In order to prevent such injuries, managers perform a variety of cultural practices. "We aerate often in order to eliminate compaction," says Dunn. "Grass is mowed according to sport and weather conditions.

"We try to keep turf areas even and consistent," Marchesano says. "We have been replacing old brass heads with new plastic pop-up rotors."

"We have formal and informal inspections on a scheduled basis as part of the department of safety program," says Walter Stasavich, superintendent of parks in Greenville, N.C.

A standard?

Respondents varied in their opinions of setting a standard for natural fields. "I would like to have a national non-profit organization (not government), research, develop, and promote standards," Stasavich says.

"I do not believe an effective determiner could be set up which would hold up in court," disagrees Gross.

"Ideally, yes, but it's not practical in our case," says Jack Cook, a high school grounds foreman in Ferguson, Mo. "We have neither the time nor funds available to correct problems."

"Yes, it would reduce injuries and allow athlete's some constitency (practice fields vs. playing fields)," says Marchesano. "This could be done by possibly an egg drop test or some type of pressure compaction test."

Field management problems may vary between warm-season and cool-season turf areas and depending on the soil type, but most managers face the same challenges.

LM

FIELD COSTS: NATURAL vs. ARTIFICIAL

by Henry Indyk, Ph.D., Rutgers University

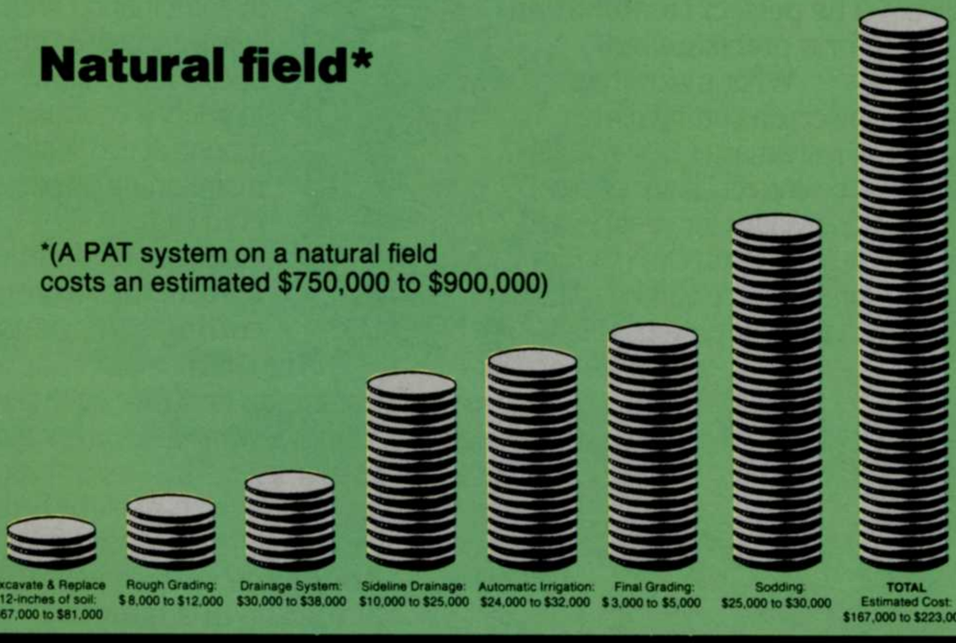
ESTIMATED FIELD COST BASED ON A 20-YEAR LOAN AT 12 PERCENT INTEREST.

Natural:		Synthetic:	
Principle:	$250,000	Principle:	$1 million
Interest:	$315,000	Interest:	$1,260,000
Total:	$565,000	Total:	$2,260,000
AVERAGE ANNUAL COST:	$28,250	AVERAGE ANNUAL COST:	$113,000

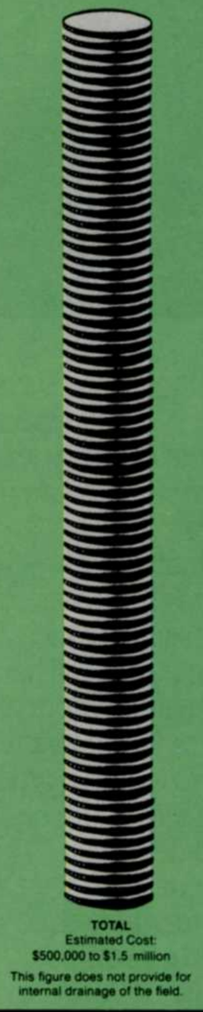
(Editor's note: It's important to note that this is based on a 20-year loan . . . studies prove that artificial surfaces must be replaced after about five years.)

