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Integrating Chemicals into Pond Management Plans

Wesley Gerrin, James L. Shelton and Sarah F. McNair,
UGA Warnell School of Forestry and Natural Resources

Chemicals can be used in many aspects of pond management, including aquatic weed control, fish disease control, and water quality improvement. Thus, chemical methods can be included in an integrated management plan that also uses physical and biological methods to achieve greater benefits for pond owners. It is important that landowners and chemical applicators properly follow all guidelines for using chemicals to save time and money and to keep ecosystems and people healthy.

The following information is intended to assist pond owners and managers with selecting appropriate chemicals for a variety of pond management scenarios, calculating proper application rates, and selecting optimal application methods.

SELECTING APPROPRIATE CHEMICALS

When selected properly, chemicals can provide quick results while minimizing non-target effects. However, choosing an inappropriate chemical can be ineffective, costly, or can cause undesirable consequences. Each chemical that has been approved for use in ponds by the U.S. Environmental Protection Agency (EPA) has a label that provides information about its intended use and proper application, expected efficacy, and safety considerations. Chemicals that are not labeled for aquatic use may not be used in or near ponds, including dam structures. Remember that you are required by federal law to carefully read chemical labels and to follow the directions. In some cases, the pond manager may choose to hire a pond consultant or aquatic applicator capable of applying the chemical properly. A list of consultants operating in Georgia and the services they provide can be found on the Warnell Outreach Website.

Whether the goal is aquatic vegetation control, water quality management, or disease control, the first step in chemical selection is correctly identifying the issue. Chemicals can differ in the mechanisms they use to achieve control, making them effective for certain issues and not for others. In many scenarios, time and money can be saved by gathering as much information as possible and identifying the problem before purchasing and applying a treatment. Your local county extension office can assist you with problem identification or direct you to specialized information.

OPTIMIZING USE OF CHEMICALS

Once an issue has been correctly diagnosed, it often is important to implement a management plan as quickly as possible. Many pond management issues can escalate quickly, usually beginning in early spring when water temperatures begin to rise, so it is important to quickly treat issues. Waiting until an issue has escalated to a larger scale will often result in more difficult and expensive management requirements. For example, if a landowner notices a small amount of an aggressive species of vegetation in early spring, treating the smaller amount immediately would be much easier and cheaper than waiting until it is denser and more widespread.

PREVENTING THE NEED FOR CHEMICALS

An integrated pond management strategy includes using a variety of tools to proactively manage ponds rather than reacting to scenarios as they occur. Preventative measures may sometimes require an initial investment but are often cheaper than more frequent or larger chemical treatments over the long term. Potential strategies for preventing issues like aggressive aquatic vegetation growth, fish disease, and poor water quality include the following:

- **Deepening pond edges and maintaining a water depth of at least 3 feet:** Aquatic vegetation requires sunlight to grow, so deeper water discourages excessive growth by not allowing as much light penetration.
- **Maintaining a vegetative buffer and healthy population of beneficial native plants:** The presence of healthy native plants will often discourage establishment of aggressive non-beneficial plants.
- **Avoiding overstocking and underharvesting fish:** Fish disease is often influenced by environmental stressors but may also be amplified at high population densities. Preventing a fish population from becoming overcrowded will likely reduce stress and the risk of disease.
- **Nutrient management:** Excessive vegetation and algae growth is often a result of excess nutrients in the water. Reducing nutrient inputs can help to reduce vegetation growth over time.

ENVIRONMENTAL CONSIDERATIONS FOR CHEMICAL USE

Using chemicals for pond management may have effects on aquatic organisms other than those being targeted for treatment. The following is a list of some potential non-target effects of certain chemicals:

- **Oxygen depletion:** When plant material dies, the decomposition process consumes oxygen from the water. Treating too much aquatic vegetation at once can cause oxygen depletion and lead to fish kills.
- **Direct toxicity:** Some chemicals that are used to treat fish disease may also be toxic to aquatic plants. On the other hand, chemicals like copper sulfate can be toxic to fish when applied at incorrect rates or if alkalinity of the water is too low.

