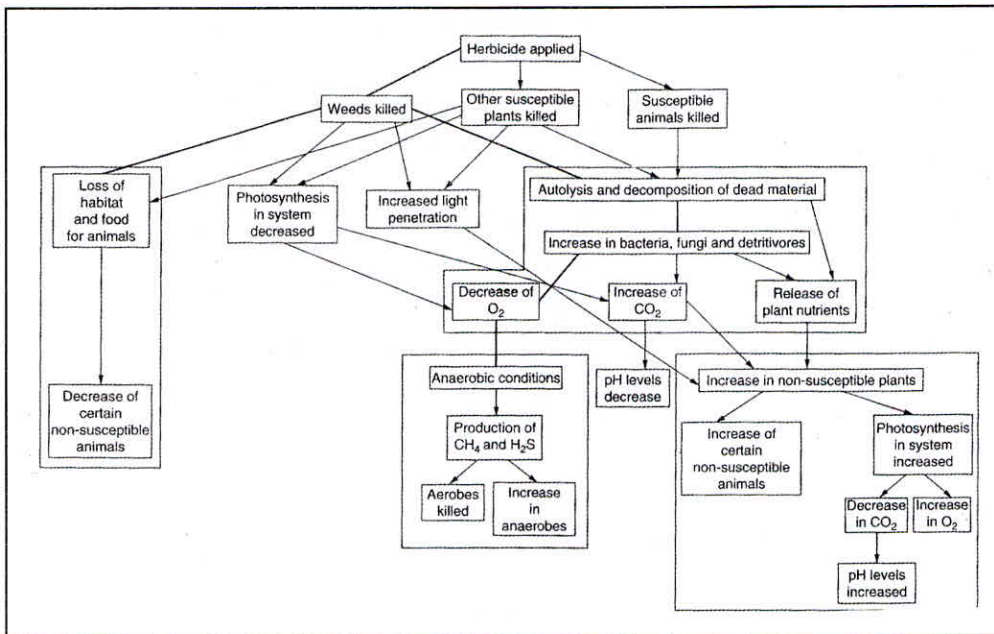
It is used for weed control in agriculture and forestry; plants are destroyed by gross dislocation of their growth process [3].

#### ***Insecticides***

It is used against insect in all developmental forms. Insecticides are used in agriculture, medicine, industry & households [8].

#### ***Molluscicides***

It also known as snail baits & snail pellets are pesticides against molluscs, which



**Fig. 1 : Effect of Herbicides**

are usually used in agriculture or gardening to control slugs & snails that can damage crops by feeding on them [10].

### **Miticides**

Miticides or acaricides are pesticides that kill mites, antibiotics miticides, mite growth regulator, carbamate miticides, formamidine miticide, permethrine & organophosphate miticides are all in this category [9].

### **Antimicrobial**

An antimicrobial is a substance that kills or inhibits the growth of microbes such as bacteria, fungi or viruses. Antimicrobial drugs either kill microbes (microbicidal) or prevent the growth of microbes [5].

### **Antimicrobials includes**

- Antibiotics
- Antibacterials
- Antiviral
- Antifungals
- Antiprotozoals
- Antiparasites