Natural field*

*(A PAT system on a natural field costs an estimated $750,000 to $900,000)



Synthetic field



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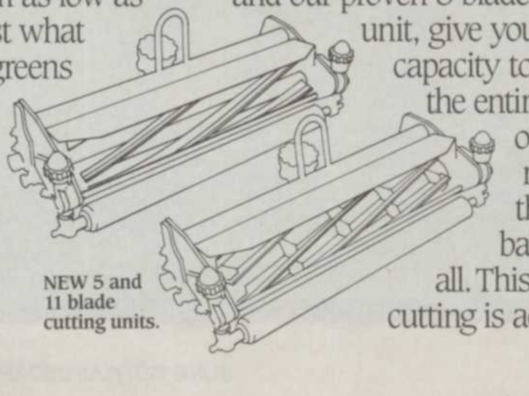

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Single-hand bedknife adjustment knob.

in combination with Toro's exclusive Variable Speed Kit. It allows you to select a consistent ground speed while maintaining a constant, even clip.

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cut kit you can easily change your height-of-cut to 5 different levels. Each flip of the handle alters the height-of-cut by .100 inch within a total range of 1/2″ above the cutting unit bench setting.

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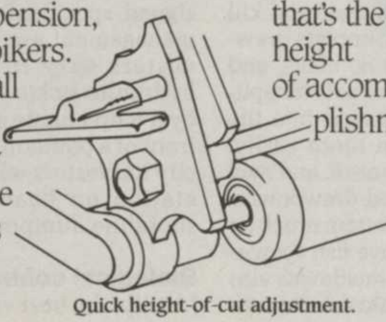

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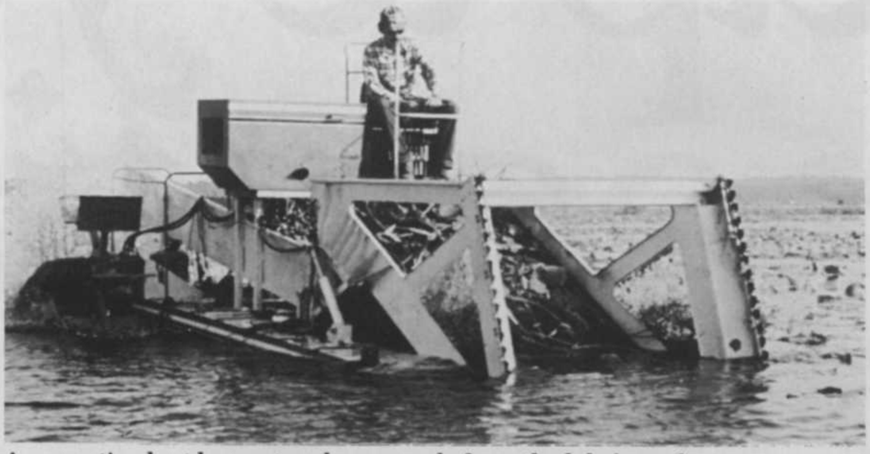
AQUATIC WEED CONTROL

Use of aquatic herbicides is just one of five means of controlling water weeds. But three cooperative extension agents in Florida think it offers advantages the others don't.

There are five major means of aquatic weed control:

- by fertilization;
- by drawdown;
- with mechanical devices;
- with biological controls; and
- with chemical controls.

The following information was excerpted from "Weed Control in Aquaculture and Farm Ponds" by D.D. Thayer, W.T. Haller and J.C. Joyce of the Florida Cooperative Extension Service.



An aquatic plant harvester clears weeds from the lake's surface.