In addition to non-target effects of chemicals, environmental conditions may have undesirable effects on certain chemicals that render them less effective **(Table 1)**. Most herbicides are ineffective if the water temperature is below 60° F at any period during the treatment, as herbicides are only effective if plants are actively growing. Some chemicals may also break down in the presence of bright sunlight, high pH, or high temperature. Additionally, certain chemicals readily bind to clay particles, reducing their effectiveness in muddy water.

Table 1. Examples of commonly used chemicals and their usage considerations. This is not an exhaustive list and is intended for example purposes. Other chemicals may have special considerations that are usually posted on their labels. Trade names are for example purposes only and are not an endorsement of any specific product.

Chemical	Intended Use	Examples of Trade Names	Possible Effect
Formalin	Parasite Control	Parasite-S	Kills algae, consequently lowering dissolved oxygen
Flumioxazin	Aquatic Herbicide	Clipper® Flumigard® SC	Less effective at pH 7 and above than in acidic water
Diquat	Aquatic Herbicide	Alligare Diquat herbicide Reward® Weedtrine®-D	Ineffective in muddy water
2,4-D	Aquatic Herbicide	Navigate® Weedar® 64	Better in spring after water temperature reaches 70° F

RESTRICTIONS

When treating water with chemicals, it is important to consider how the water is used and how the chemical could affect that use. Potential uses that could be restricted after treatment include irrigation, watering livestock, fishing, swimming, and drinking. Post-treatment water use restrictions can vary by chemical and some chemicals may not have restrictions for some uses. It is important to note that irrigation restrictions can be different for different crops. Applicators should always check the label to verify post-treatment water use restrictions before applying chemicals and before using treated water (**Table 2**).

Table 2. Examples of post-treatment water use restrictions for common aquatic herbicides. Always check product labels for water use restrictions specific to the product.

Active Ingredient	Human Uses			Animal Drinking		Irrigation	
	Drinking	Swimming	Fish Consumption	Dairy	Livestock	Turf	Crops
Copper	0 days	0 days	0 days	0 days	0 days	0 days	0 days
Diquat	1-3 days	0 days	0 days	1 day	1 day	1-3 days	5 days
Flumioxazin	0 days	0 days	0 days	0 days	0 days	5 days	5 days
2,4-D	Varies	Varies	Varies	Varies	Varies	Varies	Varies
Fluridone	0 days	0 days	0 days	0 days	0 days	30 days	30 days
Glyphosate	0 days	0 days	0 days	0 days	0 days	0 days	0 days
Imazapyr	2 days	0 days	0 days	0 days	0 days	120 days	120 days
Imazamox	0 days	0 days	0 days	0 days	0 days	1 day < 50 ppb	1 day < 50 ppb
Endothall	7-14 days	1 day	3 days	7-14 days	7-14 days	7-14 days	7-14 days

Additionally, effects of chemicals on waterbodies downstream of the treatment should be carefully considered. Chemicals should not be used in flowing water unless they are permitted for that use on the label and some chemicals require approval from regulatory agencies before treating springs, streams, or ponds with flow-through. Most aquatic chemicals that are permitted for use in static ponds with no water exchange or very little outflow stay in the pond area until they degrade. It is also important to obtain proper permissions before treating a pond or lake with multiple property owners to avoid unwanted treatments.

ADJUVANTS

Aquatic herbicides may be mixed with adjuvants to make treatment more effective. Nonionic surfactants, sticker/spreaders, and buffers are some of the common adjuvants used with aquatic herbicides **(Table 3)**. If an adjuvant is required, it should be added to the diluted tank mix before applying the herbicide to the water. Herbicide labels describe the adjuvants that are compatible with the chemical along with instructions for mixing.

Table 3. Examples of adjuvants used with aquatic chemicals and the action they perform.