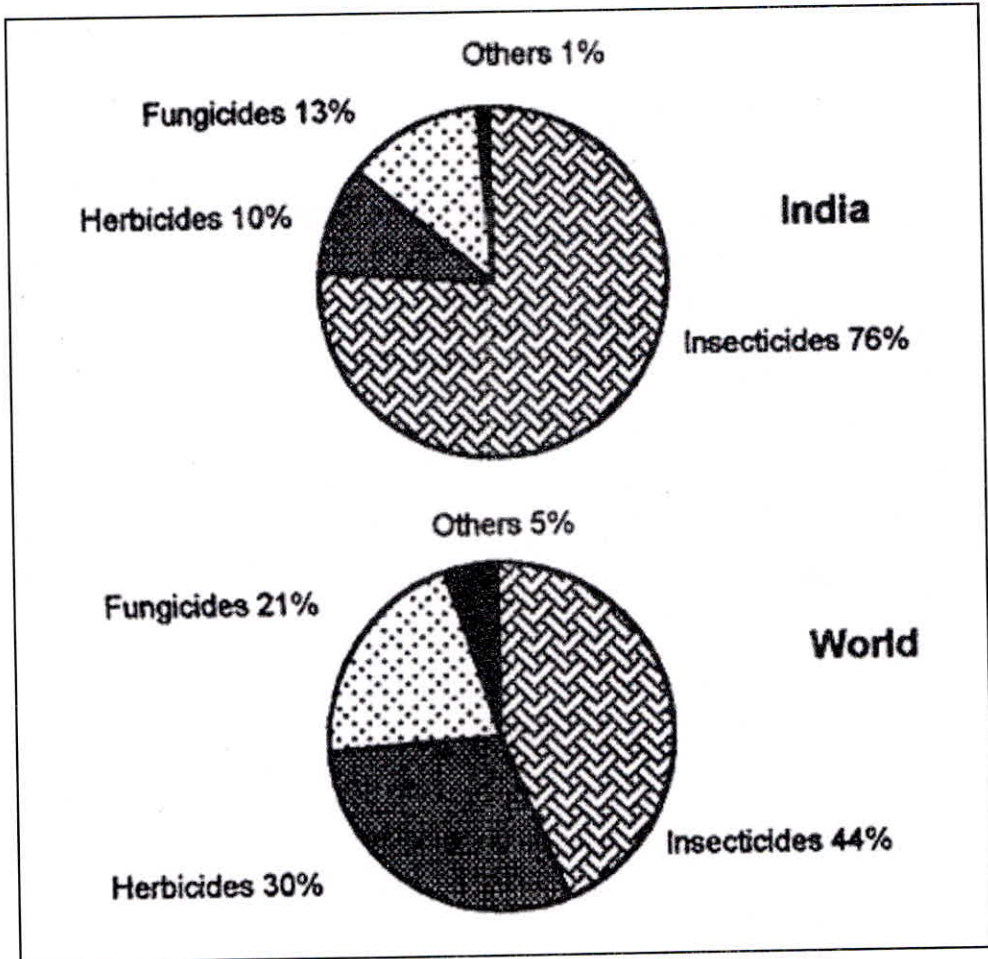


Fig. 2: Pesticides consumption pattern

Source : *Impact of Pesticide Use in Indian Agriculture - Their Benefits and Hazards.*  
(Md. Wasim Aktar\* and M. Paramasivam)

## BENEFITS OF BIOCIDES

### Improving productivity

Food grain production which stood at a mere 50 million tonnes in 1948-49, had increased almost fourth fold to 198 million tones by the end of 1996-97, from an estimated 169 million hectares of permanently cropped land (31). The use of insecticides is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century (13). Webster et.al (1999) stated that "considerable economic losses "would be suffered without pesticide use and quantified the significant increase in yield and economic margin that result from pesticide use.

### ***Disease Control***

These are most effectively tackled by killing the vectors. Insecticides are often the only practical way to control the insect that spread deadly diseases such as malaria that results in an estimated 5000 death each day (Ross 2005).

### ***Quality of food***

Pesticides help in increasing quality of food. Increasing evidence (Dietary Guidelines, 2005) shows that eating fruits and vegetables regularly reduces the risk of many concern, high blood pressure, heart diseases, diabetes, stroke and other chronic diseases

### ***Sport areas***

Herbicides and insecticides used to control weed and insects on sport pitches, cricket ground and golf courses.

### ***Buildings***

Insecticides protect building and other wooden structures from damage by termites and wood boring insects.

### ***Transport***

Herbicides are generally used for controlling roadside weed

## **SOURCES OF PESTICIDES TO LAKE**

Pesticides are purposely introduced into the environment for numerous reasons and by various methods

### ***Agriculture use***

Agriculture use of pesticides constitutes the major sources of most pesticide to surface waters (Larson et, al. 1997).The pesticide use vary tremendously in chemical structure, application rate and their potential for movement to surface waters (14).

According to the Central Institute for Cotton Research, Nagpur, 5 percent of India's agricultural land is used for cotton, yet it account for 54 percent of the total pesticides use in India[23].In India , over 3000 tonnes of Endosulfan is applied to cotton crop annually (11).

Chlorpyrifos is one of the world's widely used organophosphorus pesticides , both for agricultural pest control and household as termicides[27].Recently use of wide variety of pesticides in agriculture field made it difficult to adopt a particular method for removal of contaminants from water and the actual process of separation may depends on the chemical nature of pesticides itself [1,2].

### **Forestry**

Biocides use in forested land is small relative to agricultural use, both in terms of the mass of pesticides applied and acreage involved (Larson at 1997). Certain characteristics of the forest environment affect the movement of pesticides to surface water (14).