Fertilization

The theory behind a pond fertilization program is that phytoplankton (microscopic algae) populations increase as a result of the controlled addition of fertilizer nutrients until light penetration is reduced below the level required for growth of submersed weeds.

Before beginning a fertilization program for weed control, consider the following:

1) Once a fertilization program has begun, you must always continue the program or face possible severe weed problems.

2) Some weeds, such as hydrilla, have been shown in Florida to out-compete phytoplankton communities for nutrients, thereby making the weed problem worse. It is therefore imperative that fertilization should not be initiated until current weed infestations have been totally controlled.

3) If the fertilization of a pond is intended to be used to stimulate food production in an aquaculture pond, then additional weed control with herbicides or with weed-eating carp *Ctenopharyngodon idella* may be beneficial.

Most fertilization recommendations suggest adding inorganic fertilizer every two weeks until a shiny object placed 18 inches below the surface is no longer visible. Once this level of phytoplankton is obtained, maintain that level with periodic fertilization. The optimum pH should be at least 6.5 or higher, and liming may be required prior to fertilization.

The best time of year to begin a fertilization program is in the spring before aquatic weeds have begun to grow.

Drawdown

Water level fluctuation or pond draining can be used very effectively if the conditions are favorable. Exposing the bottom of the pond to the atmosphere will solidify suspended mud and consolidate bottom sediments to a watertight condition. Excessive nutrients suspended in the water column will be diluted as a result of the water exchange.

In order to have a successful drawdown, you must leave the water level down long enough to desiccate and kill submersed plants. An incomplete drawdown may have little to no effect, and some plant species that are not susceptible to drawdown may spread into the de-watered lake bottom more easily. Cattails are often opportunistic and may establish during extended drawdowns.

The consolidation of bottom muck by drying should also improve fish spawning and nursery areas. Drawdowns also increase options for chemical weed control. Some herbicides are only labeled for use on drained pond bottoms; treatments at this time often provide several years of weed control because the herbicides are bound in the bottom sediments.

Mechanical control

Mechanical control involves the physical harvesting of vegetation by hand or with specifically engineered equipment. For the owner of a small pond, mechanical control can be helpful for removing small populations of nuisance plants.

While the simplest mechanical harvesting devices are often the cheapest and often highly effective, commercially-made harvesters designed specifically for aquatic weed management are available. The harvesters vary in size from simple hydraulic sickle-bar cutters powered by a 5 hp engine and mounted on the front of a pontoon boat to 10,000-capacity harvesters which convey cut vegetation on board for transport to shoreline dumping sites.

Biological control

Ideally, the best weed control agent is

continued on page 36

Troubled waters?



