# PREVENTION AND MANAGEMENT OF AQUATIC INVASIVE PLANTS IN TEXAS

A Thesis

by

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ABSTRACT

Determining which non-native aquatic plants have the greatest potential to invade a new area and prohibiting those species prior to their introduction is the key to preventing future injurious invasions. Once introduced however, prioritization and effective control is important to managing infestations. This study focused on identifying potential new aquatic invasive plant species and prioritizing existing infestations in Texas, via two aquatic plant models.

An aquatic plant risk assessment was the first model. While other risk assessments of this type currently exist, a model suited to the varied environmental conditions in the State of Texas was not available. In addition, many existing models cover large geographic areas, leading to decreased accuracy on a more localized scale. This new model, referred to as the Texas Aquatic Plant Risk Assessment, was based on previous aquatic plant risk assessment and serves as a pre-entry screening tool for testing non-native plant species and identifying those which are likely to be invasive and should therefore be excluded. The model uses a series of weighted questions to give a score to each plant species tested; the higher the score, the more likely the plant is to be invasive in the State of Texas. We tested the model against 100 known non-native species within the state and subsequently ran a series of statistical tests on the results to determine the model's accuracy and find the best threshold to separate major invaders from minor and non-invaders. When model results were compared to known species invasiveness and a threshold of 50 was set between high risk major invaders and non-invaders, 100%, 87%,

and 94% accuracy was achieved in classifying major invaders, minor invaders, and non-invaders, respectively. Other, more precautionary thresholds were also explored during analysis.

The second model, the Lake Conroe Invasion Model, simulates growth and senescence of hydrilla in Lake Conroe, and the plant's response to control efforts using grass carp (*Ctenopharyngodon idella*). The model was developed using reported data from previous hydrilla infestations and control attempts at Lake Conroe, and serves as a prototype for future simulated invasion modeling. A series of simulations were run to calibrate the model, based on previously reported data, and to demonstrate the model's use. Results from the simulations accurately reflected reported growth and senescence rates of hydrilla within the lake; growth rates for grass carp in the model were also comparable to rates reported in the literature. Simulations of various management strategies showed that increasing numbers of grass carp were needed to control a hydrilla infestation as the time lag between initial hydrilla invasion and stocking of grass carp increased. However, the number of grass carp needed to control an infestation decreased as the amount of time allowed for control increased. In addition grass carp mortality rates may be significantly impacted by grass carp stocking rates relative to the number of vegetated hectares. If smaller stocking rates are preferred in order to avoid removing all aquatic vegetation from the lake, higher mortality rates likely need to be accounted for as increased mortality due to a decreased predator to prey ratio may occur.

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# NOMENCLATURE

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| AIP | Aquatic Invasive Plants |
| ANOVA | Analysis of Variance |
| AWRA | Australian Weed Risk Assessment |
| DA | Discriminant Analysis |
| LDA | Linear Discriminant Analysis |
| LOOCV | Leave One Out Cross Validation |
| MANOVA | Multivariate Analysis of Variance |
| NLPCA | Non-linear Principal Component Analysis |
| NZAqWRA | New Zealand Aquatic Weed Risk Assessment |
| NZWRA | New Zealand Weed Risk Assessment |
| PC | Principal Component |
| PCA | Principal Component Analysis |
| TXAqPRA | Texas Aquatic Plant Risk Assessment |
| USAqWRA | United States Aquatic Weed Risk Assessment |

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# CHAPTER I

## INTRODUCTION AND LITERATURE REVIEW

Plants, animals, and other biota have been transported and allowed to establish in areas outside their native range since ancient times. Records dating back to the Akkadian Empire, circa 2300 BCE, discuss in great detail the exotic monkeys, elephants, and other animals that roamed the capitol city of Agade (1). Exotic flora was also commonly found in the pleasure gardens of ancient kings and other royals throughout early times. The garden of Ramat Rahel, which existed in Israel throughout the seventh to fourth centuries BCE, contained various non-native plant species like citron from India, cedar from Lebanon, and Persian walnut (2). Exotic species during those times were valued for their medicinal and aesthetic values, used as a way to demonstrate status for the upper class, and were often given as gifts from visitors to the royals (1, 2).

When the Europeans first arrived in North America, they brought with them various plants, animals, and microbes from Eurasia; some were brought intentionally and were cultivated while some were accidental introductions. Horses, cattle, and wheat are all examples of agricultural commodities that the Europeans purposefully introduced to the Americas (3). These non-native species were used heavily by the early Americans, who spread them across the continent as their range expanded. Even upon encountering indigenous peoples who survived entirely on native flora and fauna like squash, peas, and bison for centuries, the Europeans were reluctant to adopt this new, foreign diet out of a fear of the unknown and unfamiliar. Unintentional releases by the early settlers included crop weeds like the common dandelion (*Taraxacum officinale*) and diseases like smallpox and influenza which decimated the native human populations (4, 5). Early European Americans and Native Americans alike also actively transported species to new locations within the country where they had not existed before, thus creating regionally non-native species. Examples of this include largemouth bass (*Micropterus salmoides)*, and yellow perch (*Perca flavescens)*; both species were transported by early Americans for their value as a food source and are still stocked today for their popularity in sport fishing (6).

## Defining Non-native Species

To date, over 50,000 non-native species of plants, animals, and microbes have been introduced into the United States; roughly half of those are plant species (7). Theoharides and Dukes describe four general filters that all plant species must pass through in order to become successful non-natives: transport to a new area, initial colonization, the ability to become established and survive long enough to reproduce, and successful spread across the landscape (8). Furthermore, all established non-natives can be grouped into one of three categories: beneficial, neutral, or detrimental; although the majority fall into the first two categories (4). In this context, beneficial refers primarily to economic benefit. Some of these species may exhibit negative impacts on the environment but provide us with useful services and commodities which help drive our nation's economy, and are therefore considered beneficial. Introduced livestock, like beef and dairy cattle, are a major non-point source of pollution, contributing excess nutrients to our freshwater sources and methane to the atmosphere. However, the prominence of beef and dairy products in the American diet makes them an essential, economically beneficial commodity (9). Likewise, giant reed (*Arundo donax*) is considered a major pest in many states, increasing evapotranspiration rates and outcompeting other species, however it is being considered for use as an energy source in Florida (10).

Worldwide, agriculture is highly dependent on introduced species. Very few of today's agricultural economies function solely on native crops, and none of these exclusively native crop systems exist within a modern industrialized society. The United States is certainly no exception; although the United States boasts valuable native plant species like corn (*Zea mays)* and cranberries (*Vaccinium spp.*), overall it is relatively poor in economically beneficial crops (11). Thus, US agriculture is made up of more than 98% non-native species, and adds over $300 billion to the economy each year (7, 12). Species not native to the United States like zebra (*Equus quagga*) and scimitar oryx (*Oryx dammah*), as well as regionally non-native species like rainbow trout (*Oncorhynchus mykiss*), are also purposefully introduced into the United States on a regular basis for hunting and fishing. In 2011, hunters and anglers in the United States spent roughly $90 billion on hunting and fishing related expenses, making this the most valuable outdoor recreational activity in the country (13). Hunting and fishing related expenditures contribute to a wide range of economic sectors and include food, lodging, equipment purchases, and transportation costs.

Some non-natives have no significant negative impacts on the environment or economy and can be considered relatively neutral on the scale of effects. These species are established within non-native systems; however they exist alongside native flora and fauna without excluding them from a system or greatly reducing overall biodiversity. In addition, these species produce no real economic benefit or detriment. The Mediterranean gecko (*Hemidactylus turcicus*) is a prime example of a neutral non-native species. As their common name suggests, these geckos are native to the Mediterranean region but are well established throughout the southern United States, Mexico, and numerous other warm-climate countries (14). Although their non-native range is widespread, it appears that the species is not capable of long-term survival outside of urbanized areas within its non-native range, and no significant negative ecological or environmental effects have been documented as a result of their introduction (15). Mediterranean geckos are so commonplace in some introduced ranges that many people are unaware that they are indeed a non-native species.

The third group of non-native species is those categorized as detrimental. Only a small percentage of the total number of non-native species fit into this category; a report from the Office of Technology Assessment estimated that roughly ten to fifteen percent of introduced species will become established in a new area, and only 10 percent of those established species are likely to be detrimental (16). Although the percentage of species which fall into this category is extremely small, these flora and fauna comprise the most damaging group and are to blame for a large number of negative impacts, causing severe economic and ecologic damage. Second only to habitat destruction, detrimental non-native species have the greatest negative impact on native species and habitat in the United States. Roughly 57% of plant species and 39% of animal species in the country are negatively affected through predation by or competition with non-native species (17). Additionally, Pimentel et al. estimated that direct and indirect impacts from detrimental non-native species in the US exceeded $143 billion annually in 2005. By today's standards, those impacts cost an estimated $171 billion each year (18). Gordon suggests that truly successful invaders will display one or more of the following characteristics: effective reproduction, superior competitive ability, susceptibility to few predators or pathogens, the ability to occupy a vacant niche, and the capability to alter the invaded site (19).

Detrimental non-native species are commonly referred to as exotic, non-indigenous, alien, or in the case of non-native plants, as weeds. Issues with the majority of these terms arise from their broad usage and lack of detail. Exotic, alien, and non-indigenous clearly portray a species as not native to an area; however these terms are also used to describe beneficial and neutral non-native species and may not accurately reflect their intrusive, destructive nature. Exotic can in fact be regarded in a positive manner in some instances. Plants and animals are sometimes marketed as exotic to make the species more intriguing to potential consumers. A quick search on Google for "exotic plants for sale" delivers and extensive list of tropical or rare plants for sale with descriptors like "beautiful", "unusual", and "fragrant". Weed is likely the most commonly used term to describe nuisance plants. While weed has a negative connotation, it is a highly overused word with an array of meanings. Baker described weeds as species with no human value and which interfere with human activities (20). This definition is strictly anthropocentric and excludes potential environmental impacts entirely. Furthermore, Rejmanek stated that although the majority of weedy species in the United States are indeed non-native, some weedy species are native plant species that have simply become a nuisance (21).

The term invasive was defined in Executive Order 13112 as “alien species whose introduction does or is likely to cause economic or environmental harm, or harm to human health”, and most accurately describes these harmful non-native plants and animals (22). Thus, we will use the term ‘invasive’ to refer to all detrimental or potentially detrimental non-native species for the remainder of this thesis. Furthermore, many articles describe invasive species as “a growing threat” or “potentially threatening” within non-native systems (19, 23, 24). In reality, invasive species are not a threat, but a real and very serious problem causing negative impacts on every continent on earth. Even Antarctica, which has no permanent residents and sees only 1,000 to 5,000 visitors a year, is experiencing the negative effects of invasive species (25). The chironomid midge (*Eretmoptera murphyi*), is native to southern Georgia in the United States but was unintentionally introduced to the Antarctic near a research station in the 1960s; evidence of accelerated decomposition within the soil layers is already present (25).

## Aquatic Invasive Plants

Agricultural lands, being highly economically valuable, often receive the most attention in regards to invasive species. Indeed, weedy and invasive plants in agricultural settings have the potential to greatly reduce crop yields and drive up costs through increased labor and technology needed to prevent further losses (26). However a disproportionately high percentage, 24% or 8 out of 33, of the world's most damaging invasive species are in fact freshwater invasive plants (27). This percentage is staggering, considering that less than 3% of water in the world is freshwater and only 30% of that freshwater, or less than 1% of the total amount of water in the world, is available for use as 70% of freshwater is locked up in glaciers and ice (28). Aquatic systems, specifically wetlands, boast roughly one and a half times more invasive plant species than terrestrial systems (29). A variety of hypotheses as to why aquatic systems can be more susceptible to invasion have been proposed, including Daehler's suggestion that it is due, in part, to aquatic systems being species-poor, recently changed or damaged by anthropogenic activities, or having altered nutrient cycles from run-off and deforestation (30). Vander Zanden and Olden state that freshwater system's isolation and high level of endemism are key contributors to their vulnerability to invasion (31). Baker suggested that frequent breaks in the natural plant cover within aquatic systems contribute to their invasiveness (32). It is most probable that the cause is a combination of the aforementioned; a mixture of anthropogenic changes and natural processes that lead to ideal conditions for new species to invade.

## Pathways

Aquatic Invasive Plants, or AIP, make their way into freshwater systems of the United States through a variety of pathways, however there are three general routes which facilitate the movement and establishment of AIP: intentional introduction, accidental introduction, and natural events. Pimentel et al. explained that most plant and animal introductions fall into the intentional category, with the ornamental and aquarium trade being the largest source of freshwater species introductions (3). In total, one-third of the world's worst aquatic invasives are aquarium and ornamental species (33). In addition, water gardening and hobby aquariums in the United States are growing in popularity at an incredible rate; from 1998 to 2003 the number of household water gardens quadrupled. Globally, the aquarium and ornamental trade industry is growing by about 14% per year (33). Hobbyists often buy, sell, and trade aquatic plants with other hobbyists and the internet and mail order services have had a profound effect on the trade (34). Online hobbyist groups and water gardening forums are popular places for hobbyists to exchange information with other hobbyists and solicit plants for sale or trade. In addition, numerous nursery websites offer a wide variety of plants shipped directly to the location of your choosing (34). It is easy to find virtually any plant that you desire, even prohibited plants that are categorized as noxious and are therefore illegal.

Lack of knowledge about individual plants and the possible damaging effects of AIP is also somewhat common in the ornamental plant trade community; hobbyists may be amateurs with little to no formal background in plant identification. To compound the issue, plants sold in nurseries and online are sometimes incorrectly labeled or not labeled at all (35). When a hobbyist grows tired of caring for their water garden or no longer wants a particular plant, they may simply dump them into the nearest water body, thereby facilitating the introduction of a potentially invasive species. In southern New England, it is estimated that 76% of all aquatic plants that have been introduced into the environment were a direct result of the ornamentals trade (36). Another intentional introduction pathway is cultivation of non-native plants for food or the ornamental trade in a natural system. A grower will purposefully seed a water body with a non-indigenous plant with the intention of harvesting it. Once established in the system, the plant is able to spread throughout the system freely (34, 37).

Unintentional introductions are also often a result of the ornamental trade. Plants that are sold within the trade may be harvested from a wild source or taken from a tank containing multiple plant species, and non-target, potentially invasive plants can be unintentionally packaged with the ornamental (37). Shipments of non-native plants may contain these 'hitchhikers', as they are commonly referred, leading to inadvertent introductions. Other accidental pathways include ballast water and regional transport of AIP on boats, trailers, and other aquatic equipment.

Boats, boat trailers, and other equipment used in freshwater contribute to ongoing or secondary unintentional spread of AIP between freshwater bodies across North America (38). Plant fragments, seeds, and other propagules may get caught on or attach to a trailer or boat propeller or in a bait bucket or live well (39). If equipment is not thoroughly inspected and washed or allowed to dry out for an extended period of time before being reused, these hitchhikers may be introduced into another water body, potentially continuing the spread of these unwanted species. Eurasian water milfoil (*Myriophyllum spicatum*), hydrilla (*Hydrilla verticillata*), and giant salvinia (*Salvinia* *molesta*) are all AIP in the United States which are commonly transported via boats and boat trailers. Since these and many other aquatic plant species are able to propagate vegetatively, the potential for successful establishment in new water bodies is very high. Naturally, many new AIP introductions begin near boat ramps, and temporary boat ramp closures are increasingly common in order to prevent the new invaders from spreading. Ramp closures usually involve isolating the area immediately surrounding the ramp with booms and attempting to remove the AIP through manual removal, herbicide application, or other methods, eliminating the plant before it is able to infest the new water body.

Boats, trailers, and other aquatic equipment are among the most important vectors for the regional spread of AIP. Nationally, the Aquatic Nuisance Species Task Force has created the “Stop Aquatic Hitchhikers!” campaign to educate the public about aquatic invasives (40). Simple preventative measures include removing all visible plants, mud, or animals, draining all water prior to transport, cleaning and drying all equipment, and never releasing plants or animals into a water body unless they came out of that same water body (30). Many states have adopted campaigns to help educate boaters and other recreational users of the damaging effects of AIP, and how to help prevent new infestations. In Texas, the Texas Parks and Wildlife Department has implemented a regimen called “Clean, Drain, and Dry” to illustrate an easy-to-remember way to properly clean equipment after use and to let users know that it is required by law to remove harmful plants and animals from their boats and trailers.

Although these campaigns have achieved some successes in educating stakeholders and slowing the spread of AIP, a multitude of issues arise, primarily with educating boaters to take the time to properly inspect and clean their equipment, and convincing them that their actions will have a noticeably positive impact. In 2011, Prinbeck et al. conducted a study which measured stakeholder attitudes toward preventative measures for invasive species, and the barriers that exist which prevent stakeholders from changing their attitude toward these behaviors. The study showed that the stakeholders who had a negative attitude toward the measures generally shared two main beliefs. The first was that prevention measures may actually cause more harm to the environment than the invasive species themselves. For example, boaters expressed concern about using detergents and disinfectants to clean equipment, and the possible negative effects those preventative measures could have on the ecosystem. The second belief was that the fight against invasive species was a losing battle, so small scale prevention was useless (41). Frustration was expressed with the existing social norms; some boaters claimed to be responsible boat owners who followed the guidelines, but felt that their actions were futile knowing that there were many more boaters and recreationalists out there who likely did not. Lack of visible enforcement, and large scale environmental changes like climate change and globalization were also cited as reasons for not adopting preventative measures (41).