### **Vector disease control**

Insecticides are applied to building foundation and the surrounding soil to control termites or other destructive insects. Some lakes in urban area are treated with herbicides for control of algae and undesirable weeds. urban areas have large expanses of impermeable surfaces, such as concrete and asphalt roads and sidewalks, over which biocides can easily transported by runoff water , with little or no loss from sorption. Ones the pesticides reaches these impervious surfaces, there is a relatively high probability that it will be transported to surface water bodies (14).

### **Industrial Waste**

Biocides used more heavily in cooling towers in electric power and refining industries. Cooling tower users frequently apply biocides to the circulating cooling water to control growth of microorganisms, algae, macro organisms (14).

All manufactured pesticides have the potential to be released into the environment as a part of an industrial waste stream, several studies have attributed the presence of certain pesticides in surface waters to manufacturing waste disposal [Larsen et al. 1997].

Industries like a dairy forms, tanneries, paper mills, sugar plants and distilleries located in the vicinity of the lake discharge effluents into the lake [30].

### **ATMOSPHERIC DEPOSITION**

Another rout of pesticides movement to surface water is through atmospheric deposition. Many pesticides have been observed in various atmospheric matrices (air, aerosols, rain, snow, fog). In their review of pesticides in atmosphere, Majewski and Capel (1995) reported that 63 pesticides and pesticides transformation product have been identified in atmospheric matrices. The extent to which a pesticides enters the atmosphere is a function of its physical and chemical properties, the application method and the pesticides formulation.

Although atmospheric deposition of pesticides occurs globally, the relative importance of atmospheric inputs of pesticides to particular surface water body is directly dependent on the magnitude of other sources of pesticides to that water body.

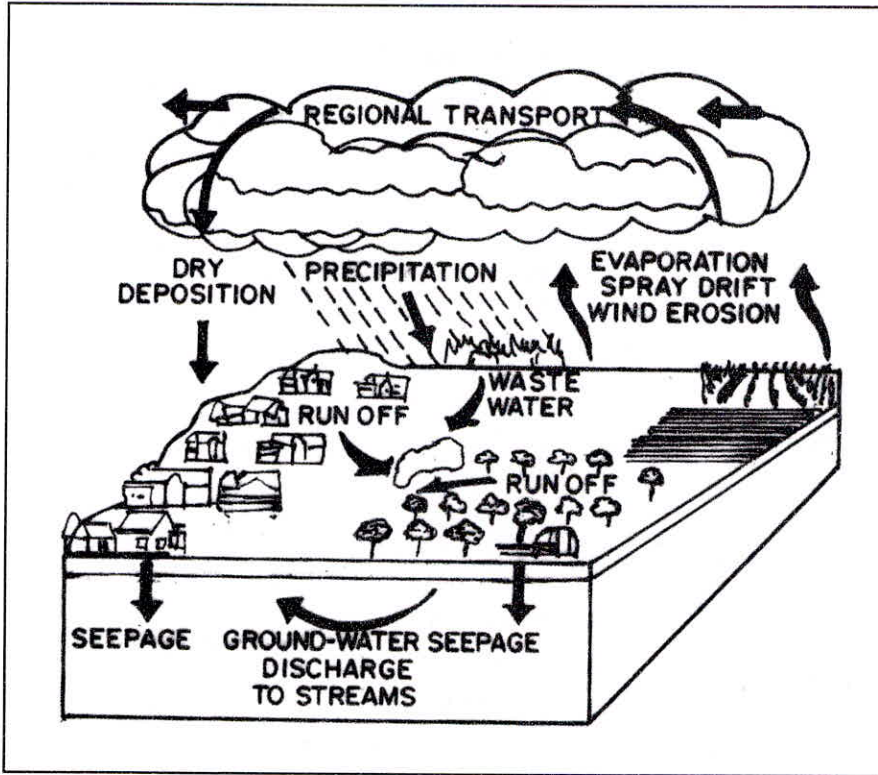


Figure 3: pesticides entering into water body

### EFFECT OF BIOCIDES ON LAKES

Biocides produce many physiological and biochemical changes in freshwater organisms by influencing the activities of several enzymes (21). Many aquatic species are taxonomically related to the target organisms of biocides. Aquatic ecosystems in agricultural areas are thus at risk of being negatively affected by these chemicals [19]. The lake provides food, water for irrigation and domestic use, means of transportation and recreation to the people (Penpolcharoen 1994). The biodiversity is markedly high, with great variety of fish, molluscs, crustaceans, insects, amphibians, reptiles and birds (15). Biocides at low concentrations may act as blockers of sex hormones, causing abnormal sexual development, abnormal sex ratios, and unusual mating behaviour. Biocides can also interfere with other hormonal processes, such as thyroid and its influence on bone development (21). Biocides are very persistent because of their high lipid solubility and chemical & thermal stability, they are widespread in the environment and exhibit potential for bioaccumulation with toxic effects on the biota (Comoni et al., 1980; Turner et al; 1986; Capuano et al 1999). Organochlorine pesticides are known to occur in aquatic systems and accumulate in aquatic organisms with biomagnification through the food chain (26).