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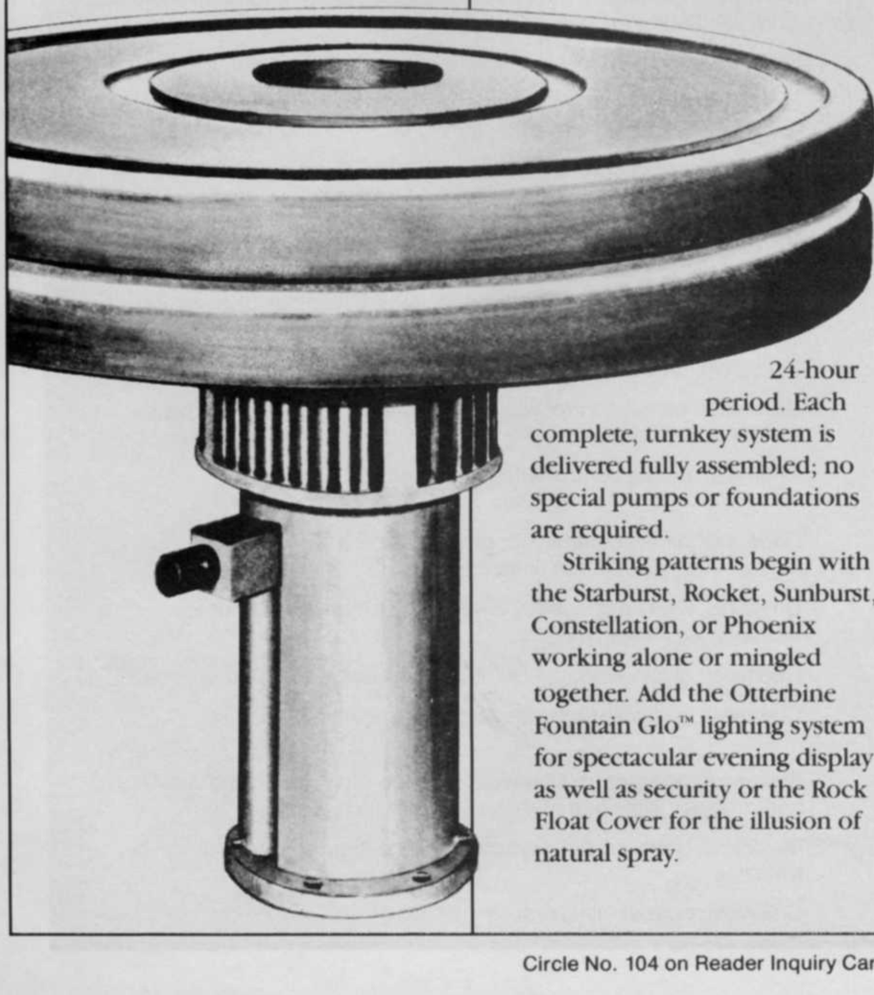

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AQUATIC WEED CONTROL

AQUATIC WEED	CONTROL
FLOATING PLANTS	
Common duckweed *(Lemna minor)*	Biological; grass carp. Chemical: diquat, simazine, 2,4-D LV ester, fluridone.
Common salvinia *(Salvinia rotundifolia)*	Biological: partial control with grass carp. Chemical: diquat.
Waterhyacinth *(Eichhornia crassipes)*	Biological: partial control with hyacinth weevil and fungus. Chemical: 2,4-D, 2,4-D + dicamba, diquat, glyphosate.
Waterlettuce *(Pistia stratiotes)*	Chemical: diquat, endothall liquid.
EMERSED PLANTS	
Pickerelweed *(Pontederia lanceolata)*	Biological: partial control with grass carp. Chemical: 2,4-D, 2,4-D + dicamba.
Alligatorweed *(Altermanthera philoxeroides)*	Biological: alligatorweed flea beetles and thrips; partial control with grass carp. Chemical: partial control with 2,4-D, 2,4-D + dicamba, glyphosate.
Cattail *(Tyhpa species)*	Chemical: 2,4-D + dicamba, diquat, glyphosate, fluridone, dalapon.
Pennywort *(Hydrocotyle unbellata)*	Chemical: 2,4-D + dicamba, diquat, 2,4-D.
Smartweed *(Polygonium hydropiperoides)*	Chemical: 2,4-D + dicamba, glyphosate, 2,4-D.
White water lily *(Nymphaea orodata)*	Chemical: fluridone, 2,4-D liquid and granular, glyphosate.
Spatterdock *(Nuphar luteum)*	Chemical: glyphosate, fluridone, 2,4-D liquid and granular.
SUBMERSED PLANTS	
Coontail *(Ceratophyllum demersum)*	Biological: grass carp. Chemical: dichlobenil, diquat, endothall liquid and granular, fenac, simazine, fluridone, 2,4-D granular.
Hydrilla *(Hydrilla verticillata)*	Biological: grass carp. Chemical: copper, diquat, endothall liquid and granular, fluridone.
Bladderwort *(Utricularia species)*	Biological: grass carp. Chemical: diquat, 2,4-D granular, fluridone.
Southern naiad *(Najas guadalupensis)*	Biological: grass carp. Chemical: dichlobenil, diquat, endothall liquid and granular, fenac, simazine, fluridone, 2,4-D granular.
Fanwort *(Cabomba caroliniana)*	Biological: grass carp. Chemical: simazine, fluridone, 2,4-D granular.
Pondweed *(Patamegeton species)*	Biological: grass carp. Chemical: copper sulfate, dichlobenil, diquat, endothall liquid and granular, fenac, simazine, fluridone, 2,4-D granular.
GRASSES AND SEDGES	
Torpedograss *(Panicum repens)*	Biological: partial control with grass carp. Chemical: glyphosate, fluridone.
Maidencane *(Panicum hemitomon)*	Biological: partial control with grass carp. Chemical: glyphosate.
Paragrass *(Branchiaria purpurascens)*	Biological: partial control with grass carp. Chemical: glyphosate, fluridone, hexazinone.
Sedge *(Cyperus species)*	Chemical: partial control with glyphosate.
DITCHBANK BRUSH	
Wax myrtle *(Myrica cerifera)*	Chemical: partial control with glyphosate, 2,4-D + dicamba, hexazinone, tebuthiuron, imazapyr.
Willow *(Salix species)*	Chemical: 2,4-D glyphosate, 2,4-D + dicamba, hexazinone, tebuthiuron, imazapyr.
Brazilian pepper *(Schinus terebinthifolius)*	Chemical: glyphosate, 2,4-D 2,4-D + dicamba, tebuthiuron, imazapyr.
Water primrose *(Ludwigia species)*	Chemical: glyphosate, fluridone, 2,4-D granular, imazapyr.
ALGAE	
Macrophytic algae	Biological: grass carp. Chemical: copper, dichlobenil, endothall liquid and granular, simazine.
Filamentous algae	Biological; grass carp. Chemical: copper, diquat, endothall liquid, simazine.
Planktonic algae	Chemical: copper, simazine.