Transport of invasive species through ballast in shipping vessels is another unintentional introduction pathway. Although more of an issue for freshwater fauna and marine species, ballast has historically been of concern for freshwater invasive plants as well (42). Cargo and freight ships use ballast to maintain stability in the water as heavy cargo is loaded and unloaded from the vessel, taking on or removing ballast to maintain equilibrium. In the past, solid media including soil, rocks, and sand were used as ballast, however this practice began to fade in the late 1880s in favor of water, which took much less time to load and unload (43). Today, water is virtually the only media used for ballast in freight and cargo vessels. Very large quantities of water are used for ballast; ships entering the Great Lakes may hold around 3 million liters of ballast water (44). In 2004 the International Maritime Organization adopted an act at the International Convention for the Control and Management of Ship's Ballast Water and Sediments which states that ballast water must be exchanged at least 200 nautical miles from the nearest land mass, in hopes that this would reduce the likelihood of non-native species being introduced into new areas (45, 46). This practice is not fail-safe however, as these exchanges do not always result in 100% exchange of the ballast water, leaving room for organisms to persist in the ballast. Some species, both marine and euryhaline freshwater species or species that can tolerate short term exposure to increased salinity, may survive in the tank even after a successful ballast water exchange, and be deposited in a new location (47). In addition, multiple AIP were introduced via solid ballast prior to it being phased out. Alligator weed (*Alternathera philoxeroides*), a highly invasive plant in many countries around the world, was introduced into Australia via solid ballast in the 1940's. Soon after its introduction, it began to grow and spread rapidly and is now considered a noxious plant (42).

Natural events are the final major pathway for invasive species introductions. Hurricanes and floods are common weather events which aid the dispersal of AIP; however, other events like landslides can also be included (48). Movement of AIP during a weather event and disturbance within the ecosystem as a result of the event are the most common attributes which facilitate AIP spread (48). Richardson et al. explained that rivers function as conveyor belts within a system, transporting fragments, propagules, and contaminants downstream (49). Floods and other natural events disrupt the ecosystem. This disturbance is a natural and essential component of maintaining a healthy system; however systems which experience natural disturbances, coupled with impacts by anthropogenic modification, are more prone to invasion by new AIP when a major flood event occurs (49). Other natural events include animal-mediated transport and wind dispersal (50). Birds, turtles, beavers, and other animals passively contribute to the transport of aquatic plants, especially on a local scale. Some waterfowl are known to consume large amounts of aquatic plant seeds, many of which remain viable following gut passage. In addition, many waterfowl are migratory, leading to possible long-distance spread of plant seeds.

### *Categories of Aquatic Invasive Plants*

There are a variety of types of aquatic plants, which can be rooted or un-rooted and may live above or below the water surface. Attatched-floating species are plants which float on the surface, but have roots that extend down into the soil layer. This group includes water lily (*Nymphaea spp*.) and water sheild (*Callitriche stagnalis*) (51).

Free-floating species may or may not have roots, float on the water surface unattached, and include giant salvinia and water hyacinth (*Eichornia crassipes)* (51). Submerged species are rooted in the soil layer and grow up through the water column. Hydrilla, American waterweed (*Elodea canadensis*), and giant cabomba (*Cabomba aquatica*) are all submerged species. Erect emergent and sprawling emergent species are both rooted, grow up through the water column, and breach the surface; however erect emergents tend to display linear growth above the surface, while sprawling emergents tend to grow more laterally. Many-stalked spike rush (*Eleocharis multicaulis*) is an erect emergent, while examples of sprawling emergents include tropical American water grass (*Luziola subintegra*) and waxy mannagrass (*Glyceria declinata*). Some species may fall into more than one of these categories; submerged species sometimes grow to the water's surface, often referred to as "topping out", and can then continue to grow above the surface. Parrotfeather milfoil (*Myriophyllum aquaticum*), a submerged plant, can grow up to one meter above the water surface under ideal conditions (52). Wetland and riparian plants are also often included in the list of aquatic plant types; these are plants which are commonly found in our around a water body, but may not require standing water to survive. Giant reed, purple loosestrife (*Lythrum salicaria*), and Japanese sweetflag (*Acorus gramineus*) fit into this category. Giant reed can be found along thousands of miles of riparian area, but also thrives in disturbed areas away from water, like highways, right-of-ways, and pastureland (53).

## Impacts

Negative impacts from AIP in the United States are widespread and include economic costs, loss of commercial and recreational use, and environmental damage. Economic costs are a quantified version of environmental damages, usage losses, and costs of management and control; this also accounts for factors like willingness-to-pay for free goods and services, and other non-tangible costs. While estimating the true economic cost of invasive species is difficult because some impacts resulting from AIP may not be well documented, there is enough data available to estimate the various costs associated with AIP (3). In the 1990s it was estimated that the United States invested roughly $100 million annually in control and management efforts for aquatic invasive plants. Adjusted for today's standards, that number is over $200 million (18). This number is most likely lower than the actual amount as all methods, such as private control efforts, may not be included or accurately accounted. Control costs have increased in the past two decades as well; Florida's total state and federal budget for AIP control alone in FY 2012-2013 was roughly $16 million, with $7.4 million of that going directly toward the fight against hydrilla (54). Florida allocates the most money of any state toward fighting aquatic invasive species, and rightly so; due largely to the ornamental and aquarium trade coupled with the state's tropical climate, Florida has been the epicenter for many AIP invasions in the United States and still boasts the largest number of AIP in the country (55, 56).

Although the amount of money invested in control efforts seems high, many states' AIP infestations still greatly outweigh the available management and control funds in each state; furthermore, economic losses due to AIP each year would be exponentially higher were control and management not pursued. Even in the 1940s, annual losses from water hyacinth were estimated to be around $65 million in Louisiana (57). Florida was spending roughly $6 million on AIP control in the 1960s, but their estimated benefits totaled $82 million (58). In Texas, the state-allocated budget for controlling AIP is an estimated $1.4 million for FY14, with half of that budget being used for the control of giant salvinia alone. The remainder of the budget is split between hydrilla, water hyacinth, giant reed, and other major aquatic invaders (59).

### *Ecological Impacts*

MacDonald et al. outline an extensive list of environmental impacts from invasive species, many of which apply to AIP (60). Alteration of hydrological cycles, including surface-flow patterns and water-table depth, is a heavily cited impact from AIP, especially in areas where water is limited and an increase in pressures from invasive species can reduce the soil moisture content (60, 53). Watts and Moore explain that giant reed is a well-established invasive plant, found in all 25 of the southernmost states which grows well both along river edges and further up the river bank, and contains a toxin which makes the plant undesirable as a food source for animals (53). In their 2011 study, Watts and Moore found that giant reed's evapotranspiration rates are high, but still similar to rates of other riparian reeds. However, this species often outcompetes native plants, forming extensive, dense monotypic stands with high leaf area, resulting in high stand-level estimates of water use.

Biogeochemical processes are often affected by AIP, including nutrient immobilization, eutrophication, and changes in water chemistry (60). Free-floating AIP often cover the surface of the water, blocking sunlight from entering the water column, effectively killing off any submersed plants below that require light to photosynthesize. This can also lead to decreased amounts of dissolved oxygen in the water that is normally produced via photosynthesis. Hypoxic conditions can occur during the summer as a result of reduced D.O. levels and increased temperatures (61).Decreased flow rates can be an issue when AIP growth restricts water movement, resulting in increased siltation rates as suspended particles fall out of the water column (19). Other environmental effects from AIP include altered disturbance regimes, reduced recruitment of native species, decreased biodiversity of both native plant and animal species, and increases in unwanted pest species (60). Giant salvinia, a highly invasive aquatic fern native to Brazil, has infested numerous countries over the past three decades, grows in dense mats on the water surface, and can double in size in as little as four days under ideal conditions (62). Giant salvinia can severely impact waterways by decreasing or eliminating light penetration into the water column, decreasing D.O. levels, creating unfavorable habitat for fish, and choking out native plant species (62). Mats up to one meter thick have been reported and sometimes form floating islands, accumulating sediments and even providing habitat for other types of vegetation to grow (63). Giant salvinia mats are also good habitat for mosquitoes which can carry transmittable diseases like malaria and dengue fever (64).

*Usage Impacts*

Impacts on recreational and commercial use from AIP result in millions of dollars lost each year to our economy. AIP clog waterways, block boat ramps, and restrict access. Submerged AIP like Eurasian water milfoil (*Myriophyllum spicatum*) grow in thick stands, can tolerate a wide range of nutrient levels, are found in fresh or brackish waters, and are able to grow in deep water communities of less than 15% sunlight penetration, often filling the entire water column until they top out (65). Because of this, these invaders are able to create dense, impenetrable stands which get caught in boat propellers and restrict activities like swimming and boating (66).

Commercial losses due to AIP can affect a number of businesses; tourism and recreation is likely the largest industry affected. Lakes that are infested with AIP will not be attractive to tourists looking to boat, swim, or fish. This results in a large decrease in revenue for businesses like outfitters and fishing guides who earn their money directly from lake use (67). Hotels, restaurants, and retail shops near the lake that rely on lake-bound tourists will also be affected by the decrease in visitors. Other affected industries include commercial fisheries and the housing and construction industries.

Lakes which have a large draw for boaters for their fishing quality and scenic views are more at risk of being invaded due to the high rate of AIP transfer via boats and trailers. The same lakes that are heavily used by boaters are also likely to be popular with other lake enthusiasts, including people who desire to live on the lakefront. Many people place a high value on waterfront properties for their aesthetic value, ease of access to the water, and the sense of exclusivity and relative isolation that comes with living on the water. Therefore, AIP which limit use of the lake or detract from its aesthetics, making the area less desirable, would likely cause a decrease in property values or a decrease in interest to build near the infested water body in the future. Horsch and Lewis conducted a study in 2009 which focused Eurasian water milfoil infestations in 172 lakes in northern Wisconsin to test this hypothesis. The study concluded that property owners were willing to pay between $13,700 and $48,400 more for property on a lake that was not infested with Eurasian water milfoil. Following invasion, lakefront property values were reduced by 8%, and overall land value decreased by an average of 13%.

**Removal and Control Techniques**

With AIP's potential to significantly damage an ecosystem and harm the economy, it should come as no surprise that many methods have been developed in an attempt to control or remove them. Manual removal involves hand-pulling, cutting, or raking the unwanted plants from the water (68). This method is relatively inexpensive, allows the invasive plants to be removed while leaving the desirable plants intact, and is a good option for ponds and small bodies of water. However, in a large scale setting with a serious infestation such as a lake or wetland this method is not a viable option (68). Mechanical removal is similar to manual removal, however instead of individuals going out into the water and pulling the AIP by hand, a machine is put into the water that will remove the plants which can then be composted or otherwise disposed of. This may be a more feasible option for large stands, however many AIP can regrow from fragments, so any portion of the plant not removed from the water has the potential to repopulate the area, and both mechanical and manual removal typically must be repeated multiple times in a given season. In addition, neither method is feasible in areas that are physically difficult to access (68).

Biological control, or bio-control, is a popular but somewhat controversial method for AIP control. An animal, insect, bacteria, or fungal pathogen that is known to feed on the AIP of concern is stocked in the area where the invasive is growing with the hope that, over time, the bio-control agent will reduce the presence of the invasive to a manageable level (69). It is imperative, however, that species proposed for use as bio-control agents be tested extensively to ensure that they do not have the potential to become an invasive and target native or economically valuable species. Giant salvinia has become a highly invasive species in many countries, however successful control has been achieved through the use of the salvinia weevil (*Cyrtobagous salviniae*) (70). The salvinia weevil, like giant salvinia, is native to South America and has been found to feed only on giant salvinia (71). The Lower Senegal River was infested with giant salvinia in 1999, threatening socioeconomic conditions as well as biodiversity in the river. Salvinia weevils were introduced to the river in 2000 and 2001, and by 2002 control of the infestation was achieved (72).

Although bio-control can be successful over time, failures in the past have led to some negative public perception. Grass carp (*Ctenopharyngodon idella*) are a popular fish species for bio-control of hydrilla. A triploid form of this herbivorous fish which are unable to reproduce, eliminating the worry of invasiveness, and have been used to effectively control hydrilla in recent decades (69). However diploid grass carp, a non-sterile form of the fish, were stocked prior to the use of triploid grass carp, leading to grass carp reproduction in some systems and a negative public perception of the method.

A fourth method for controlling AIP is the use of herbicides, which are widely used to control AIP populations in both terrestrial and aquatic systems. A multitude of herbicides have been used over the years and pesticide control laws have been in place in the United States since 1910 (73). However in the 1960s, concern began to grow over the possible negative impacts of some commonly used herbicides. Shortly after, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) was passed in 1972, and with it stringent standards and costly testing requirements were put in place limiting the number of compounds approved for use in aquatic ecosystems (73). By 1976, only 20 compounds were approved for use (74); today that number has dropped to less than 15. FIFRA dictates that herbicides approved for aquatic use must not be persistent in the environment and cannot pose more than a one in one million chance of causing significant damage to human health, the environment, or wildlife when applied appropriately (73).

Herbicides affect plants in a number of different ways, can be selective or nonselective, and are classified as systemic or contact herbicides. Some herbicides disrupt a part of the photosynthesis process; others degrade the integrity of the plants cell walls while others inhibit cell growth. Systemic herbicides are slow acting and work through the plant, often killing the entire plant. Glyphosate, fluridone, 2,4 D, triclopyr, imazapyr, imazamox, and bispyribac-sodium are all systemic herbicides (74, 75).

Contact herbicides, conversely, work quickly by killing whatever part of the plant they are applied to. They often may only reach the leaves and stems of the plant and do not kill roots or rhizomes, many times resulting in regrowth of the invasive. Contact herbicides include endothall, diquat, copper, SCP, flumioxazin, and carfentrazone (76). Selective herbicides are effective in controlling certain types of plants, making them a good choice when spraying an area with many different species of plants (76, 77). The selective herbicide 2,4 D is very effective at controlling broadleaf plants like Eurasian water milfoil. Other herbicides are nonselective, and will severely damage or kill almost any plant that it is applied to. Glyphosate and diquat are effective nonselective herbicides.

Once AIP are introduced into a system, management is imperative. There are countless examples of existing invasions which make it clear that if left unchecked, AIP will continue to establish and spread into previously un-infested areas with devastating consequences. Although total eradication is a lofty and often unachievable goal, minimization of the effects caused by aquatic invasive plants is a critical component within the goal of maintaining aquatic systems that are ecologically healthy and diverse, and available for anthropogenic use. In addition, invasion must be managed on two levels: existing and potentially new invasive species which threaten biodiversity and ecological health must be identified, and species must be prioritized so that existing invasions can be effectively controlled (78). Risk assessments can be highly effective in achieving these goals.

## Modeling Aquatic Invasive Plants

From assessing the likelihood of injury upon admission to a nursing home to determining the risks of stock investment, risk assessments are used in virtually every profession as a reliable predictive management tool (79, 80). Within plant invasion ecology, risk assessments are used for the identification of potential new invaders and the prioritization of existing invasives for management. AIP risk assessments have been designed for numerous countries. Perhaps the most widely cited plant risk assessment is the Australian Weed Risk Assessment model, or AWRA, developed in 1999 for the state government of Western Australia, the westernmost state in the country, and subsequently adopted by the Australian Government Department of Agriculture, Fisheries, and Forestry (81). The AWRA is a biosecurity assessment tool designed to effectively screen plants which are being imported into the country and decipher, with a high level of accuracy, whether or not a plant should be considered ‘weedy’, or invasive, and therefore banned from entry (81).

The model is a questionnaire-style assessment consisting of 49 weighted questions that are divided in eight categories which assess a plant’s climate tolerance and distribution, domestication, weediness in other areas, undesirable traits, plant type, reproductive abilities, dispersal mechanisms, and persistence attributes (81). Each question requires a yes or no answer, which is then converted into a number. Once the questionnaire is complete, the plant receives a score ranging from -14 to 29; the higher the score, the more likely the plant is to become weedy if introduced into Australia. Extensive analysis and validation was performed on the AWRA by testing the model against 370 non-native plant species already present in Australia. The taxa included weedy species, as well as beneficial species from agriculture or other areas (81). One hundred percent accuracy was not possible because the range of scores for non-weeds overlaps the range of scores for serious weeds, -14 to 6 and 0 to 29 respectively. Analysis determined, however, that it was possible to ensure that none of the serious weeds were accepted as non-weedy by setting the threshold for acceptance at a score of zero and the threshold for rejection at six, leaving all scores in between the two thresholds as species which require further evaluation (81). The AWRA is a useful screening tool, however its limitations lie in its focus toward terrestrial plants; although the model does include a question in its “plant type” category regarding aquatic plants, the model is primarily suited for assessing agricultural or other terrestrial flora. In addition, the AWRA includes questions which are not applicable to the assessment of aquatic species, like fire hazards as a result of the plant’s growth in an area, and does not include any questions addressing a plant’s tolerances to various water quality parameters, which are important factors in determining an aquatic plant’s establishment success (81).