Adjuvant Type	Action
80-20 non-ionic surfactant	Spreads the chemical over the leaf surface
Crop oil	Sticks and spreads the chemical over the leaf surface
Cide Kick II (citrus-based adjuvant)	Sticks and spreads the chemical over the leaf surface
Foliar fertilizer	Works through the leaf to make herbicides more effective on emergent aquatic weeds
Sinker	Carries the herbicide through water to plants near the pond bottom
Buffer	An acid or base used to change tank mix pH according to the chemical requirements

TREATMENT METHODS

Selecting the best treatment method depends on the specific conditions that exist near or in the pond or tank, and the properties of the chemical used in treatment. Carefully observe factors such as the weather, water temperature, water quality, fish condition and population density, upstream and downstream land uses, uses of the pond water, and all other conditions of possible concern that appear on the label.

Some labels indicate that a chemical can be poured into the pond and allowed to diffuse throughout the pond, but most chemicals are evenly applied over the weed bed.

Treatments Applied to Pond Water

- **Surface Area Treatments:** Contact pesticides, inorganic fertilizers, and lime are examples of chemicals with application rates based on the surface area of the pond—not the volume of water. These chemicals are generally sprayed or broadcast over the pond surface.
- **Total Water Column Treatments:** Systemic pesticides are an example of chemicals with application rates based on the total volume of water. Specific application techniques include injection directly into the water with undiluted chemical or some dilution of the chemical sprayed or broadcast upon the surface of the water. Regardless of which method is used, further dispersal throughout the water column depends on water currents.
- **Directed Treatments:** This application technique is intended primarily for control of submersed aquatic vegetation and is intended for applying herbicide closer to the bottom. A boat carrying application equipment drags a hose or boom just above the pond bottom. The chemical disperses through nozzles, and the specific gravity of the chemical causes the treatment to remain near the bottom where weeds are rooted. Special adjuvants may be needed to perform bottom treatments, and equipment may include specialized pumps and tank mix agitators.

Specialized Treatments for Aquaculture Settings

- **Dip Method:** This involves exposing fish to a strong chemical solution for a short period. Fish are usually netted, dipped into a chemical, and then returned to the culture area.
- **Flush Method:** This method is only applicable in tanks, raceways, or egg incubators. A stock solution of a chemical is applied to the upper end of the unit and allowed to flush throughout the system.
- **Bath Treatments:** Bath treatments involve applying a chemical, usually in a relatively high concentration, directly to the culture area and, after a specified time, diluting it with fresh water to remove it from the culture area. Bath treatments are used in culture tanks, but are difficult to apply in ponds, because most water supplies are not adequate to substantially change pond volume.

INFORMATION REQUIRED FOR CALCULATING CHEMICAL TREATMENT RATES

Properly calculating treatment rates for ponds requires chemical formulation, effective concentration, and an estimate of water volume or treatment surface area.

Chemical Formulations

Chemical products used for pond management will usually contain varying amounts of active ingredients and inert ingredients. The active ingredients are the chemicals that will provide the desired result, whereas inert ingredients are added to improve the convenience, safety, and handling of the chemical. Application rates are only based on the amount of active ingredient in the chemical formulation. Chemical formulations are printed on the product label.

Active Ingredient	By Wt.
*Flumioxazin	51%
Other Ingredients	49%
Total	100%

*2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2*H*-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1*H*-isoindole-1,3(2*H*)-dione

Clipper™ Herbicide is a water dispersible granule containing 51% active ingredient.

EPA Reg. No. 59639-161 EPA Est. 11773-IA-01

Effective Chemical Concentration (ECC)

An effective chemical concentration of an active ingredient will have the desired result when applied according to label directions. The common method to express chemical concentrations is parts per million (PPM). One PPM is equivalent to the ratio of one pound of chemical to 999,999 pounds of water or one gram of chemical to 999,999 grams of water. Common PPM unit conversions are shown in **(Table 4)**.

Table 4. Examples of conversion factors for common PPM units.

1 part per million of water =
2.72 pounds per acre-foot
1,233 grams per acre-foot
0.326 gallons per acre-foot
0.0000624 pounds per cubic foot
0.038 grams per gallon
1 milligram per liter
0.001 grams per liter
0.133 ounces per 1,000 gallons

Estimate of Pond Surface Area and Volume

To properly calculate chemical application rates, an accurate estimate of pond or vegetation surface area is required. Surface area can be measured in Google Earth Pro using the instructions found in a separate publication: Measuring Surface Area in Ponds.