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Hydrilla can spread by plant fragments, underground stems, seed, leafbuds or buds on underground stems.

Cattail is an emersed plant which must be controlled by chemicals such as glysophate.

A VIRUS TO LIVE WITH

Research using a virus to biologically control a certain type of noxious blue-green algae has shown promising results, says an aquatic microbiologist with the Institute of Food and Agricultural Sciences (IFAS), at the University of Florida in Gainesville.

E. J. Phlips, Ph.D., a researcher in the Fisheries and Aquaculture Department, has isolated a virus effective in controlling one species of microcystus blue-green algae. He hopes to isolate a number of other viruses by the end of the year.

Phlips and his staff collect water samples from sewage systems, polluted lakes and waterways throughout the state searching for viruses which kill only blue-green algae. Phlips tests these viruses with the algae in his lab, since the two rarely exist together in the water.

Herbicides have been the most popular method for controlling aquatic fo-

continued on page 40

one that keeps weed pests restrained naturally. Many native plants have biological restraints that keep them from growing prolifically.

Years of research are required to ensure that the introduced organism does not become another dangerous pest. Most biological organisms will not eradicate the host plant, but will instead reduce the plant's potential to become a serious pest.

Insects and plant pathogens — Over the years, insects have proven to be the most popular biological control agents due to their high degree of host specificity.

The alligatorweed flea beetle (*Agasicles hygrophila*), discovered in South America and introduced into the United States in 1964, is the best example of an extremely successful biocontrol program using insects.

The waterhyacinth has had several biocontrol agents to help reduce its prolific growth. However, unlike alligatorweed, these biocontrol agents don't appear capable of quickly controlling the plant. Two waterhyacinth weevils (*Neochetina eichhorniae, N. bruchi*), the waterhyacinth mite (*Orthagalumna terebrantis*) and fungus (*Cercospora rodmanii*) can often be found associated with the plant.

Herbivorous fish — Numerous exotic fishes around the world are reported to consume aquatic vegetation.

Of the fishes examined to date, the grass carp appears to be the best candidate for aquatic plant control in a variety of situations and climates, and may provide the only practical control method for water bodies where herbicides cannot be used. This fish has provided excellent control of submersed plants, filamentous algae and small floating plants such as duckweeds.

The grass carp is used by Arkansas and other states for this purose in natural lakes and has been researched by a number of other states. Florida has conducted research and has approved the use of the triploid grass carp, which has three sets of chromosomes as opposed to the normal two sets and is thus sterile.