Soon after the development of the AWRA, the model was adapted for terrestrial plants in New Zealand and referred to as the New Zealand Weed Risk Assessment, or NZWRA, where the model again showed high accuracy in detecting invasive species. However, New Zealand has experienced a large number of aquatic plant invasions, so a model better suited to correctly identifying aquatic invasive species was developed shortly after implementation of the NZWRA (82). The adapted model, the New Zealand

Aquatic Weed Risk Assessment of NZAqWRA, included questions about tolerances to water clarity, salinity, and pH, as well as the type of aquatic habitat that plant preferred, such as lentic, lotic, or wetland (82). Subsequent models have been developed in numerous areas around the world including Chile, Argentina, Micronesia, Hawaii, California, and Florida. While the basic format of the risk assessment has remained constant, questions within the assessment have been altered, providing effective predictive tools in each new location.

Recently, a risk assessment model was adapted for use in the United States. This new model, the United States Aquatic Weed Risk Assessment or USAqWRA, was based largely on the NZAqWRA, modified by the inclusion of three questions which were used in the Australian and Micronesian models but not in the New Zealand version, as well as the revision of several existing questions so that they applied more directly to conditions within the United States (83). The USAqWRA consists of 38 questions in twelve categories, ranging from temperature and salinity tolerance, to dispersal mode and cloning ability, to resistance to management techniques. The model has a score range of 3 to 91, and can detect between invaders and non-invaders with higher accuracy than the AWRA because of the inclusion of a third intermediate category, minor invaders, which was previously excluded (83). The USAqWRA was assessed against 130 introduced aquatic plant species which have had the opportunity to establish within the United States, and maximum accuracy with this model was achieved with a threshold of 24, meaning a score greater than or equal to 24 indicates high invasiveness (83). An additional change that was made when developing the USAqWRA was the inclusion of a minimum date of establishment. When testing the model, only species which had been in the trade or established within the US for at least 30 years were included. The 30 year minimum excluded species which were introduced more recently and may not have had adequate time within the trade to become established, and therefore likely had insufficient data for proper testing (83).

### *Successes and Areas of Improvement*

Aquatic plant risk assessments have proven to be highly effective as pre-border screening tools in many areas around the world, allowing governments to make educated decisions on which species are not likely to be invasive and therefore should be considered safe for importation, while excluding those that are likely to cause damage if allowed entry. In 2008, Gordon et al. conducted a study to look at the AWRA, and six subsequent models based on the AWRA which were adapted for other geographies. The study concluded that the models show consistent accuracy over the varied geographies and are a suitable and highly adaptable tool for initial screening. Correct rejection of major invaders varied from 82-100%, with only four out of 367 species being erroneously accepted into the major invaders category (84). Furthermore, Keller at al. conducted a cost-benefit analysis of the AWRA which looked at economic benefit at 10, 25, 50, and 100 years in Australia (85). The study concluded that the model provides some economic benefit after 10 years, with greatly increased savings over time. After 50 years, the analysis estimates a savings of $1.8 billion (85).

In the United States, the USAqWRA is able to distinguish between most potential invaders and non-invaders in the United States on a broad scale however improvements may be possible if adapted on a regional or state level (83). The United States covers a large geographical area and a multitude of climates, so invasiveness and potential distribution of AIP varies greatly across the nation. Furthermore, some species which were categorized as non-invaders after being used as test species for the USAqWRA may actually be established and spreading in some areas of the country, and some species which were categorized as major invaders in the USAqWRA may only be regionally invasive. Flowering rush (*Butomus umbellatus*) was introduced to the United States in the early 1900s, is easily attainable through the ornamentals trade, and is known as a major invader in some northern states displacing native vegetation and disrupting boat traffic (86). However, there are no records of establishment outside of cultivation for this species in Texas or any other southern state (87). Due to the broad geographical area that is covered by the USAqWRA, data which best represented overall conditions within the United States were used to make the determination, leaving room for possible oversight of some localized invasions (88).

Reducing the area covered by the model to a regional or state level could eliminate some of these shortcomings and produce a more accurate predictive model. The state of Texas is an excellent location for this type of risk assessment; although geography and climate within the state show some variance, warm temperatures and generally mild winters make Texas prime habitat for potential new AIP. Texas is also home to some of the largest distributors of aquatic ornamentals in the world. (35).

Additionally, understanding the significance of various species' traits in relation to species invasiveness could be highly informative. Determining what attributes contribute most considerably to a species ability to successfully invade an area could help us to more successfully predict for potential future invasion.

In addition to an aquatic plant risk assessment, a secondary model that simulates spatial and temporal growth of AIP could also be useful tool for both prediction of invasive growth patterns and management of existing infestations in reservoirs in Texas. Although many aquatic plant models have been developed to model AIP invasion, a model simulating aquatic plant invasion specific to large reservoirs in Texas has not yet been developed. Understanding how a species would grow and spread once introduced, and the effectiveness of possible management techniques, could be highly useful in deciding whether or not to prohibit a species from being imported into the state, or in deciding how to manage a species once it has become established.

# CHAPTER II

# ADAPTING AN AQUATIC PLANT RISK ASSESSMENT FOR THE STATE OF TEXAS

## Materials and Methods

The TXAqPRA consists of the 38 questions used in the USAqWRA and an additional two questions which are new to the TXAqPRA (see appendix for model). Questions fall into twelve sections based on various aspects of the plants ecology such as environmental tolerances, dispersal modes, ease of management, and invasiveness in other areas. Although few major changes were made to questions adapted from the USAqWRA, some alterations were made in order to clarify the guidance used to answer each question. During testing, we were not able to answer every question for each species in our analysis, due to a lack of available data. To ensure reliability in testing and for future use however, a limit needed to be set on the number of questions that could be left unanswered for the assessment to still be considered reliable and accurate. Like the USAqWRA, we limited the number of possible unanswered questions per species tested to five (83).

Gordon et al. suggested the inclusion of a pre-screening step that would immediately exclude from further analysis any plant that is not tolerant of the environmental conditions within the area of interest in a regional model (83). This would likely lead to incorrect rejection of some species however, as invasive plants often display a unique ability to rapidly evolve and survive in foreign areas with varied environmental conditions (89). Thus, a pre-screening step was not included in the TXAqPRA. Rather, a question was added to the model regarding the hardiness zones of the plant's native range. If the hardiness zones of the plant's native region overlap with those in Texas, the plant received additional points as it was more likely to be tolerant of temperatures and therefore successful in the introduced area. While the original Hardiness Zones Map only covers the United States, the map has been adapted for worldwide use, and this World Hardiness Zones Map was used during testing (90). Finally, the USAqWRA model included a question regarding a plant's invasiveness in other countries. The TXAqPRA included this question, and included an additional question regarding the plant's invasiveness in other states within the United States. If the plant was invasive or adventive (meaning those species exist in the area but have minimal or no documented impacts) in other states, the plant received additional points as there is a greater chance of those species being introduced and having the opportunity to establish in Texas.

One hundred aquatic plant species that have had the chance to establish in Texas were used to evaluate the TXAqPRA (see appendix for a detailed species list). Twenty three were species which are established in Texas and have documented impacts (major invaders), thirty species which are adventive in Texas (minor invaders), and forty seven were species in the trade but which have no documented establishment within Texas (non-invaders). Plants were not used unless they had a known history of establishment as exotics in Texas, or were known to be in the aquarium and ornamentals trade within the United States. Furthermore for the non-invader and minor invader categories, only plants which have been established in Texas or in the trade for at least 30 years were used. This decision was based on previous work by Gordon et al. which examined the effect year-of-introduction had on prediction of invasiveness (88). While the 2011 study found no direct correlation between year of introduction and prediction of invasiveness, a precautionary approach was suggested when using for evaluation species with a shorter time of establishment, in part to reduce the risk of misclassifying incipient invaders which may lack sufficient time needed to display their true impacts or data to correctly categorize them. Species categorized as major invaders in Texas were not required to meet the 30 year minimum establishment date, as data proving their invasiveness in Texas was already available.

Finally, only macrophyte species able to persist in freshwater systems were included in the evaluation. This group includes attached-floating, free-floating, submerged, erect emergent, and sprawling emergent species. Plant data were gathered by searching websites, peer reviewed journals, encyclopedias, textbooks, and by contacting aquatic plant specialists. Data regarding plant ecology and environmental tolerances was gathered from studies within the plant's native range whenever possible. Other data, like information regarding invasiveness in other countries and management potential, came from studies within the plant's introduced range. Default scores for plants with no known establishment outside of their native range were included for applicable questions.

*Analysis*

We first replicated the analysis performed in the USAqWRA (83), using univariate analysis of variance (ANOVA) on survey sums, to identify differences in mean scores among invader categories, and slid thresholds between the three invader categories to produce the most accurate delineation. We then planned contrasts that first assessed the primary question of whether established major invasive taxa differed from minor and non-invader taxa, followed by a secondary test to contrast minor and non-invaders.

To assess fundamental relationships among question responses and to increase statistical power for subsequent analyses by reducing dimensionality of the data set, we conducted principal components analysis (PCA). We approached this with both nonlinear and regular PCA. Typically, non-linear principal components analysis (NLPCA) is used for data sets that contain variables which are not always linearly related (i.e. two is not necessarily twice as much as one), which is the case with the data in this risk assessment and as well as its predecessors (91). NLPCA adjusts the ordinal scale to an optimal (correlation maximizing) linear approximation. Each question within the TXAqPRA has a range of possible scores, and score ranges vary from question to question. For example, possible scores for question 1.8 range from zero to three with all numbers within that range as possible choices, while scores for question 2.5 are zero, one, or five only, excluding two, three, and four as possible choices. Thus, data in this questionnaire approach are ordinal. We conducted regular PCA to see if the NLPCA fundamentally changed or improved the analysis. The SPSS procedure CatPCA (92) was used to generate optimized non-linear principal component scores, setting the assumed underlying data distribution to be normal, and imputing for missing data. Imputing missing data we felt was preferable to simply leaving blanks in the data both for summing values (seen in previous risk assessments) and for quantitative analysis. During summing, data blanks are essentially rendered as zero as they contribute nothing to the sum. Treating data blanks as zero will add bias (systematic change in species sums) based on the deviation of zero from the average value for given questions. Data blanks are a problem for multivariate analysis as they require case-wise deletion of data (i.e. removal of species from the analysis, even if their data are upwards of 75 % (our minimum inclusion criterion) complete. Thus data blanks are biased for the summing approach, and prevent inclusion of a vast amount of useful data in quantitative analysis. Conversely, imputed values are by definition unbiased and exert no special leverage for either analysis method, and allow inclusion of all data including cases where 35 to 39 (of 40) questions provide diagnostic information. The regular PCA and imputation were conducted using JMP Pro v.13 (93).

Principal components of imputed data were analyzed for structure to reveal fundamental relationships and clustering among question responses. Principal components also were used to generate subsequent ordinations to reveal the nature of differences among invasiveness categorizations, by examining among group differences in principal component scores, scaled to within group differences (94). Principal components summarizing 96% of total variation were used as dependent variables in multivariate analysis of variance (MANOVA) and in discriminant analysis (DA).

MANOVA was used to generate effect strengths and P-values using regular covariance PCA scores as there was little difference among models using alternative data reduction (or no reduction) schemes.  Use of PC scores was mainly warranted to provide the most powerful statistical model. DA was used to provide intuitive heuristic measures of group differentiation (i.e. distribution of correct and incorrect predicted invasive statuses) and to suggest whether covariance structures were homogeneous or heterogeneous among groups.

Robustness of DA results was assessed via leave-one-out cross-validation (LOOCV), in which the DA was re-run 100 times, each time excluding one species from analysis and allowing the DA to predict into which category the plant should be classified.  When using raw variables (100% variance; $p = 40$) we would naturally expect higher classification success than using PCA scores (≈95% variance) due to greater information content and greater potential for over-fitting.  Validation results should allow us to detect over-fitting if the raw variables fail substantially more in validation relative to PC scores.  To see if alternative data formats produced different magnitudes or types of misclassification we ran DAs with the raw (non-imputed) sums as well as with the 40 (imputed) question responses and their PC scores, using linear discriminant analysis (LDA) assuming equal prior probabilities of group membership.  A quadratic DA was conducted to examine how much prediction improvement could be obtained by allowing covariance patterns to differ among groups in direction and magnitude.

When considering results of each DA construct, we conditioned our evaluation based on the nature of misclassifications made, under the following hierarchy of severity:

Most severe misclassification: Classification of major invader as non-invader.

2nd most severe: Classification of major invader as minor invader.

3rd most severe: Classification of minor invader as major invader.

4th most severe: classification of non-invader as a major invader

These rankings are based on the idea that the ecological (and eventual monetary) cost of incorrectly classifying a major invader would be the greatest, followed by the monetary cost of classifying minor invasives as major, because less grave ecological cost is likely. We did not consider misclassification between minor and non-invaders paramount for our analysis as such misclassifications would likely not entail significant ecological and monetary costs.  Structure coefficients, correlations of the imputed question responses with canonical axis scores, were used to interpret the meaning of multivariate axes.

## Results

All 100 species considered for assessment of the TXAqPRA met our minimum threshold for information completeness and were included in the analysis. Sums for raw data, in which data blanks were essentially treated as zeroes, and imputed data were similar in distribution and were highly correlated (Pearson $r > 0.99$, $P < 10^{-114}$). Therefore only the raw summary scores are described here. Raw summary scores (sums of ordinal responses) for all species tested ranged from 7 to 82, with an overall mean of 41.3 and a median of 39. Major invaders (mean=68.0, median=71) scored higher on average than minor invaders (mean=41.6, median=40), and minor invaders scored higher on average than non-invaders (mean=28.5, median=27).

Scores ranged from 50 to 82 for major invaders, 28 to 64 for minor invaders, and 7 to 55 for non-invaders, as illustrated in Fig. 1 below. Twenty seven percent (6/22) of major invaders and thirteen percent (4/31) minor invaders has overlapping scores. Six percent of non-invaders (3/47) and eighteen percent of major invaders (4/22) overlapped. Ninety seven percent of minor invaders (30/31) and 49% of non-invaders (23/47) overlapped. All species scoring above 64 were major invaders, and all species scoring below 28 were non-invaders.

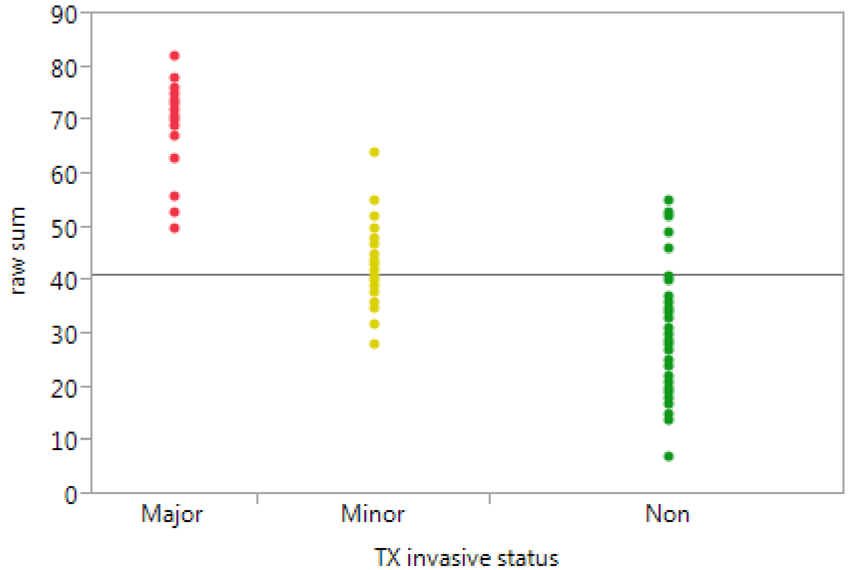


**Fig. 1.** Summary scores by invasive status for raw (non-imputed) data where blanks were treated as zeroes. Major invaders were reasonably well-bounded from the other two groups, validating the utility of the traditional approach to invasive species screening. Greater overlap was seen between the minor and non-invasive categories than between major and minor or major and non-invasive categories. Horizontal bar represents overall mean score.

Summary scores differed significantly among invasiveness categorizations, whether using raw sums or imputed data sums ($F_{2,\,97} = 121.5$, $R^2_{adj.} = 0.71$; $F_{2,\,97} = 115.9$, $R^2_{adj.} = 0.70$, respectively; both $P \leq 10^{-25}$). Residuals did not differ from normality (e.g, for raw sums, Shapiro-Wilk W = 0.98, NS) nor did they exhibit autocorrelation (e.g, for raw sums, Durbin Watson statistic = 1.81, NS). Effect strengths were both very similarly strong (both $R^2_{adj.} \approx 0.7$), suggesting that treating blanks as zeroes provided in this case no net bias. Using the raw sums, major invaders differed distinctly from minor and non-invaders (planned contrast, $F_{1,\,97} = 191.7$, $P < 10^{-23}$). Minor and non-invaders were also distinguishable in their mean summary scores (planned contrast, $F_{1,\,97} = 33.3$, $P < 10^{-7}$). Similar trends were noted for the imputed data sums (both contrasts $P \leq 10^{-7}$).

Although the raw and imputed scores indicated similarly strong differentiation among groups in this study, the imputed scores may often prove more robust in future implementations of this method and in any case allow for inclusion of all cases in an expanded analytical framework. Multivariate differentiation among groups was significant and strong ($F_{40, 156} = 8.69$, $P < 10^{-22}$). As with the ANOVA analysis on summed scores, both contrasts were significant in the MANOVA (major invaders v. other two classes: $F_{20, 78} = 15.7$, $P < 10^{-22}$; minor v. non-invader: $F_{20, 78} = 4.88$, $P < 10^{-6}$). Canonical scores from MANOVA, using the NLPCA scores from SPSS or the regular PCA scores from JMP were highly correlated ($r = 0.97$), so only the regular (standard metric) approach is reported.