If a volume estimate is required, an estimate of average depth is needed in addition to an estimate of surface area. The average depth of a pond should be estimated using as many measurements as possible from a variety of locations that are representative of the various depths that occur **(Example in Figure 2)**. If depth measurements are not representative of the entire pond, the volume estimate could be skewed. In other words, a pond with complex depth contours might warrant more depth measurements than a pond with a more uniform depth. Depth can be measured along transects using a stadia rod, recreational fish finders, or other sonar units. Once a representative sample of depth measurements is obtained, average depth can be calculated by adding all depth measurements and dividing by the total number of measurements.

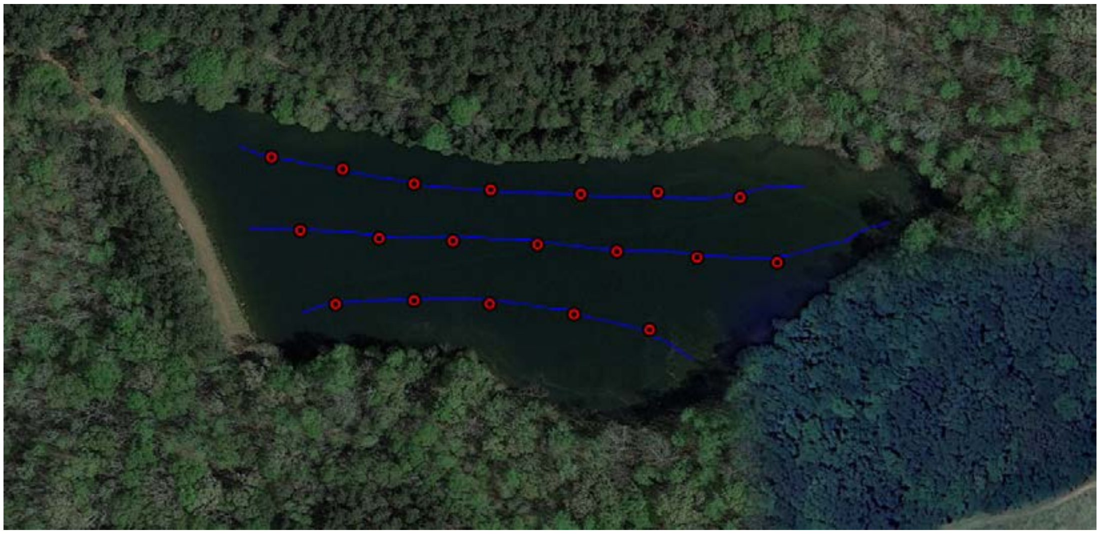

Figure 2: ***Example of taking depth measurements at multiple locations (red circles along 3 transects) for estimating average depth of a pond. In this example, 19 depth measurements would be averaged to calculate the mean water depth of this pond.***

Once a surface area measurement and an average depth have been obtained, volume can be estimated using the following formula **(Measurement units must be consistent, i.e. acres and feet for acre-feet or meters and square meters for cubic meters)**:

$$Volume = Surface\ Area \times Average\ Depth$$

Units of volume estimates will be dependent on the units used to measure depth and surface area but can be converted to any units necessary for the chemical treatment **(Table 5)**.

Table 5. Examples converting water volume from 1 acre-foot to other volume units.

1 acre-foot =
43,560 cubic feet
325,872 gallons
2,719,000 pounds
1233.48 cubic meters

EXAMPLES OF CALCULATING CHEMICAL TREATMENT AMOUNTS

Many aquatic chemical labels provide treatment rates in amount of product per unit of surface area. Given this information, the amount of product that is needed can be calculated using the following formula:

*Amount of Product Per Unit Area = Application Rate * Surface Area*

The following formula can be used to determine the amount of chemical needed to treat a pond if rate of product application is provided in parts per million and not amount of product per unit surface area:

*Amount of Chemical=V * CF * ECC * AI*

V = The volume of water to be treated (must know units).

CF = Conversion factor for weight of chemical needed to have a concentration of 1 ppm.

ECC = Effective chemical concentration of active ingredients needed to correct the issue. This unit of measure must be in ppm and can be found on the product label.