The three possible management strategies using grass carp:

1) complete vegetation removal within one to two years with a heavy stocking rate;

2) winter stocking, before the spring growth of weeds begins, using fewer fish to maintain a lesser amount of vegetation in the system and increasing the grass carp population as needed; and

3) integrated control using chemical treatments to obtain desired levels quickly and stock grass carp to maintain this level.

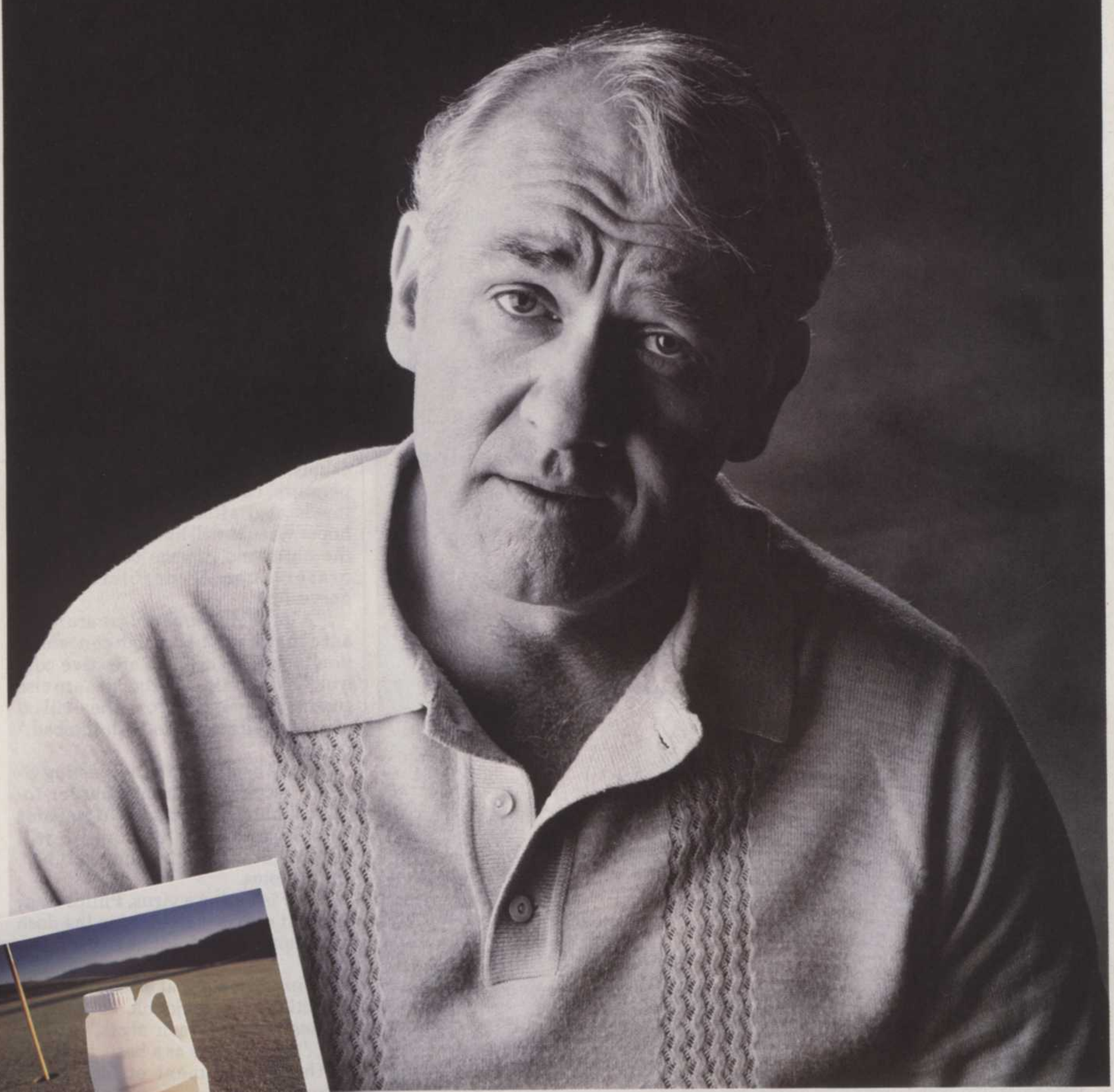
Chemical control

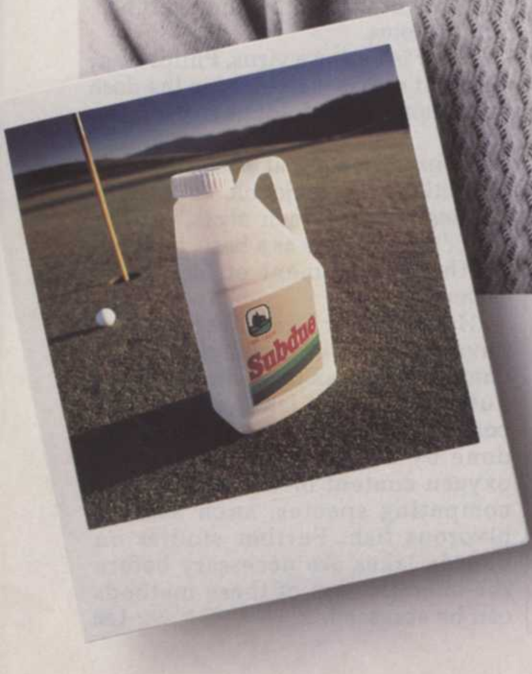
Controlling aquatic plants with herbicides is the most commonly used method of weed control. Chemical weed control has several advantages:

- Herbicides may be directly applied to undesirable vegetation, offering a high degree of selectivity and leaving desirable levels of vegetation.
- Pre-emergence application of appropriate herbicides can provide early weed control. This may be used to promote desirable vegetation without competition during critical early growth stages.
- Herbicides reduce the need for mechanical control which can increase turbidity and affect fish populations.
- Erosion may be reduced by promoting the lower growing grass species for cover.
- Many weeds, especially perennials, that cannot be effectively controlled by other methods are generally susceptible to herbicides.
- Routine use of herbicides under a maintenance program usually reduces the cost of weed control.

For chemical aquatic weed control agents, see the accompanying chart. **LM**

"One of my employees ran the mower into the lake. My wife totalled our new Volvo. And my daughter just dyed her hair purple. But what really concerns me is Pythium."





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A VIRUS TO LIVE WITH

from page 38

liage, but Phlips says, "Viruses are a more attractive alternative because they are specific to algae."