Structure coefficients for the two canonical axes revealed the contribution of each of the 40 questions within the TXAqPRA in determining which of the three categorizations the plant received. Here, we will focus on structure coefficient loadings along canonical axis one, as those were most significant in differentiating major invaders from minor and non-invaders. Questions with loadings of 0.65 and above along canonical axis one corresponded to the questions that most effectively separated major invaders from minor and non invaders. Nine questions fell into the 0.65 and above category on canonical axis one: questions 2.4, 2.5, 8.2, 8.3, 8.4, 9.1, 9.3, 12.1and 12.2, as seen in Fig. 2 below.

In further examining those questions that most contributed to identifying major invaders, we found similarities among certain groups of questions. The group with the highest loading, the propensity to establish into either existing or recently disturbed vegetation (questions 2.4 and 2.5), was a trait of both major and minor invaders relative to non-invaders, though was most highly associated with major invaders.  Establishment is therefore an obvious trait for invasives to facilitate their invasions, but the strong relationship between major invasives and establishment in disturbed environments suggests a highly opportunistic nature of the most invasive species, likely due to open niche space.  The group with the second highest loading included questions 12.1 and 12.2, which dealt with species existence in areas outside their native ranges, a trait that was also strongly linked to major invaders. The third highest group, questions 8.2, 8.3, 8.4, 9.1, and 9.3 all involve some form of arrested succession and were once again, strongly linked to major invaders. Thus, a species ability to limit other species be it plant, animal, or human, from an area is highly correlated with successful invasion.

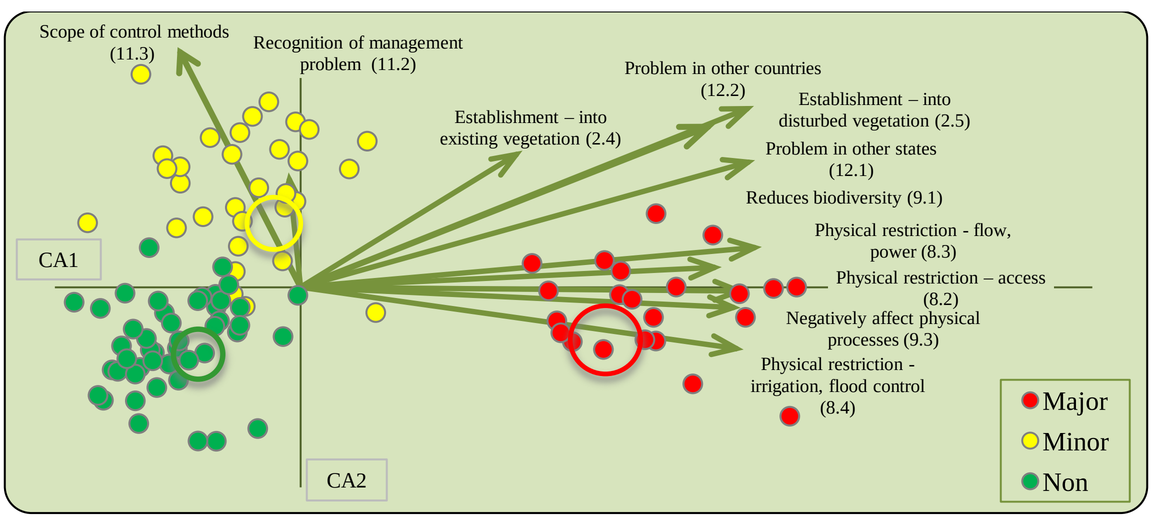


**Fig. 2.** Canonical ordination of 100 plant species based on 40 imputed question responses.  Circles give multivariate centroids (95% confidence region for class means). Vectors indicate large response loadings (structure coefficients ≥ 0.7 for canonical axis one (CA1); ≥ 0.3 for canonical axis two (CA2). Major invaders are distinct in their response profile from other classes by vectors projecting to the right in this space; minor invaders are distinct from other classes by vectors projecting upward in this space.

Additionally, further analysis of the structure coefficients of the two canonical axes showed the usefulness of the two new questions which were added to the TXAqPRA. Question 1.2 regarding Hardiness Zones of the plants native range had loadings for canonical axes one and two of 0.151 and 0.106, respectively. Question 12.1 regarding the species' presence in other states had loadings for canonical axes one and two of 0.753 and 0.170 for axes one and two, respectively, making this question highly informative when separating major invaders from minor invaders.

Discriminant Analysis using the 40 imputed questions, the imputed summary scores, and the raw summary scores was performed using LDA. Results showed that the LDA performed using the imputed sum scores resulted in the highest percent species misclassified (25%), the LDA using raw summary scores produced 22% misclassification, and LDA using the 40 imputed questions produced the least percentage species misclassified (3%). Based on these results, LOOCV was performed on the two most successful DA, the LDAs using raw summary scores and the 40 imputed questions.

Results revealed the two DAs abilities to successfully predict for each species invasive status, and can be seen in Table 1 below. LOOCV on the raw summary scores was slightly more successful in correctly predicting for species' invasive status, 24% misclassification. Additionally, this method did not result in any major invaders being classified as non-invaders, which we identified previously as the most severe misclassification possible, but misclassified four major invaders as minor invaders. LOOCV on the 40 imputed questions resulted in one major invader misclassified as a non-invader (the most severe error), but only one major invader misclassified as a minor invader; therefore, this was the best overall method. It is also important to note that the largest amount of misclassifications made in both LOOCVs were non-invaders being misclassified as minor invaders, which is a relatively low-risk misclassification.

**DA Confusion Matrices**

| | Raw Summary Scores | | | error profile | |
|---|---|---|---|---|---|
| | Major | Minor | Non | 0421 | |
| Major | 18 | 4 | 0 | check | % |
| Minor | 2 | 24 | 5 | sum | wrong |
| Non | 1 | 10 | 36 | 100 | 22 |

| | 40 Imputed Questions | | | error profile | |
|---|---|---|---|---|---|
| | Major | Minor | Non | 0000 | |
| Major | 22 | 0 | 0 | check | % |
| Minor | 0 | 29 | 2 | sum | wrong |
| Non | 0 | 1 | 46 | 100 | 3 |

**LOOCV Confusion Matrices**

| | Raw Summary Scores | | | error profile | |
|---|---|---|---|---|---|
| | Major | Minor | Non | 0421 | |
| Major | 18 | 4 | **0** | check | % |
| Minor | 2 | 24 | 5 | sum | wrong |
| Non | 1 | 12 | 34 | 100 | 24 |

| | 40 Imputed Questions | | | error profile | |
|---|---|---|---|---|---|
| | Major | Minor | Non | 1130 | |
| Major | 20 | 1 | **1** | check | % |
| Minor | 3 | 17 | 11 | sum | wrong |
| Non | 0 | 10 | 37 | 100 | 26 |

**Table 1.** Confusion matrices detailing DA and LOOCV classification success. LDA using 40 imputed questions produced the least percent misclassified during DA, and the least number of major misclassifications during LOOCV. Numbers in red indicate the most severe misclassifications resulting from LOOCV.

## Discussion

Our study revealed an improved method for predicting and understanding invasive species and gave useful insight into the biological and management factors related to invasiveness of non-native aquatic plants in Texas. We found that standard parametric multivariate methods were equivalent or even superior to more specialized but less familiar methods for ordinal data, making quantitative analysis accessible for more researchers and resource managers. Further methodological exploration may be useful, for example using multidimensional preference (95) or alternative methods of imputation, for example nearest-neighbor (96), as they could prove superior for alternative data sets. Beyond the improved statistical power and discriminatory ability of the multivariate approach, the ordination of question analytical approach also offers a system to determine which questions best separate the classes, and hence suggests what basic biological and management factors are important in determining invasiveness. In addition this approach also identifies questions of little significance that they can be removed from surveys if desired, to reduce the workload of investigators.

In addition, results from the basic sum method and ANOVA test, as well as the detailed MANOVA tests provided highly informative data regarding various applications of the model. The sum method and ANOVA test produced accurate predictions of the invasive potential of new aquatic plant species and is useful as a standalone test. The MANOVA testing provided analytical guidance and detailed insight into what specific factors determine invasive potential, and could be used in addition to the ANOVA test or independently.

If using the basic sum method and ANOVA test, a variety of options are available when analyzing results of the risk assessment. Using a one-threshold approach, all plants which score 50 or greater would be considered potential major invaders, or high risk species, and all plants scoring 49 or less would be adventive or non-invasive plants, acceptable for importation. Using this threshold gives 100% accuracy in correctly identifying high risk major invaders, classifies minor invaders with 87% success (i.e. 13% of minor invaders are incorrectly classified as major invaders), and correctly classifies 94% of non-invaders.

A second approach would be two use two thresholds; plants scoring 65 or greater would be considered high risk major invaders, plants scoring 50 or below would be considered safe for importation, and all plants with scores of 51 to 64 would require further evaluation before they could be placed into a category. An upper threshold of 65 classifies major invaders and minor invaders with 73% and 100% success, respectively. Although the two threshold method results in reduced immediate success in indentifying major invaders, more stringent evaluation of those species scoring from 51 to 64 could result in fewer species being incorrectly classified as major invaders and subsequently being needlessly excluded from importation.

Although a significant amount of overlap occurred between minor and non-invaders, it is important to remember that separating potential major invaders from minor and non-invaders is of greatest concern when conducting this type of risk assessment. If using the model to identify new, potentially serious invaders, distinguishing species that will only be adventive from those which are not likely to establish at all would be of least concern. Furthermore, varying environmental conditions and the ability of species' to adapt to those changing conditions will inevitably lead to some inherent unpredictability in species' establishment and survival success, so 100% correct classification of all new aquatic plant species is not realistic.

While data collection is feasible (we were able to find sufficient data to answer all 100 questions used during evaluation of the TXAqPRA), gathering information to answer all questions within the risk assessment can be tedious, particularly when multiple species are tested at one time. Although answering all questions in the risk assessment will provide the greatest prediction of invasive potential, if a user is not able to answer all 40 questions due to lack of manpower, or if the user wishes to simplify the assessment due to time constraints, the user could opt to target only those questions which are most informative in determining invasive potential, which were identified previously, and still be confident in accurately identifying potential major invaders.

Similar to previous aquatic plant risk assessments, the goal of this study was to test the usefulness of the TXAqPRA for predicting the invasive potential of aquatic plant species which have not yet been introduced into natural areas. As a result, the plant scores received in this model reflect the invasive potential of a species in a natural setting only, and may not apply to agricultural or other non-natural areas. Some species which are highly invasive in agricultural settings may not be highly invasive outside of those heavily altered and managed areas. *Fimbrystilis miliacea*, for example, is known to be a serious invader of rice fields (97) but is not invasive in natural settings, which is reflected in the low score this species received in the TXAqPRA.

Many of the same plant traits or environmental factors that have been cited as highly important in a plant's initial invasion success were also found to be exceedingly important in this risk assessment. Results from the MANOVA test indicated that the single most important question within the risk assessment in predicting a new species' potential as a major invader was question 2.5, which assesses the plant's ability to invade disturbed areas. This result is strongly correlated with the widely accepted theory that the leading cause of decreased biodiversity worldwide is damage to or loss of habitat (97). Disturbed or altered areas are highly sensitive to invasion by new non-native species, and those highly invasive species are often able to outcompete and reduce or eliminate native species. Additionally, the second most important factor in predicting invasion success in this risk assessment was question 12.1, which evaluates a species' presence in other states within the United States. This result is also strongly supported by previous research which states that any establishment of a species outside of its native range is a strong indicator of future invasion potential in new areas (82, 83, 97)

This model also has the potential to be used as a management tool to prioritize existing AIP infestations for management. Use of the model for existing infestations would require all data used to be from within the area of interest, and should be used in conjunction with information regarding feasible control options, estimated control costs, and likelihood of long-term management success. In particular, possible incipient invaders could be targeted; species which receive a high score in the risk assessment and are currently established in the state but are not yet considered highly invasive in the area of interest could be identified and control efforts could be implemented. Identifying those established species which are likely to become a major issue in the future and attempting control before they develop into a serious infestation could be highly beneficial in reducing control costs and minimizing damages.

Finally, this risk assessment has been tested and evaluated and is accurate for predicting the invasive potential of new aquatic plant species within the State of Texas; thus its accuracy in other areas cannot be guaranteed. If use in areas outside of Texas is desired, similar evaluation to the analysis conducted in this study should be performed on known non-native species within the new area of interest, to determine accuracy before using the model to predict for new species in that area. Similar to the TXAqPRA and other previous models however, it is likely that minimal alteration would be necessary for this model to be accurate and useful in other areas, making future adaptation of this model a highly viable option.

# CHAPTER III

# SIMULATING AQUATIC PLANT INVASION AND MANAGEMENT IN A RIVERINE RESERVOIR

## Model Overview

The invasion model, which simulates spatial and temporal growth of submerged AIP and the effects of subsequent management practices in a reservoir in Texas, is a spatially-explicit, individual-based model programmed in NetLogo (98); software which is free and easily attainable via internet download (http://ccl.northwestern.edu/netlogo/). The model was designed using hydrilla growth in Lake Conroe, an 8,142 hectare impoundment. This infestation, which began just two years after the lake was impounded in 1973, was very well documented and serves as a useful case study model for AIP simulation modeling (99). The model described herein simulates invasion, growth, and senescence of hydrilla based on factors such as water temperature, water depth, and day length, and the plant's response to control efforts.

## Model Description

The model simulates the growth and senescence of hydrilla, the growth and mortality of grass carp (*Ctenopharyngodon idella*), and the consumption of hydrilla by grass carp (Fig. 3). The model was parameterized based on previous grass carp research (100, 101, 102). Although diploid grass carp have been used for aquatic vegetation control in the past (99, 101), their use in Texas is now prohibited. Since 1992 only triploid grass carp, a sterile form of this fish, have been allowed for use in the state (103). Thus, triploid grass carp were used in this model.

Plant growth was simulated on a daily time-step and first modeled uninhibited hydrilla growth within the lake. The depth at which aquatic plants can grow is limited by the amount of light penetration into the water column; many submerged plants require a minimum of 15% sunlight penetration. Hydrilla has a drastically lower light requirement, about 1% of full sunlight or less, so it is able to colonize areas much deeper than other aquatic plants. There is a limit to the depth at which hydrilla can grow however (roughly 6 meters), so bathymetry data for the lake was included to limit growth to areas of the lake which are within the proper depth range (104, 105, 106). Day length data for the Lake Conroe area was also included in the model, as day length plays a significant role in the growth and senescence cycle of hydrilla (107). Hydrilla regrowth rates following control were also included. Management techniques such as biological control through the use of triploid grass carp, herbicide treatment, and mechanical removal were then added to the model. The focus of this research was investigating the relationship between hydrilla growth patterns and control efforts through the use of triploid grass carp however; thus only results from biological control simulations will be described here. For a more detailed model description, see the appendix.

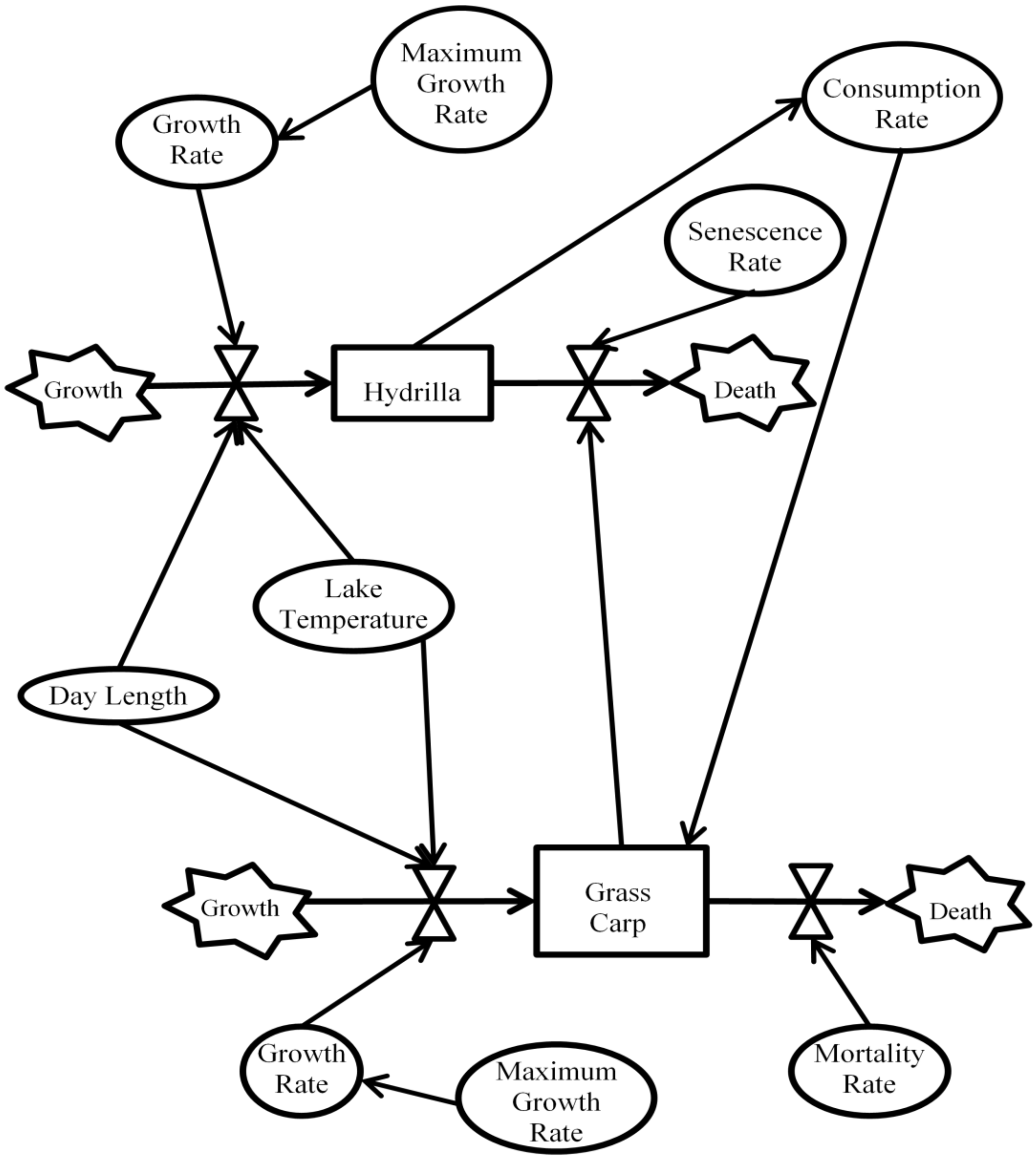


**Fig. 3.** Conceptual model representing the growth and senescence of hydrilla, the growth and mortality of grass carp, and the consumption of hydrilla by grass carp.