AI = The active ingredient ratio is equal to 100% divided by the percentage of a chemical that is an active ingredient.

Example (Label to the right)

$AI = {}^{100\%}/_{51\%} = 1.96$

Active Ingredient	By Wt.
*Flumioxazin	51%
Other Ingredients	49%
Total	100%

*2-[7-fluoro-3,4-dihydro-3-oxo-4-(2-propynyl)-2*H*-1,4-benzoxazin-6-yl]-4,5,6,7-tetrahydro-1*H*-isoindole-1,3(2*H*)-dione

Calculations of chemical application rates differ based on whether the chemical is a solid formulation or a liquid concentrate formulation. Liquid concentrate formulations can have active ingredients given in pounds per gallon or a liquid concentrate formulation that is 100% active ingredient. The following examples provide calculations for each possible scenario.

Application Rate Example 1 (Solid Formulation):

Based on the information provided in the table to the right, how much chemical (in pounds) would be required to treat a pond with a surface area of 4 acres and an average depth of 3 feet?

Active Ingredient	51%
Other Ingredients	49%
Effective Concentration	0.5 ppm

Amount of Chemical = *V* * *CF* * *ECC* * *AI*

V = 4 acres * 3 feet = **12 *acre-feet***

CF = **2.72 *pounds per acre - foot*** (see Table 4)

ECC = **0.5 *parts per million***

AI = 100%⁄51% = **1.96**

Amount of Chemical = 12 * 2.72 * 0.5 * 1.96 = **31.99 *pounds***

Application Rate Example 2 (Liquid Concentrate):

Based on the information provided in the table to the right, how much liquid chemical (in gallons) would be required to treat a pond with a surface area of 50,000 square feet and average depth of 3 feet.

Active Ingredient	28%
Other Ingredients	72%
Effective Concentration	0.25 ppm

Amount of Chemical=*V* * *CF* * *ECC* * *AI*

V =(50,000 feet^2 * 3 feet)/43,560 feet^3/acre - foot = **3.44 *acre-feet***

CF = **0.326 *gallons per acre - foot***

ECC = **0.25 *parts per million***

AI = 100%/28% = **3.57**

Amount of Chemical = 3.44 * 0.326 * 0.25 * 3.57 = **1 *gallon***

Application Rate Example 3 (Liquid Formulation Pounds Active Ingredient Per Gallon):

Based on the information provided in the table to the right, how much liquid chemical (in gallons) would be required to treat a pond with a surface area of 6 acres and average depth of 4 feet.

Active Ingredient	2 pounds of active ingredient per gallon
Effective Concentration	0.5 ppm

Amount of Chemical=*V* * *CF* * *ECC* * *AI*

V = 6 *acres* * 4 *feet* = **24 *acre - feet***

CF = **2.72 *pounds per acre - foot***

ECC = **0.5 *parts per million***

AI = 1 *gallon*/2 *pounds* = **0.5**

Amount of Chemical = 24 * 2.72 * 0.5 * 0.5 = **16.32 *gallons***

Application Rate Example 4 (Liquid Formulation 100% Active Ingredient):

Based on the information provided in the table to the right, how much liquid chemical (in gallons) would be required to treat a culture unit that is 180 feet long, 20 feet wide, and 5 feet deep.

Active Ingredient	100%
Other Ingredients	0%
Effective Concentration	15 ppm
Water weight per gallon	8.34 lbs.
Chemical weight per gallon	9.1 lbs.

Amount of Chemical = *V* * *CF* * *ECC* * *AI*

V = 180 *feet* * 20 *feet* * 5 *feet* = **18,000 *ft*^{3}**

CF = **0.0000624 pounds per *ft*^{3}**

ECC = **15 *parts per million***

AI = 100%/100% = **1**

Amount of Chemical = 18,000 * 0.0000624 * 15 * 1= **16.85 *pounds***

Must be converted to liquid units since chemical is a liquid formulation.

Amount of Chemcial = 16.85 *pounds*/9.1 *pounds per gallon* = **1.85 *gallons***

SUPPLEMENTAL READINGS

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