Phlips has conducted his research for the last six months with the help of a $20,000 grant from the U.S. Department of Agriculture, part of a larger grant for the Center for Aquatic Weed Control. Similar research has been conducted in the Great Lakes region and New England with promising results, Phlips adds.

His studies have been directed in part toward lyngbya, one type of blue-green algae found in Florida. "It forms a very dense, thick mat on the bottom of lakes, produces a bad odor and is reputed to produce toxic substances," Phlips said.

Algae breeding grounds are enhanced by sewage, runoff and industrial waste dumpage into lakes and canals. Light intensity, rainfall, temperature, carbon dioxide and oxygen levels also affect the algae. Phlips hopes viruses will biologically control the algae and replace or reduce the present use of herbicides and harvesting.

"A lot of blue-green algae are tolerant of herbicides, so a high concentration is used to achieve effective control," Phlips said. "Herbicides are also general in their action, so they kill off good blue-green algae with the bad," he said.

He has been examining existing viruses specific to certain harder-to-control blue-green algae. "It remains to be seen how many more we will find and how effective they will be," Phlips notes.

After isolating a virus, Phlips says, the next step is to determine the dose requirement and longevity of the virus.

"Our ultimate goal is to establish a collection of the major bloom-forming species of blue-green algae," Phlips says, "and use this as a basis for work on the development of biocontrol technologies."

He and other Center researchers have also been experimenting with controlling algae by controlling the nutrient input in lakes and also by controlling the lake environment, done by either adjusting the pH, oxygen content or the presence of competing species, such as herbivorous fish. Further studies on Florida lakes are necessary before the effectiveness of these methods can be assessed. **LM**