## Model Calibration and Evaluation

I calibrated the model by using information gathered from a previous study by Klussmann et al. (99), which detailed hydrilla control on Lake Conroe through the use of diploid grass carp. Following the initial hydrilla invasion in 1975, approximately 270,000 diploid grass carp were introduced to the lake in two large stocking events at 29 sites throughout the reservoir. 166,835 fish were stocked in the fall of 1981 and 103,165 were stocked in the summer of 1982, resulting in the desired 74 fish per vegetated hectare. By 1983, two years after grass carp were first stocked, no submerged macrophytes remained in the lake.

For the calibration simulations, triploid grass carp were introduced to the model in identical densities and at similar locations within the lake to data in the Klussmann et al. (99) study, using previously described triploid grass carp consumption, growth, and mortality rates. Then, a series of simulations were run over a nine year time period (1975-1983), and the threshold for the spread of hydrilla from one patch to another, as well as the initial biomass of hydrilla within each infested patch, were calibrated so that the model mimicked observed patterns of hydrilla coverage on the lake. Results from the calibration simulations were most comparable to results reported by Klussmann et al (99). when initial hydrilla density was 10,000 kg $ha^{-1}$ and the threshold for spread was 20,000 kg $ha^{-1}$ (Fig. 4). With these parameters, simulated hydrilla grew as expected reaching peak biomass in the fall of 1981 and being completely eliminated from the lake by 1983. Simulated grass carp growth rates were also reasonable. Klussmann et al. stated that grass carp in Lake Conroe reached an average mean weight of 5,620g by May of

1983; grass carp in our simulation reached an average mean weigh of 5,093g by August of 1983.

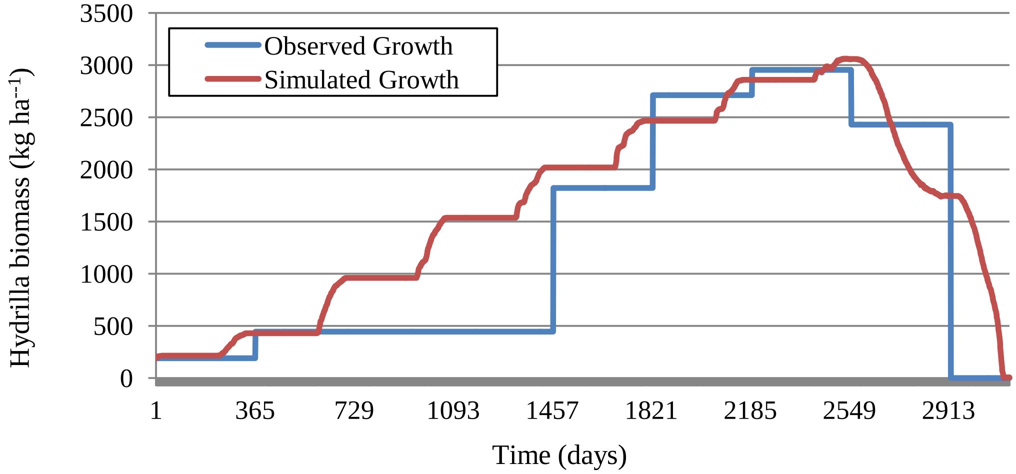


**Fig. 4.** Calibration simulation results. Simulated growth results shown here were achieved using an initial biomass density of 10,000 kg $ha^{-1}$ and a threshold for spread of 20,000 kg $ha^{-1}$.

I then evaluated overall model performance by simulating a second study of hydrilla control on Lake Conroe using  triploid grass carp which occurred from 2006 to 2007 (102).  During this study, nearly 102,000 triploid grass carp were stocked into the lake from March 2006 to November 2007. This management effort differed greatly from the previous control effort. In the earlier project, fish were introduced in two large stocking events, achieving 74 fish per vegetated hectare. In the 2006-2007 control attempt fish were introduced in seven small stocking events, initially reaching an estimated 22.5 fish per vegetated hectare. The number of fish introduced per stocking event was gradually increased over the remainder of the project until an estimated 103.8 fish per vegetated hectare was achieved by November 2007 (Table 2). Despite repeated stockings of grass carp over the 20 month period, the grass carp were not able to reduce the amount of hydrilla in the lake. The hydrilla was eventually reduced to roughly 40 acres by 2008 using an integrated pest management plan that included grass carp, herbicide, and planting of carp-resistant native plant species (108). Although controlling the hydrilla in Lake Conroe using grass carp was not successful in this instance, it nonetheless served as a useful measure against which to compare model performance.

| **Date** | **Number of grass carp stocked** | **Cumulative number stocked** | **Number of surviving fish** | **Stocking rate (N/ha)** |
|---|---|---|---|---|
| March 2006 | 4,330 | 4,330 | 4,300 | 22.5 |
| August 2006 | 9,311 | 13,641 | 13,064 | 36.8 |
| October 2006 | 13,800 | 27,441 | 26,168 | 56.6 |
| February 2007 | 10,000 | 37,441 | 33,376 | 70.7 |
| August 2007 | 23,386 | 60,827 | 54,983 | 72.6 |
| August 2007 | 25,364 | 86,191 | 71,735 | 99.8 |
| November 2007 | 15,575 | 101,766 | 81,564 | 103.8 |

**Table 2.** Lake Conroe grass carp stocking information for 2006 and 2007 (from Chilton et al. 2008). The number of fish assumed to survive after each stocking event was estimated using an annual mortality rate of 32% (Chilton et al. 2008).

Rates of initial hydrilla biomass density and the threshold spread that were found to be most accurate during the calibration simulations were used during this evaluation, and the same grass carp growth, mortality, and consumption rates utilized during calibration were also used. We initialized hydrilla growth to represent the spatial expansion of hydrilla observed in 2004, and model results were then compared to reported growth patterns from 2004 to 2007 (102). Simulated results of hydrilla growth patterns during the evaluation simulation differed greatly from observed results from 2004 to 2007 (Fig. 5). While the observed hydrilla growth reported from Chilton et al. continued to increase despite the introduction of grass carp, simulated hydrilla growth in the model decreased following the introduction of grass carp.

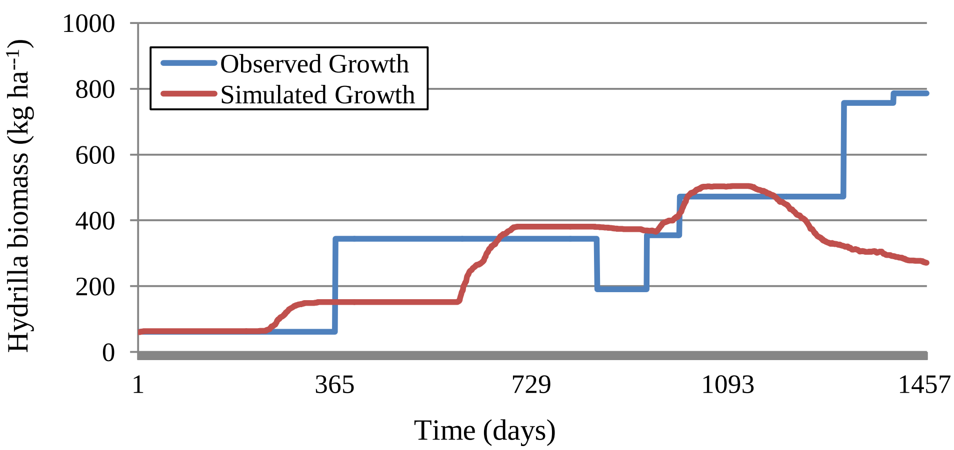


**Fig. 5.** Evaluation simulation results. Observed growth reported by Chilton et al. showed an increase in hydrilla growth, despite continued grass carp stocking (102). Results from the simulation showed a decrease in hydrilla after grass carp stocking.

As a result of the evaluation simulation outcome, I further investigated the 2004 to 2007 hydrilla management data to explore possible explanations as to why the simulation results differed so greatly from the observed hydrilla growth patterns.

Although fish were stocked in multiple events in increasing numbers with a final estimated rate of 74 fish per vegetated hectare, control of the hydrilla infestation was not achieved. It is unclear why the hydrilla continued to expand across the lake, in spite of the repeated stockings of grass carp (102). One hypothesis is that the failure to control hydrilla resulted either from increased grass carp mortality during stocking events or from increased predation losses due to a decreased grass carp to predator ratio. Previous studies of triploid grass carp mortality have reported mortality rates as high as 52% (109), citing stress from hauling and stocking, water temperatures, and predators as possible causes.

To test this hypothesis, I increased the grass carp mortality rate until simulated results mimicked actual data. Annual grass carp mortality rates in excess of 95% produced results most similar to reported data (Fig. 6), suggesting the actual mortality rate during the 2006 to 2007 stocking events may have been much higher than the estimated 32% annual mortality rate estimated by Chilton et al (102).

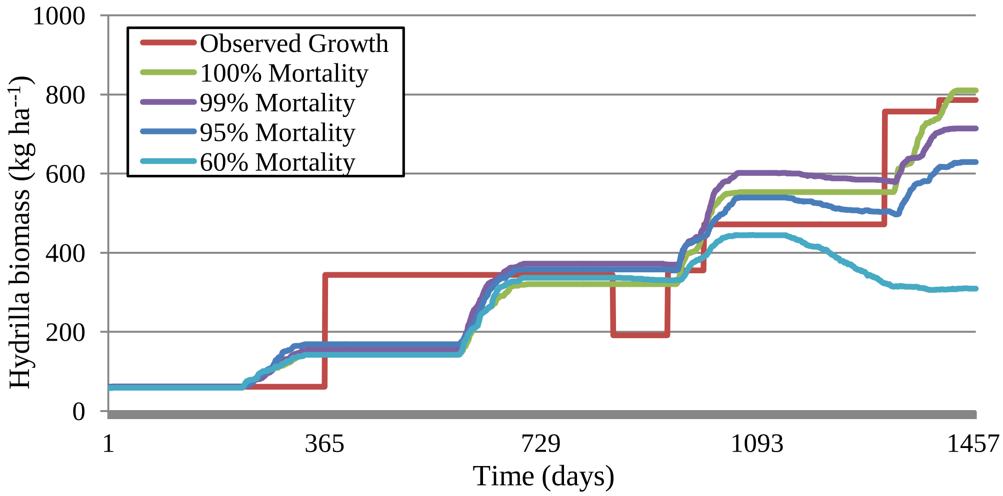


**Fig. 6.** Results of simulations exploring the effect of increased grass carp mortality.

### Simulations of Hydrilla Invasion and Management

Finally, to demonstrate use of the model and to evaluate alternative management strategies, I ran two sets of simulations in which I varied the time between discovery of a hydrilla invasion and the stocking of grass carp and the number of grass carp stocked (Fig. 7). Each simulation was initialized with an invasion that covered 190 ha with no grass carp present. Grass carp weighing 0.309 g were then stocked at varying times following the hydrilla invasion, once during each simulation. In the first set, I determined the number of grass carp that would need to be stocked to eradicate hydrilla within four years of grass carp stocking, assuming the stocking occurred (1) six months, (2) one year, (3) or three years after invasion. In the second set, I determined the number of grass carp that would need to be stocked to eradicate hydrilla within (1) one,

(2) three, or (3) five years after hydrilla invasion, assuming the stocking occurred one year after invasion.

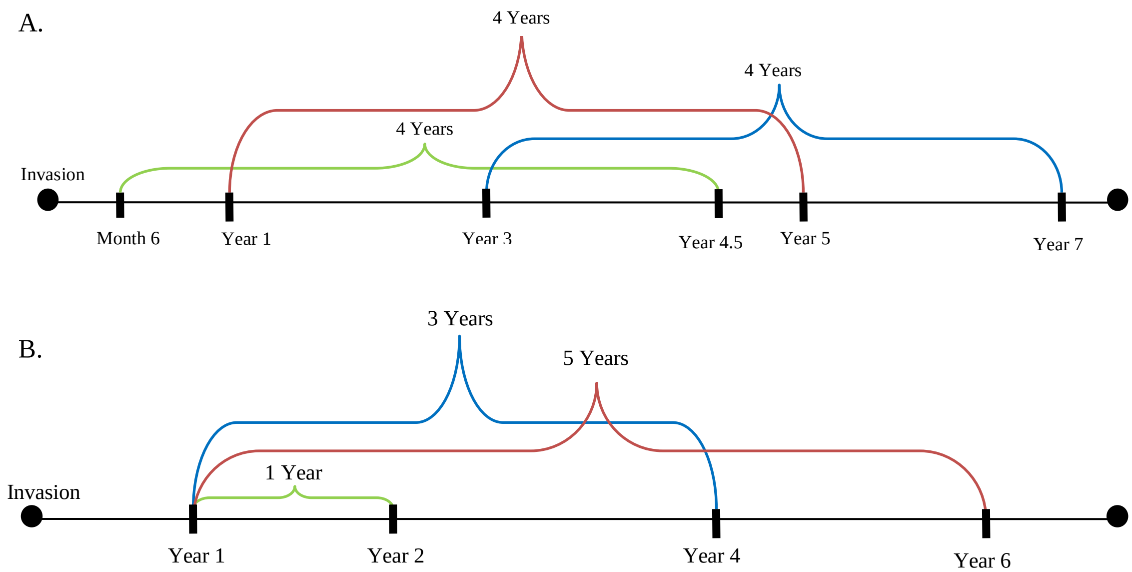


**Fig. 7.** Diagrammatic representation of the two sets of simulations demonstrating use of the model. (A) Grass carp were stocked (1) six months, (2) one year, (3) or three years after invasion to determine the number that would be needed to eradicate hydrilla within four years of stocking. (B) Grass carp were stocked one year after invasion to determine the number that would be needed to eradicate hydrilla within (1) one, (2) three, or (3) five years after invasion.

Results from the first set of demonstration simulations are shown in Fig. 8. Stocking densities needed to control the hydrilla infestation increased as the lag time between initial invasion and grass carp stocking event increased. If grass carp were stocked one year after initial invasion, only 27,000 grass carp (66 per vegetated hectare) were needed to control the infestation within four years of grass carp stocking. If grass carp were stocked three years after initial invasion however, approximately 80,000 grass carp (56 per vegetated hectare) were needed to control the invasion within four years of the stocking event. As expected, less control is needed the earlier the control effort is attempted.

Conversely, results from the second set of demonstration simulations showed that the density of grass carp needed to control a hydrilla infestation decreased as the amount of time allowed to control the infestation increased (Fig. 9). If control was desired within one year of grass carp stocking, approximately 60,000 grass carp (141 per vegetated hectare) were needed; only 27,000 grass carp (62 per vegetated hectare) were needed to control the same infestation when five years were allowed for control. Results from both scenarios were modeled using a single stocking event in each simulation and represent immediate hydrilla control, however regrowth was experienced during some simulations after initial control was achieved. In order to achieve long term hydrilla control through the use of grass carp, additional grass carp stockings would likely be necessary, due to grass carp mortality over time.