## EFFECTS ON FISH

Fish are valuable source of high grade protein and occupy an important position in the socio-economic conditions of South Asian countries. India is the third largest producer of fish & second largest in Inland fish production with annual production of 7.75 million tonnes (23). The biological indicators like fish help in the studies of aquatic pollution by biocides (30). The fish show restlessness, rapid body movement, convulsions, difficulty in respiration, excessive mucous secretion, change in colour and loss of balance when exposed to pesticides. Similar changes in behaviour are also observed in several fishes exposed to different biocides (21) Salmon in the Lake Erie show a variety of reproductive and developmental problems, for example, early sexual development and a loss of the typical male secondary sexual characteristics, such as heavy protruding jaws and red coloration on the flanks. Some pesticides such as organochlorine, organophosphates and carbamates are known to cause morphological damage to the fish testis. These also affect female fish in the same way. They cause delayed oocyte development and inhibition of steroid hormone synthesis. In fish, endocrine disruptors interrupt normal development and cause male fish to have female characteristics. Disruption of the balance of endocrine hormones during development of young fish can also cause defects of the skeletal system, resulting in deformities and stunted growth [27, 29]. The use of DDT was prohibited in the United States in 1973, and Toxaphene was banned in 1982. Production of both has ceased in the United States. Unfortunately, degraded metabolites of the parent compound are still present in the environment. Elevated levels have been found in several fish species (25).

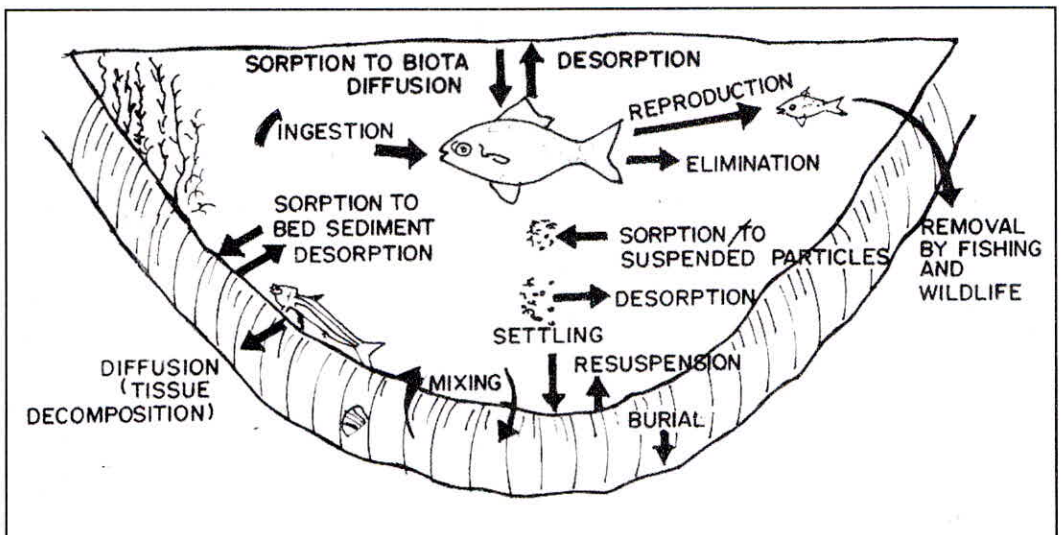


Fig. 4: Pesticide movement to, from, within sediment and aquatic biotic phase of hydraulic system



## **Effects on amphibians**

Since 1989, there has been a growing realization that amphibian populations have been declining at an alarming rate [21]. Nearly 600 amphibian populations studied in Western Europe show 53% decline beginning in the 1950s. In North and South America, 54% and 60% of the populations, respectively, have shown significant declines. In Australia and New Zealand, as much as 70% of the amphibian populations studied have declined. According to the 2004 IUCN Red List. Amphibians are important components of aquatic habitats, especially in tropical regions of the world.