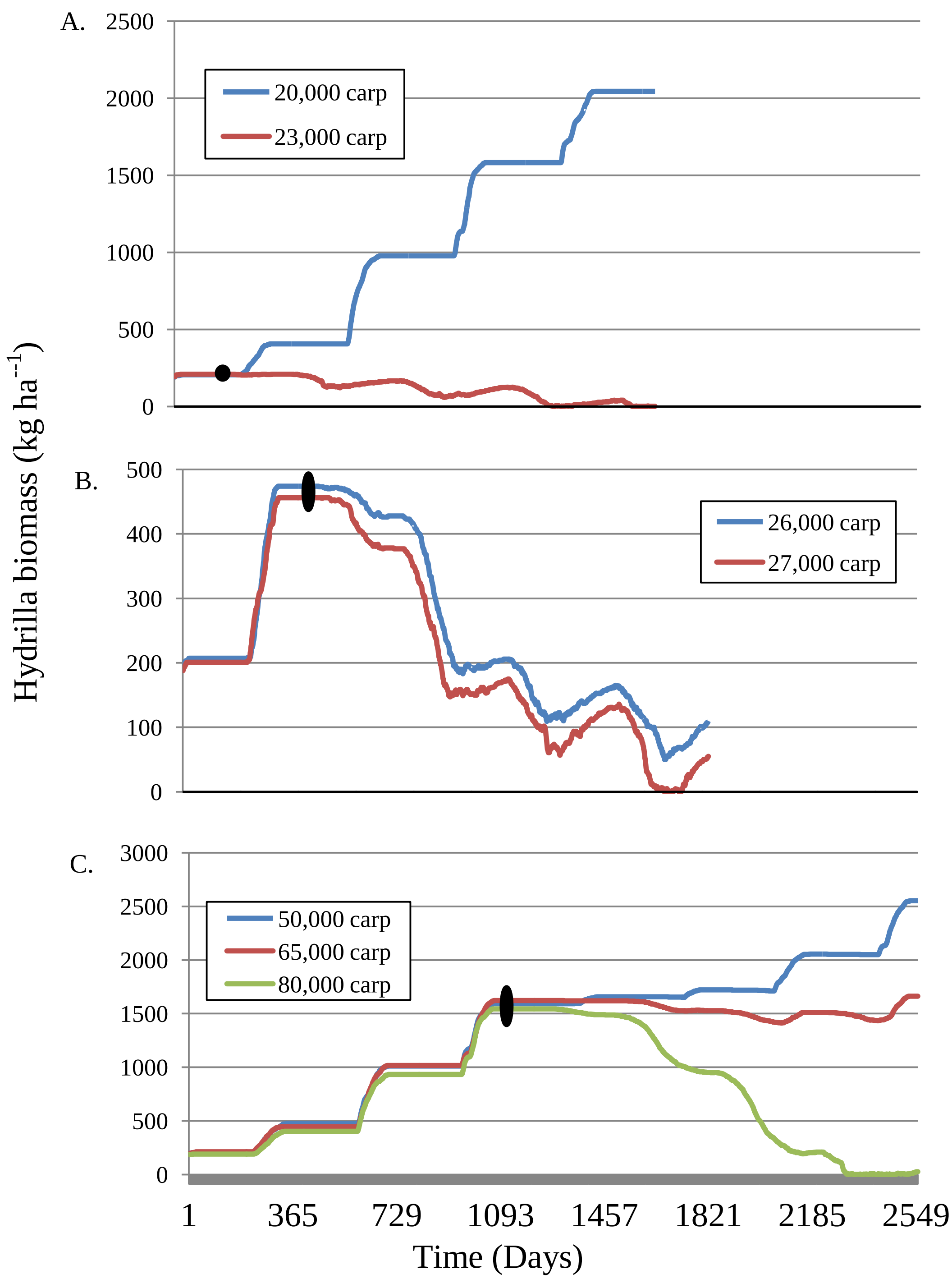


**Fig. 8.** Results from set one of the demonstration simulations. Graphs show how many grass carp were necessary to control a hydrilla infestation when hydrilla was allowed to grow for (A) six months, (B) one year, and (C) three years prior to grass carp stocking. Black dot denotes when grass carp were stocked.

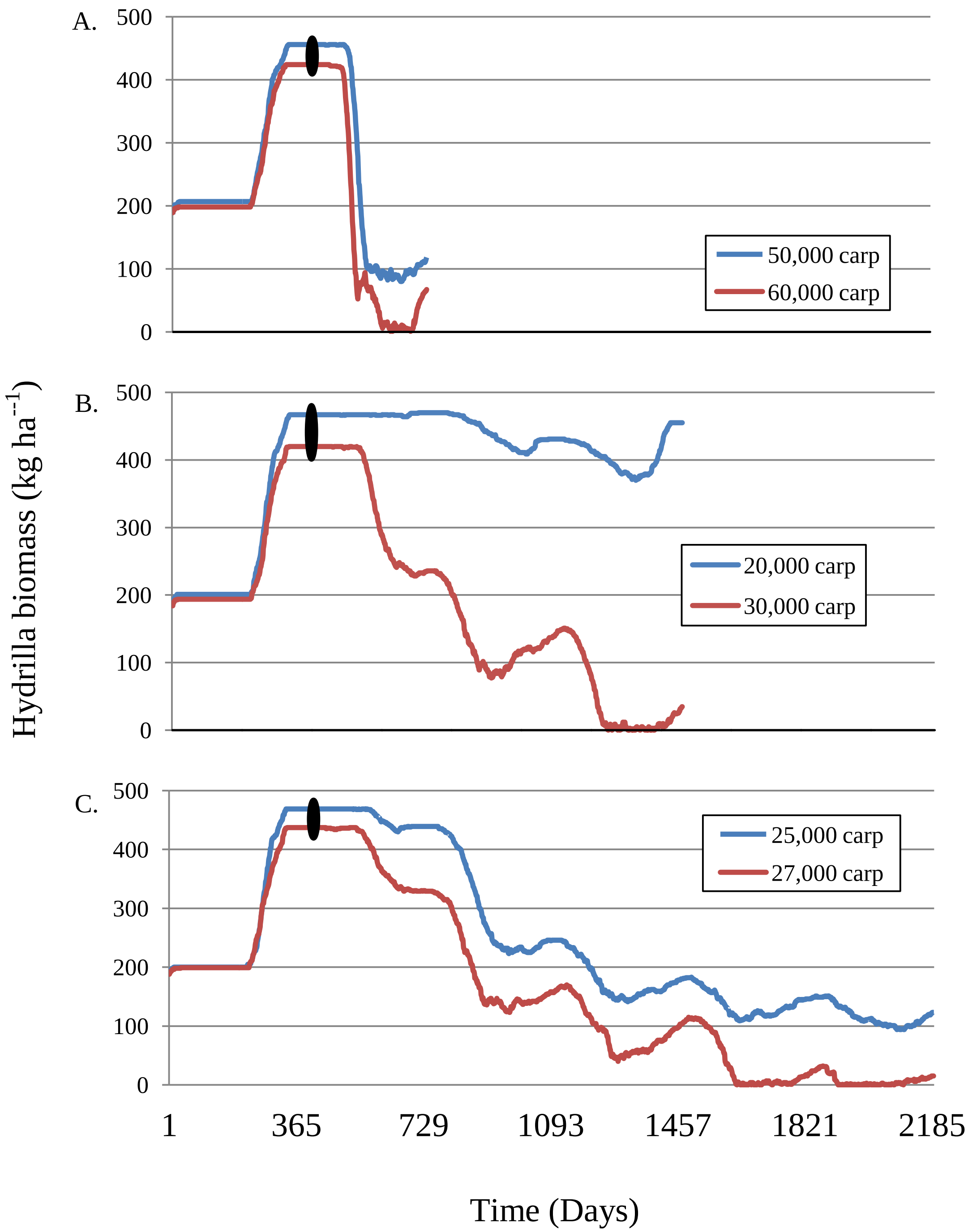


**Fig. 9.** Results from set two of the demonstration simulations. Graphs show how many fish were needed to control a hydrilla infestation when (A) one year, (B) three years, or (C) five years was allowed for grass carp to control the infestation. Carp were stocked one year after initial infestation in each simulation. Black dot denotes when grass carp were stocked.

## Discussion

Though results described here are only applicable to the hydrilla infestation at Lake Conroe, adaptation of the model to suit other impoundments and vegetation types should be possible. All data used in the creation and evaluation of this model were easily obtained through open access government websites and other readily available sources and produced accurate, true-to-life results. Thus, the model is a highly useful prototype for future aquatic plant invasion modeling which could be utilized by lake managers, ecologists, state-level resource managers, or other stakeholders. Use of this model in conjunction with the TXAqPRA could also be valuable as a preventative management tool. Incipient invaders, species who were identified in the TXAqPRA as potential future major invaders but currently exist in the state as adventives or are in the trade but are not established outside of captivity, could be simulated and the results used to determine if preventative control efforts would be prudent in order to avoid a future serious infestation.

It is unknown why the 2006-2007 control efforts were not effective in reducing the amount of hydrilla in Lake Conroe, however it is plausible that mortality rates of grass carp during these stocking events were higher than rates listed in the report (annual mortality rate of 32%, or 2.7% per month) (102). Although the actual cause is not known, increased mortality during stocking events or due to predation are both possible causes for the grass carp's failure to control the hydrilla infestation. Stocking rates during the 2006-2007 control began much lower than the recommended 74 fish per vegetated hectare and gradually increased with each stocking event. It is possible that predators living in the lake were able to eliminate large numbers of grass carp between stockings, drastically increasing the mortality rate and reducing the number of fish available to consume hydrilla.

While results from our mortality simulations suggest nearly 100% grass carp mortality during the 2004 to 2006 control efforts, actual mortality rates may not have been so extreme. Other factors, in conjunction with an increased mortality rate, may have contributed to the observed pattern of hydrilla growth. An increase in hydrilla growth, due to lake temperature changes or increased nutrients in the lake, could have contributed to the unsuccessful control of the hydrilla. However, these simulations give useful insight into recommendations for successful grass carp stocking in the future. One or two large stocking events, rather than multiple small stocking events, may lead to greater success in the control of AIP. If predation is indeed the main cause of fish mortality, larger stockings could overwhelm predators resulting in a lower overall mortality rate. If multiple smaller stocking events are preferred however, managers would likely need to estimate a higher rate of grass carp mortality. Many grass carp could be eliminated before AIP control is achieved, due to a low predator to prey ratio.

The simulations described in this research demonstrated basic use of the invasion model, which was parameterized to represent control of hydrilla in Lake Conroe. However, the model has the potential for use in a variety of other growth and management scenarios. Temperature is the main limiting factor for both plant and grass carp growth, as well as for grass carp consumption rates. Annual water temperature data could be manipulated to simulate extreme cold or warm years as well as years with average temperatures, to determine the number of fish needed to control an infestation based on water temperatures in a given year. A second scenario could involve determining the number of fish needed to reduce the infestation without completely eliminating all vegetation. Managers or stakeholders may be reluctant to remove all aquatic vegetation due to the impact on fishing or other activities; thus determining the density of fish needed to reduce but not eliminate vegetation could be useful. Additionally, various integrated pest management strategies could be simulated in the model. Use of herbicide treatment in conjunction with biological control or mechanical removal is often used to control AIP infestations; multiple control methods could be simulated to determine the combination that will be most effective.

Simulation models of aquatic plant invasion could be highly useful in testing various management techniques and in determining what technique, or combination of techniques, would be likely to produce the most effective AIP control. Management can be very costly, so the ability to simulate control techniques prior to application could reduce expenses through decreased labor and a reduction in the total amount of control required. In addition, the model could be useful when interacting with managers or educating stakeholders on the importance of preventative measures. Visual representation of a potential infestation could be highly effective in conveying the importance of preventative actions and the serious consequences of an AIP infestation.

# CHAPTER IV

# CONCLUSIONS

Future work in aquatic invasion modeling should include adapting the TXAqPRA and Lake Conroe Invasion Model for new geographic locations. Risk assessments which are modified for more specific geographical areas have the potential to further increase accuracy by eliminating issues in categorization, due to the inherent generality of data when the risk assessment is applied on a larger scale, as well as serve as a useful management tool for existing AIP. Risk assessments from the Australian Weed Risk Assessment lineage have already proven highly useful in their respective locales. Additionally, the minimal amount of alteration required to achieve accuracy in each new location makes this a highly valuable predictive management tool.

The Lake Conroe Invasion Model also has the potential to be a useful tool if adapted for other water bodies and aquatic plant species. Managing large AIP infestations can be very costly, especially when testing various control options in the field to determine the most successful management strategy. Simulating aquatic plant invasion and management could be a more efficient method. Testing various control techniques prior to field application to determine the best course of action could reduce costs and result in more effective management in a shorter time period.

Finally, future use of the invasion model combined with the TXAqPRA could be extremely useful as a preventive management tool. If the risk assessment was used to test non-native species in the area of interest, incipient invaders, or species that receive a ‘major invader’ score in the risk assessment but currently exist in the area of interest only as adventive species, could be identified. Those incipient invaders could be simulated to reveal their potential growth patterns; varied environmental factors could result in invasive behavior not currently seen in the area of interest. Simulation results could help managers determine if preventative management efforts would be worthwhile to prevent a serious infestation in the future, and if so, determine the best course of action for effective management.

Managing aquatic plant invasions will be of increasing importance as global trade of these plants grows and demands on the world’s freshwater resources increase. As availability of non-native plants and the interest in water gardening and aquarium-keeping grows, so does the threat of new, potentially devastating invasives (Keller et al. 2007). Left unchecked, AIP will continue to grow and spread, disrupting ecosystems, decreasing biodiversity, limiting the amount of available freshwater, and increasing control costs. Adequate pre-entry screening can decrease costs from control efforts and loss of use of water bodies for commerce and recreation. Although the fight against AIP is daunting and at times can seem like fighting a losing battle, control of existing invasions coupled with proper pre-entry screening and exclusion of potential new invasive species can be effective in stemming the tide of AIP.

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APPENDIX A

TEXAS AQUATIC PLANT RISK ASSESSMENT

**Table A-1.** Detailed list of plants used during testing an evaluation of the TXAqPRA.

| Scientific Name | Common Name | Native Range | TX Invader Status | Intro Date[1] | Growth Type |
|---|---|---|---|---|---|
| *Acorus calamus* L. | sweetflag, calamus | Asia | Minor | 1975 | erect emergent |
| *Acorus gramineus* Soland. | grassleaf sweet flag | Japan/ E. Asia | Non | 1976 | sprawling emergent |
| *Aldrovanda vesiculosa* L. | watersheel plant | Central Europe/SE Asia/ NE Australia | Non | 1976 | free floating |
| *Alternanthera philoxeroides* (Mart.) Griseb. | alligatorweed | South America | Major | 1900 | submerged/emergent |
| *Alternathera sessilis* (L.) R. Br. ex DC. | sessile joyweed / dwarf copperleaf | Asia | Minor | 1950 | sprawling emergent |
| *Anubias barteri* Schott. | giant anubias | Central and West Africa | Non | 1969 | sprawling emergent |
| *Anubias heterophylla* Engl. | Congo Anubias | Africa | Non | 1981 | erect emergent |
| *Aponogeton crispus* Thunb. | wavy swordplant | Sri Lanka | Non | 1800s | submerged |
| *Aponogeton distachyos* L. | cape pondweed | S. Africa | Non | 1976 | submerged/emergent |
| *Aponogeton madagascariensis* (Mirb.) H. Bruggen | Masagascar lace plant, laceleaf | Madagascar | Non | 1976 | submerged |
| *Arundo donax* L. | giant reed | Eastern Asia | Major | 1800s | erect emergent |
| *Baldellia ranunculoides* (L.) Parl. | lesser water plantain | Europe/N. Africa | Non | 1976 | submerged/erect emergent |
| *Butomus umbellatus* L. | flowering rush | Eurasia | Non | 1929 | erect emergent |
| *Cabomba aquatica* Aubl. | giant cabomba | South America | Minor | 1967 | submerged/emergent |
| *Callitriche stagnalis* Scop. | pond water-starwort | Europe/N. Africa/ Asia | Non | 1944 | submerged/emergent |
| *Canna indica* L. | Indian shot | tropical America | Minor | 1976 | erect emergent |
| *Cardamine lyrata* Bunge | chinese ivy | Japan/Korea/N. China/Siberia | Non | 1976 | submerged/sprawling emergent |
| *Centella asiatica* (L.) Urb. | centella, gotu kola, spadeleaf | Asia, Australia | Minor | 1970 | sprawling emergent |
| *Ceratophyllum submersum* L. | spineless hornwort | Europe | Non | 1981 | submerged/free floating |
| *Ceratopteris thalictroides* (L.) Brongn. | watersprite | E. Asia, Madagascar | Minor | 1970 | submerged/emergent/ floating |
| *Colocasia esculenta* (L.) Schott | taro, cocoyam | Asia | Major | 1832 | erect emergent |
| *Cryptocoryne beckettii* Thwaites ex Trimen. | beckett's water trumpet | Sri Lanka | Minor | 1967 | erect emergent |
| *Cryptocoryne wendtii* De Wit | Wendt's water trumpet | SE Asia, Thailand | Non | 1958 | submerged/emergent |
| *Cryptocoryne willisii* Engler | cryptocoryne willisii | Sri Lanka | Non | 1968 | submerged |
| *Cyperus alternifolius* L. | umbrella plant | Old World/Africa/Madagascar | Minor | 1970 | erect emergent |
| *Cyperus difformis* L. | variable flatsedge, small flower umbrella plant | Asia/ Old World Tropics | Major | 1979 | erect emergent |
| *Cyperus esculentus* L. | yellow nutsedge | W Africa/Asia | Major | 1968 | erect emergent |

| Scientific Name | Common Name | Native Range | TX Invader Status | Intro Date[1] | Growth Type |
|---|---|---|---|---|---|
| *Cyperus involucratus* Rottb. | Umbrella sedge | Madagascar/Africa | Minor | 1976 | erect emergent |
| *Cyperus iria* L. | ricefield flatsedge | Asia | Minor | 1970 | erect emergent |
| *Cyperus papyrus* L. | papyrus sedge, king tut | N & C Africa/Sri Lanka | Minor | 1929 | erect emergent |
| *Cyperus rotundus* L. | purple nutsedge,nutgrass | India | Major | 1970 | erect emergent |
| *Echinochloa colona (*L.) Link | jungle rice | Asia | Minor | 1970 | erect emergent |
| *Echinochloa crus-galli* (L.) P. Beauv. | barnyardgrass, millet | Eurasia | Minor | 1970 | erect emergent |
| *Egeria densa* Planch. | Brazilian elodea | South America | Major | 1970 | submerged/emergent |
| *Eichhornia azurea* (Sw.) Kunth | anchored/blue water hyacinth | South America | Non | 1962 | submerged/emergent |
| *Eichhornia crassipes* (Mart.) Solms | water hyacinth | South America | Major | 1880s | free floating |
| *Euryale ferox* Salisb. | prickly water lily, fox nut | N. India/China/E Russia/Japan | Non | 1976 | Attached-floating |
| *Fimbristylis miliacea* L. Mahl. | grass-like fimbry | S/SE Asia | Non | 1978 | erect emergemt |
| *Glyceria fluitans* (L.) R. Br. | water mannagrass | Europe/Mediterranean/W. Asia | Non | 1967 | erect emergent |
| *Glyceria maxima* (Hartm.) Holmb. | reed sweet grass | N Eurasia | Non | 1979 | erect emergent |
| *Heliotropium indicum* L. | turnsole/ india heliotrope | Old World | Minor | 1970 | erect emergent |
| *Heteranthera zosterifolia* Mart. | star grass | Brazil to N Argentina | Non | 1976 | submerged/emergent |
| *Hottonia palustris* L. | water violet, featherfoil | Europe/N Asia | Non | 1976 | submerged/emergent |
| *Houttuynia cordata* Thunb. | chameleon | Japan/Nepal | Non | 1976 | sprawling emergent |
| *Hydrilla verticillata* (L.f.) Royle | hydrilla | Asia | Major | 1960s | submerged/emergent |
| *Hydrocleys nymphoides* (Willd.) Buch. | waterpoppy | Brazil | Minor | 1970 | free floating |
| *Hydrocotyle leucocephala* Cham. et Schlecht. | Brazilian pennywort | S Mexico to N Argentina | Non | 1982 | submerged |
| *Hygrophila corymbosa* (Blume) Lindau | giant hygrophila, water wisteria | India, Burma, Malaysia, Indonesia | Minor | 1970 | submerged/emergent |
| *Hygrophila polysperma* (Roxb.) T. Anderson | Indian swampweed | Asia | Minor | 1980 | submerged/emergent |
| *Ipomoea aquatica* Forssk. | swamp morning-glory/water spinach | China/India | Non | 1979 | sprawling emergent |
| *Iris laevigata* Fisch. | rabbit ear iris | E Asia (China/Japan) | Non | 1976 | erect emergent |
| *Iris pseudacorus* L. | yellow flag, paleyello wiris | British Isles/W. Asia/N. Africa/ Mediterranean | Major | 1771 | erect emergent |
| *Juncus inflexus* L. | blue rush, European meadow rush | Caucasus/Europe | Non | 1917 | sprawling emergent |
| *Landoltia punctata* (G.Mey.) Les & D.J.Crawford | giant duckweed | SE Asia, Australia | Minor | 1944 | free floating |
| *Limnocharis flava* (L.) Buch. | yellow velvetleaf, yellow bur-head | W. Indies/Mexico/Tropical S. America | Non | 1976 | erect emergent |
| *Limnophila indica* (L.) Druce. | Indian marshweed | Tropical Africa/ India/China/Australia | Minor | 1976 | submerged/emergent |
| *Limnophila sessiliflora* (Vahl) Bl. | Asian marshweed/ambulia | India to SE Asia | Minor | 1975 | submerged/emergent |
| *Ludwigia hexapetala* (Hook. & Arn.) G.L. Nesom & Kartesz | creeping waterprimrose | Central/South America | Minor | 1944 | sprawling emergent/free floating |
| *Ludwigia peruviana* L. H. Hara | primrose-willow | Central/South America | Major | 1979 | sprawling emergent |
| *Lythrum salicaria* L. | purple loosestrife | Europe/Asia | Major | 1800s | erect emergent |
| *Marsilea drummondii* A. Braun. | common nardoo | Australia | Non | 1976 | sprawling emergent/submerged |

| Scientific Name | Common Name | Native Range | TX Invader Status | Intro Date[1] | Growth Type |
|---|---|---|---|---|---|
| *Melaleuca quinquenervia* (Cav.) S.F. Blake | meleluca/paperbark, punktree | E. Australia/Indonesia | Major | 1962 | erect emergent |
| *Mentha aquatica* L. | water mint | Europe/N. Africa/Asia | Non | 1967 | sprawling emergent |
| *Myosotis scorpioides* L. | true forget-me-not | Europe/Asia | Non | 1975 | erect emergent |
| *Myriophyllum aquaticum* Vell. | parrot's feather milfoil | South America | Major | 1890 | submerged/sprawling emergent |
| *Myriophyllum spicatum* L. | Eurasian watermilfoil | Eurasia | Major | 1975 | submerged/emergent |
| *Najas minor* All. | brittle waternymph | Eurasia/Old World | Minor | 1979 | submerged |
| *Nasturtium officinale* R. Br. | watercress | Europe | Minor | 1800s | attatched-floating/emergent |
| *Nelumbo nucifera* Gaertn. | sacred lotus | Asia/Australia | Non | 1976 | Attached-floating |
| *Nuphar japonica* DC | Japanese pond lily, japanese spatterdock | Japan | Non | 1983 | attached floating |
| *Nymphaea alba* L. | White Water Lily | Europe/Asia/Africa | Non | 1897 | Attached floating |
| *Nymphaea colorata* Peter. | blue tropical water lily | Tanzania | Non | 1938 | attached floating |
| *Nymphaea gigantea* Hook. | great blue Australian waterlily/ giant waterliliy | Australia | Non | 1976 | attached floating |
| *Nymphaea lotus* L. | Egyptian lotus | Egypt | Non | 1800s | Attached-floating |
| *Nymphaea micrantha* Guill. & Perr. | blue Egyptian Lotus | West Africa | Non | 1976 | attached floating |
| *Nymphoides indica* (L.) Kuntze | banana plant, water snowflake | India | Minor | 1800s | Attached-floating |
| *Nymphoides peltata* (S.G. Gmel.) Kuntze | yellow floatingheart, water-fringe | Eurasia | Major | 1800s | Attached-floating |
| *Oryza sativa* L. | red rice | India/Tailand/S.China | Minor | 1800s | erect emergent |
| *Ottelia alismoides* (L.) Pers. | ottelia, mudplant, duck lettuce | Africa/Asia | Minor | 1970 | submerged/emergent |
| *Panicum repens* L. | torpedo grass | Africa | Major | 1970 | erect emergent |
| *Pistia stratiotes* L. | water lettuce | South America or Africa | Major | 1970 | free floating |
| *Polygonum hydropiper* L. | water pepper | Eurasia/Africa | Minor | 1830 | erect emergent |
| *Potamogeton crispus* L. | curled-leaf pondweed | Eurasia, Africa, Australia | Major | 1970 | submerged |
| *Ranunculus lingua* L. | greater spearwort | Europe/Siberia/Central Asia | Non | 1976 | erect emergent |
| *Rotala indica* (Willd.) Koehne | indian toothcup | Asia | Non | 1946 | submerged/emergent |
| *Rumex crispus* L. | curly dock | Europe/N. Asia | Major | 1970 | erect emergent |
| *Salvinia minima* Baker | common salvinia, water spangles | South America/Mexico | Major | 1920s | free floating |
| *Salvinia molesta* Mitchell | giant salvinia | South America | Major | 1998 | free floating |
| *Schoenoplectiella mucronata* (L.) J. Jung & H.K. Choi | bog bulrush, ricefield bulrush | Africa/Asia/ Australia/Europe | Non | 1942 | erect emergent |
| *Sphenoclea zeylanica* Gaert. | chickenspike, goose weed | S/E Asia | Minor | 1970 | erect emergent |
| *Trapa bicornis* Osbeck | water caltrop, devil's pod | E. Asia | Non | 1976 | attached-floating |
| *Trapa natans* L. | water chestnut | Asia | Non | 1976 | attached-floating |
| *Typha angustifolia* L. | narrowleaf cattail | Eurasia | Non | 1970 | erect emergent |
| *Typha x glauca* Godron | cattail hybrid, white cattail | hybridized in states | Non | 1979 | erect emergent |
| *Vallisneria spiralis* L. | tapegrass, straight vallisneria | S. Europe, N. Africa | Minor | 1970 | submerged |
| *Verbena bonariensis* L. | purpletop vervain, South American vervain | South America | Minor | 1970 | erect emergent |
| *Verbena brasiliensis* Vell. | Brazilian vervain | Brazil | Minor | 1970 | erect emergent |

| Scientific Name | Common Name | Native Range | TX Invader Status | Intro Date[1] | Growth Type |
|---|---|---|---|---|---|
| *Veronica beccabunga* L. | European speedwell, brooklime | Europe/N. Africa/N&W Asia | Non | 1876 | sprawling emergent |
| *Victoria amazonica* (Poepp.) J.C. Sowerby | Amazon water-lily, giant waterlily | South America | Non | 1800s | attached-floating |
| *Xanthosoma sagittifolium* (L.) Schott | arrowleaf elephant ear | Puerto Rico, US Virgin Islands | Major | 1979 | erect emergent |

**Table A-2.** List of plants with corresponding scores.

| ***Question*** | ***Acorus calamus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 1 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 5 |
| **Score** | 52 |

References: 87, 110-123

| *Question* | *Acorus gramineus* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 1 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 1 |
| **Score** | 35 |

References: 124-130

| ***Question*** | ***Aldrovanda vesiculosa*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 0 |
| **Score** | 18 |

References: 87, 124, 131-137

| *Question* | *Alternanthera philoxeroides* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 5 |
| **Score** | 78 |

References: 87, 97, 112, 138, 139

| ***Question*** | ***Alternathera sessilis*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 5 |
| **Score** | 48 |

References: 87, 97, 112, 140-145

| ***Question*** | ***Anubias barteri*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 29 |

References: 146-150

| ***Question*** | ***Anubias heterophylla*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 22 |

References: 151-156

| ***Question*** | ***Aponogeton crispus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | - |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 1 |
| **Score** | 25 |

References: 156, 157-160

| ***Question*** | ***Aponogeton distachyos*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 3 |
| **Score** | 28 |

References: 87, 124, 161-164

| *Question* | *Aponogeton madagascariensis* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 0 |
| Establishment – into existing vegetation (2.4) | -5 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 7 |

References: 124, 165-168

| ***Question*** | ***Arundo donax*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 2 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 74 |

References: 87, 112, 118, 163, 169, 170

| ***Question*** | ***Baldellia ranunculoides*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -5 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 1 |
| **Score** | 21 |

References: 124, 171-174

| ***Question*** | ***Botumbus umbellatus*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 4 |
| **Score** | 46 |

References: 87, 118, 163, 175, 176

| ***Question*** | ***Cabomba aquatica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 4 |
| **Score** | 35 |

References: 156, 177-179

| ***Question*** | ***Callitriche stagnalis*** |
| --- | --- |
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 4 |
| **Score** | 40 |

References: 84, 180-184

| ***Question*** | ***Canna indica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 4 |
| **Score** | 36 |

References: 87, 112, 124, 185-188

| ***Question*** | ***Cardamine lyrata*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 0 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 0 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 14 |

References: 124, 189-191

| ***Question*** | ***Centella asiatica*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 39 |

References: 87, 112, 192-196

| ***Question*** | ***Ceratophyllum submersum*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 0 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 20 |

References: 124, 142, 155, 197, 198

| ***Question*** | ***Ceratopteris thalictroides*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 4 |
| **Score** | 39 |

References: 87, 112, 118, 156, 199-201

| ***Question*** | ***Colocasia esculenta*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | *3* |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 53 |

References: 87, 118, 202-204

| ***Question*** | ***Cryptocoryne beckettii*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 1 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 1 |
| **Score** | 40 |

References: 87, 156, 205-208

| ***Question*** | ***Cryptocoryne wendtii*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 0 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 0 |
| **Score** | 21 |

References: 87, 124, 149, 156, 159, 209, 210

| ***Question*** | ***Cryptocoryne willisii*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 20 |

References: 124, 156, 159, 211

| ***Question*** | ***Cyperus alternifolius*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 3 |
| **Score** | 38 |

References: 112, 195, 212-214

| ***Question*** | ***Cyperus difformis*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 2 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 5 |
| **Score** | 56 |

References: 87, 111, 142, 215-218

| ***Question*** | ***Cyperus esculentus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 70 |

References: 87, 124, 219-223

| ***Question*** | ***Cyperus involcratus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 0 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 39 |

References: 87, 124, 224-226

| ***Question*** | ***Cyperus iria*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 41 |

References: 87, 112, 217, 218, 227, 228, 229

| ***Question*** | ***Cyperus papyrus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 3 |
| **Score** | 40 |

References: 87, 124, 230-234

| *Question* | *Cyperus rotundus* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 69 |

References: 87, 112, 218-220, 235, 236

| ***Question*** | ***Echinochloa colona*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 5 |
| **Score** | 48 |

References: 87, 112, 237-240

| ***Question*** | ***Echinochloa crusgalli*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 55 |

References: 51, 87, 241-247

| ***Question*** | ***Egeria densa*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 4 |
| **Score** | 71 |

References: 87, 112, 118, 176, 186, 248

| ***Question*** | ***Eichhornia azurea*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 5 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 4 |
| **Score** | 55 |

References: 87, 112, 118, 156, 159, 163, 249

| ***Question*** | ***Eichhornia crassipes*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 2 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 3 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 72 |

References: 87, 112, 118, 156, 159, 218, 250-253

| *Question* | *Euryale ferox* |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 15 |

References: 118, 124, 254-258

| ***Question*** | ***Fimbristylis miliacea*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 22 |

References: 87, 218, 228, 259

| ***Question*** | ***Glyceria fluitans*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 36 |

References: 87, 142, 260-263

| ***Question*** | ***Glyceria maxima*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 0 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 1 |
| **Score** | 34 |

References: 87, 264-268

| ***Question*** | ***Heliotropium indicum*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 32 |

References: 87,112, 142, 226, 269

| ***Question*** | ***Heteranthera zosterifolia*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 1 |
| **Score** | 24 |

References: 124, 270-273

| ***Question*** | ***Hottonia palustris*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 17 |

References: 124, 163, 274-276

| ***Question*** | ***Houttuynia cordata*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 31 |

References: 87, 124, 277-279

| ***Question*** | ***Hydrilla verticillata*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 5 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 2 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 82 |

References: 87, 104, 105, 156, 176, 218, 280

| ***Question*** | ***Hydrocleys nymphoides*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 4 |
| **Score** | 44 |

References: 87, 112, 159, 156, 176, 281, 282

| ***Question*** | ***Hydrocotyle leucocephala*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 3 |
| **Score** | 25 |

References: 159, 160, 283-285

| ***Question*** | ***Hygrophila corymbosa*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 4 |
| **Score** | 32 |

References: 87, 286-290

| ***Question*** | ***Hygrophila polysperma*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 0 |
| **Score** | 64 |

References: 87, 156, 159, 291-293

| ***Question*** | ***Ipomoea aquatica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 5 |
| **Score** | 53 |

References: 55, 87, 142, 195, 294-298

| ***Question*** | ***Iris laevigata*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 0 |
| **Score** | 21 |

References: 118, 124, 299-301

| ***Question*** | ***Iris pseudacorus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 50 |

References: 87, 111, 112, 118, 142, 226, 302, 303

| ***Question*** | ***Juncus inflexus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 29 |

References: 87, 304-310

| ***Question*** | ***Landoltia punctata*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 43 |

References: 87, 311-315

| ***Question*** | ***Limnocharis flava*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 4 |
| **Score** | 37 |

References: 87, 124, 316-318

| ***Question*** | ***Limnophila indica*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 2 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 3 |
| **Score** | 36 |

References: 87, 124, 155, 319-321

| ***Question*** | ***Limnophila sessiliflora*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 1 |
| Management - Effectiveness of control (11.5) | 2 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 1 |
| **Score** | 50 |

References: 87, 111, 124, 142, 297, 322

| ***Question*** | ***Ludwigia hexapetala*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 1 |
| **Score** | 47 |

References: 34, 87, 323-325

| ***Question*** | ***Ludwigia peruviana*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | - |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 1 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 40 |

References: 87, 124, 195, 326-329

| *Question* | *Lythrum salicaria* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 73 |

References: 87, 330-334

| ***Question*** | ***Marsilea drummondii*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 2 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 25 |

References: 124, 335-337

| ***Question*** | ***Melaleuca quinquenervia*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 1 |
| Management - Effectiveness of control (11.5) | 2 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 5 |
| **Score** | 67 |

References: 87, 338-345

| ***Question*** | ***Mentha aquatica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 4 |
| **Score** | 35 |