The mechanisms responsible for the decline of amphibian populations include chemical pollution from pesticides [30]. The health of amphibians can suffer from exposure to pesticides. Because of their semi permeable skin, the development of eggs and larvae in water, and the position in the food web, amphibians are prone to adverse effects of waterborne and airborne pollutants in their breeding and foraging habitats. Pesticides may affect amphibian populations in a number of ways; they may kill individual amphibians directly or indirectly through alterations in immune or neurological function. Pesticides may also affect recruitment in amphibian populations by disrupting normal growth and development of the young or by impairing adult reproduction. An extensive research study conducted in Quebec, Canada, shows that hind limb deformities are commonly observed in transformed bullfrogs, green frogs, northern leopard frogs and American toads.

Very rapidly deteriorating status of freshwater turtles and tortoises in Southeast Asia has resulted in an increasing number of these species being listed as threatened in the IUCN Red List; globally 42% of turtle and tortoise species are threatened [28]. The decline in the population of alligator in the Lake Apopka, Florida (USA), is contaminated by organochlorine pesticides that emanate from a chemical spill. Here, a number of disturbing abnormalities were recorded in hatchlings and juvenile alligators, including modifications of enzyme activity, concentrations of sex hormones, abnormal ovarian morphology and unusually small phalluses [16, 17]. The common snapping turtle (*Chelydra serpentina*) is the largest freshwater turtle occurring in Canada. Snapping turtle eggs from the Great Lakes contain high concentrations of fat-soluble contaminants which are absorbed while food is being digested. These organochlorine pesticides. Abnormal development, such as incidence of unhatched eggs or deformed animals, occurs at the highest rates in the sites which are the most contaminated [21].

## **Effect on planktons**

The effects of insecticides on natural organic chemical communication in the plankton community. Some species of the cladoceran *Daphnia* develop protuberant structures (neckteeth, high helmets, long tailspins), an anti-predator strategy, when exposed to a chemicals. Lower (sub lethal) concentrations of insecticides also can affect

morphology of the *Daphnia* [22]. Large zooplankton species, which generally are superior to small zooplankton species in competition, are also more sensitive to insecticides. Relatively low insecticide concentrations, which damage only large taxa (*Daphnia*), may affect the population dynamics of other zooplankton indirectly through altered competitive relationships. The effects of insecticide on the zooplankton community are also influenced by factors such as temperature, chemical properties (e.g. degradation rate), population trends among the organisms, community structure (presence or absence of predators), and timing of the chemical application. These factors modify interrelationships between organisms and, therefore, control the recovery process of the zooplankton community following insecticide impacts. Results to date suggest that insecticide stress decreases the average size of the organisms, reduces energy transfer efficiency, elongates the food chain and sometimes increases species richness [32].

The direct acute effect of exposure to cypermethrin was a rapid decrease of many species of crustacean zooplankton [19]. Zooplankton communities were more sensitive to the chemicals than phytoplankton communities. The chemical stresses caused an absolute decrease in zooplankton biomass due to the direct effect of toxicity. However, phytoplankton biomass might increase or decrease depending on the toxicity of the chemical stresses [4]. Zooplanktons exposed to the compounds exhibited several behavioural responses like irritability, violent movements, loss of equilibrium, and inability to swim. In addition, organophosphate insecticides cause changes in the abundance and diversity of plankton [18].

## **RESULT & DISCUSSION**

Biocides are often considered a quick easy and inexpensive solution for controlling weeds and insect's pest in urban landscapes. However, biocides use comes at a significance cost. Biocides have contaminated almost every part of our environment.

Kumblad et al 2000 analysed sample of Songkhla Lake, Thailand & the mean concentration of DDT in fish species found to be in ranged from 33 to 170 ng/g lipid weight (0.086-707 ng/g fresh wt.) Licata et al (2004) detected the residue of pp DDT in *Mytilus galloprovincialis* from southern (7.00-11.00ng/gw.w and 148.3-275ng/g l.w) & western (7.60-15.37ng/g w.w and 126.7-256.2 ng/g l.w) areas of lake Furo. C.A Bishop et al 2005 detected pp dichloro-diphenyl-dichloroethylene from snake of Lake Erie, Canada and maximum average concentration found to be 3.6 ng/g wet wt.

India banned DDT for agriculture purposes in 1989, but continues to use between 5000-10000 kg/ year for malaria control. The present stage of contamination in India are substantially lower , but keep in mind the long term health hazards of pesticides residues it is advisable to regularize the monitoring of pesticides contaminants in fish as these are highly lipophilic & persist in nature & more over fish has tremendous capacity to concentrate them.

Globally, studies need to consider benefit and effects of biocides on lakes , for the protection and conservation of lakes.

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