References: 87, 124, 346-348

| ***Question*** | ***Myosotis scorpioides*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 34 |

References: 87, 111, 118, 124. 155, 349

| ***Question*** | ***Myriophyllum aquaticum*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 75 |

References: 87, 118, 350-354

| ***Question*** | ***Myriophyllum spicatum*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 76 |

References: 87, 111,156, 218

| ***Question*** | ***Najas minor*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 1 |
| **Score** | 35 |

References: 87, 156, 195, 355-357

| *Question* | *Nasturtium officinale* |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | - |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 43 |

References: 887, 118, 124, 358-361

| ***Question*** | ***Nelumbo nucifera*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 2 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 4 |
| **Score** | 33 |

References: 87, 124, 218, 362-367

| ***Question*** | ***Nuphar japonica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 0 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 1 |
| **Score** | 14 |

References: 142, 258, 363, 368, 369

| ***Question*** | ***Nymphaea alba*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 3 |
| **Score** | 36 |

References: 87, 156, 163, 124, 363, 370

| ***Question*** | ***Nymphaea colorata*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 0 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 15 |

References: 124, 258, 363

| ***Question*** | ***Nymphaea gigantea*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 19 |

References: 124, 163, 363

| ***Question*** | ***Nymphaea lotus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | - |
| Problem in other countries (12.2) | - |
| **Score** | 30 |

References: 87, 124, 258, 371-374

| ***Question*** | ***Nymphaea micrantha*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 18 |

References: 124, 375, 376

| *Question* | *Nymphoides indica* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 4 |
| **Score** | 42 |

References: 87, 118, 377-379

| ***Question*** | ***Nymphoides peltata*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 4 |
| **Score** | 63 |

References: 87, 112, 118, 156, 380-382

| ***Question*** | ***Oryza sativa*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 0 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 3 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 39 |

References: 51, 87, 112, 383

| *Question* | *Ottelia alismoides* |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 4 |
| **Score** | 28 |

References: 87, 112, 156, 384, 385

| ***Question*** | ***Panicum repens*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 72 |

References: 87, 112, 218, 386-390

| ***Question*** | ***Pistia stratiotes*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 71 |

References: 4, 87, 112,118, 163, 391

| ***Question*** | ***Polygonum hydropiper*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 38 |

References: 87, 115, 392, 393

| ***Question*** | ***Potamogeton crispus*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 2 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 73 |

References: 87, 112, 118, 163, 394, 395

| ***Question*** | ***Ranunculus lingua*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 0 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 21 |

References: 112, 396-401

| ***Question*** | ***Rotala indica*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 1 |
| Problem in other countries (12.2) | 1 |
| **Score** | 21 |

References: 87, 112, 155, 402- 404

| ***Question*** | ***Rumex crispus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 3 |
| Seeding ability - Viability/ persistence (6.2) | 2 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 53 |

References: 87, 112, 142, 218, 405-408

| ***Question*** | ***Salvinia minima*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 4 |
| **Score** | 70 |

References: 87, 112, 409-412

| *Question* | *Salvinia molesta* |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 2 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 5 |
| Dispersal outside catchment by accidental human activity (4.2) | 3 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 0 |
| Seeding ability - Viability/ persistence (6.2) | 0 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 5 |
| Reduces water quality (9.2) | 3 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 2 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 76 |

References: 87, 218, 252, 410, 413, 414

| ***Question*** | ***Schoenoplectiella mucronatus*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -5 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 0 |
| Management - Duration of control (11.6) | 0 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 30 |

References: 87, 415

| ***Question*** | ***Sphenoclea zeylanica*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 45 |

References: 51, 87, 112, 218, 416

| ***Question*** | ***Trapa bicornis*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 0 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 0 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 2 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 2 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 1 |
| **Score** | 33 |

References: 87, 112, 417-419

| ***Question*** | ***Trapa natans*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 0 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 1 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 2 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 1 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 4 |
| Problem in other countries (12.2) | 5 |
| **Score** | 49 |

References: 87, 112, 417, 420-424

| ***Question*** | ***Typha angustifolia*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 2 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 1 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 46 |

References: 51, 87, 97, 112, 425-427

| ***Question*** | ***Typha x glauca*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 1 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 1 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 0 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 41 |

References: 87, 97, 195, 218, 428, 429

| ***Question*** | ***Vallisneria spiralis*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 2 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 3 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -5 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 3 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 4 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 5 |
| Physical restriction -water use, recreation (8.1) | 2 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 2 |
| Physical restriction - irrigation, flood control (8.4) | 2 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 1 |
| Negatively affect physical processes (9.3) | 2 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 4 |
| **Score** | 52 |

References: 112, 118, 156, 163, 176, 430, 431

| ***Question*** | ***Verbena bonariensis*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 42 |

References: 87, 112, 432, 433

| ***Question*** | ***Verbena brasiliensis*** |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 3 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 2 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 1 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 1 |
| Physical restriction - water flow, power generation (8.3) | 1 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 1 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 1 |
| Management - Ease of management implementation (11.1) | 0 |
| Management - Recognition of management problem (11.2) | 0 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 1 |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 3 |
| **Score** | 40 |

References: 51, 87, 112, 434, 435

| *Question* | ***Veronica beccabunga*** |
|---|---|
| Temperature tolerance (1.1) | 3 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 2 |
| Water/substrate type tolerance (1.4) | 2 |
| Water clarity tolerance (1.5) | 0 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 2 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 1 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 1 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 1 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 2 |
| Problem in other countries (12.2) | 1 |
| **Score** | 27 |

References: 87,124, 218, 436, 437

| *Question* | *Victoria amazonica* |
|---|---|
| Temperature tolerance (1.1) | 1 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 1 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 0 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 1 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 1 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 1 |
| Establishment – into existing vegetation (2.4) | 0 |
| Establishment – into disturbed vegetation (2.5) | 0 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 1 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 0 |
| Generation time (5.1) | 2 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 0 |
| Physical restriction -water use, recreation (8.1) | 0 |
| Physical restriction – access (8.2) | 0 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 0 |
| Aesthetic obstruction - visual, olfactory (8.5) | 0 |
| Reduces biodiversity (9.1) | 0 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | - |
| Management - Recognition of management problem (11.2) | - |
| Management - Scope of control methods (11.3) | - |
| Management - Control method suitability (11.4) | - |
| Management - Effectiveness of control (11.5) | - |
| Management - Duration of control (11.6) | - |
| Problem in other states (12.1) | 0 |
| Problem in other countries (12.2) | 0 |
| **Score** | 15 |

References: 87, 118, 258, 112, 438

| ***Question*** | ***Xanthosoma sagittifolium*** |
|---|---|
| Temperature tolerance (1.1) | 2 |
| Hardiness Zones (1.2) | 1 |
| Range of habitat (1.3) | 3 |
| Water/substrate type tolerance (1.4) | 1 |
| Water clarity tolerance (1.5) | 1 |
| Salinity tolerance (1.6) | 0 |
| pH tolerance (1.7) | 1 |
| Water level fluctuation - tolerates periodic flooding/drying (1.8) | 2 |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | 3 |
| Ponds, lakes and other standing waters, including their margins (2.2) | 2 |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | 3 |
| Establishment – into existing vegetation (2.4) | -3 |
| Establishment – into disturbed vegetation (2.5) | 5 |
| Competition – between growth form (3.1) | 0 |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | 0 |
| Dispersal outside catchment by accidental human activity (4.2) | 2 |
| Dispersal outside catchment by deliberate introduction (4.3) | 1 |
| Effective spread within waterbody/ catchment (4.4) | 1 |
| Generation time (5.1) | 3 |
| Seeding ability - Quantity (6.1) | 1 |
| Seeding ability - Viability/ persistence (6.2) | 1 |
| Vegetative propagation (7.1) | 3 |
| Physical restriction -water use, recreation (8.1) | 1 |
| Physical restriction – access (8.2) | 2 |
| Physical restriction - water flow, power generation (8.3) | 0 |
| Physical restriction - irrigation, flood control (8.4) | 1 |
| Aesthetic obstruction - visual, olfactory (8.5) | 1 |
| Reduces biodiversity (9.1) | 3 |
| Reduces water quality (9.2) | 0 |
| Negatively affect physical processes (9.3) | 0 |
| Human health impairment (10.1) | 0 |
| Weed of agriculture (10.2) | 0 |
| Management - Ease of management implementation (11.1) | 1 |
| Management - Recognition of management problem (11.2) | 1 |
| Management - Scope of control methods (11.3) | 0 |
| Management - Control method suitability (11.4) | 0 |
| Management - Effectiveness of control (11.5) | 1 |
| Management - Duration of control (11.6) | 2 |
| Problem in other states (12.1) | 3 |
| Problem in other countries (12.2) | 4 |
| **Score** | 53 |

References: 87, 112,195, 439, 440

Table A-3. TXAqPRA model.

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Temperature tolerance (1.1) | **(0-3)** Score 3 if maintains full photosynthetic tissue and summer growth form throughout winter, 2 if dies back to tuber/bulb/rhizome, or partial photosynthetic tissue (or similar structure) during winter, 1 if adult plants completely die but viable seeds remain. Use a climate matching tool if direct evidence is not available. Default = 1 for annual species. |
| Hardiness Zones (1.2)[2] | **(0-1)** Score 1 if native range falls within the same USDA Plant Hardiness Zones as Texas, 0 if not. Data from introduced range may be substituted if species is well established outside of native range and data from native range cannot be found. See attached Hardiness Zones map for reference. |
| Range of habitat (1.3) | **(1-3)** Score 3 if able to grow from water to dry land (e.g. upland areas), 2 if water to wetland, or from shallow to deep (>5 m) water, 1 narrow range. Default = 1 if no information is available; 2 for free-floating plants, unless more information is available. |
| Water/substrate type tolerance (1.4) | **(1-2)** Score 2 if tolerant of sandy to muddy (or peaty) substrate, or oligotrophic to eutrophic waters, 1 if restricted by either. Default = 1 if no information is available. |
| Water clarity tolerance (1.5) | **(0-1)** Score 1 if unaffected by water clarity (i.e. floating or emergent, or submerged species tolerant of very low light levels, such as *Myriophyllum spicatum* and *Hydrilla verticillata*). 0 if affected by water clarity (i.e. growth is stunted or prohibited). |
| Salinity tolerance (1.6) | **(0-2)** Score 2 if species can persist in saline conditions (i.e. marshes, estuaries, etc). Score 1 if species can tolerate moderately saline conditions or can only tolerate saline conditions for short periods of time (i.e. transport in ballast water, temporary saline inundation within a normally freshwater habitat). Score 0 if information states that the species can only tolerate freshwater, default=0 if no data can be found to support growth in saline water. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| pH tolerance (1.7) | **(0-1)** Score 1 if tolerant of both acidic and basic pH or no information is available, 0 if restricted to neutral, basic, or acidic pH. |
| Water level fluctuation - Tolerates periodic flooding/drying (1.8) | **(0-3)** Score 3 for species which have evidence of tolerating periodic flooding/drying with a specified time period longer than 1 month (e.g., "months"; "X months", "winter flooding"), 2 for evidence of tolerance of flooding/drying over a period of days/a couple of weeks, 1 for species that die back during periods of flooding/drying , and 0 for species that do not tolerate flooding/drying. Default = 1 if no evidence can be found to support tolerance of flooding/drying. |
| Lentic - rivers, streams, drains, or other flowing waters, including their margins (2.1) | **(0-3)** Score 3 if major invasive (reaches high density and dominates plant community), 2 if minor invasive (common, but rarely or never dominant), 1 if present but not invasive, 0 if absent. |
| Ponds, lakes and other standing waters, including their margins (2.2) | **(0-3)** Score 3 if major invasive (reaches high density and dominates plant community), 2 if minor invasive (common, but rarely or never dominant), 1 if present but not invasive, 0 if absent. |
| Swamp, marsh, bog, or other wet areas not covered by 2.1 or 2.2 (2.3) | **(0-3)** Score 3 if major invasive (reaches high density and dominates plant community), 2 if minor invasive, 1 if present but not invasive, 0 if absent. |
| Establishment – into existing vegetation (2.4 | **(-5, -3, 0)** Score 0 if able to invade existing vegetation, -3 if the species can only colonize certain types of vegetation (e.g., turf-forming shoreline vegetation or species that cannot tolerate complete submersion), -5 if there is no evidence that the species can move into existing vegetation. Default = 0 if there is evidence of establishment, but no specific information about level of invasion into existing vegetation and/or type of vegetation being invaded. Default = -3 for species that have not established outside of their native range. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Establishment – into disturbed vegetation (2.5) | **(0, 1, 5)** Score 5 if able to aggressively colonize following disturbance (i.e. vegetation clearance, newly constructed waterbodies, natural event like a flood or hurricane, or nutrient enrichment), 1 if the species grows in disturbed areas, but there is no other information, 0 if there is no evidence of establishment in disturbed areas. Information from either the native or introduced range may be used to answer this question. Default = 1 for no information. |
| Competition – between growth form (3.1) | **(0-2)** Score 2 if able to completely displace other growth forms (submerged, floating, emergent), 1 if some suppression, 0 if no displacement. Default = 0 if species has been in the trade globally for >30 years and there is no information about the species displacing other growth forms. |
| Dispersal outside catchment by natural agents (e.g. birds, wind) (4.1) | **(0, 1, 3, 5)** Score 5 if species (including seeds, rhizomes, fragments etc.) well adapted, and likely to be frequently dispersed, by natural agents, 3 if transport by natural agents is possible but uncommon, 1 if propagule could be spread in bird crop or growth form favors transport by natural agents but is not explicitly mentioned, 0 if no evidence of dispersal by natural agents and growth form does not support this mode of transport. |
| Dispersal outside catchment by accidental human activity (4.2) | **(1-3)** Score 3 if major pathway, seeds/fragments adapted for easy transportation (e.g., via boat/trailer, fishing gear), 2 if the species is a floating plant or a macrophyte, but no explicit mention of high spread in the literature, 1 if not mentioned, not likely to be spread by human activity based on growth form and life history. Default = 1 if no information is available. |
| Dispersal outside catchment by deliberate introduction (4.3) | **(0-1)** Score 1 if species is desirable to humans (e.g., or used for medicinal, food, ornamental, restoration, etc. purposes in the U.S. or elsewhere). If species is not used or no information exists, score = 0. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Effective spread within waterbody/ catchment (4.4) | **(0-1)** Score 1 for spread within a waterbody or among waterbodies, 0 for very little or no spread, or lack of information. Occurrence along streams or riverbanks or in rivers can be used as evidence, as well as evidence of water dispersal. |
| Generation time (5.1) | **(1-3)** Time between germination of an individual and the production of living offspring, not seeds or other dormant structures. Score 3 if rapid (reproduction in first year and >1 generation/year), 2 if annual or produces one generation every year including the first year, 1 if not reproductively mature in the first year. Default = 1 if no information is available. |
| Seeding ability - Quantity (6.1) | **(0-3)** Score 3 if >1000 seeds/plant/year, 2 if 100-1000, 1 if <100 and/or evidence that seed are produced (in native or introduced range), 0 if seed not produced in introduced range. |
| Seeding ability - Viability/ persistence (6.2) | **(0-2)** Score 2 if highly viable for >3 years, 1 low viability or evidence of seed production with no information on viability, 0 no viable seeds or no seeds produced. |
| Vegetative propagation (7.1) | **(0, 1, 3, 5)** Score 5 for naturally fragmenting from rhizomes, stolons, or other vegetative growth into tissue capable of producing new colonies (e.g., *Egeria densa*), 3 if produces rhizomes/stolons, but there is no other information about the formation of new colonies elsewhere, 1 if vegetative propagation possible but uncommon, 0 for no vegetative spread. |
| Physical restriction - water use, recreation (8.1) | **(0-2)** Score 2 for major nuisance, 1 for minor nuisance. Default = 0 if the species has not established outside of its native range. If there is a reasonable amount of information about the species and it has established outside of its native range, default = 0. |
| Physical restriction – access (8.2) | **(0-2)** Score 2 for major nuisance, 1 for minor nuisance. Default = 0 if the species has not established outside of its native range. If there is a reasonable amount of information about the species and it has established outside of its native range, default = 0. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Physical restriction - water flow, power generation (8.3) | **(0-2)** Score 2 for major nuisance, 1 for minor nuisance. Default = 0 if the species has not established outside of its native range. If there is a reasonable amount of information about the species and it has established outside of its native range, default = 0. |
| Physical restriction - irrigation, flood control (8.4) | **(0-2)** Score 2 for major nuisance, 1 for minor nuisance. Default = 0 if the species has not established outside of its native range. If there is a reasonable amount of information about the species and it has established outside of its native range, default = 0. |
| Aesthetic obstruction - visual, olfactory (8.5) | **(0-2)** Score 2 for both visual and odor problems, 1 for either, 0 if neither, or no mention of these impacts. Surface matting of macrophytes scores 1 for visual impact. |
| Reduces biodiversity (9.1) | **(0, 1, 3, 5)** Score 5 for extensive monospecific stands which eliminate other species, 3 for species that become dominant, 1 for small monospecific stands, and 0 if species does not become dominant over or reduce other species. Default = 0 for this question if species has been in the trade globally for >30 years and no information is found or if the species is not established outside of its native range. |
| Reduces water quality (9.2) | **(0, 1, 3)** Score 3 if evidence that this species causes reduced oxygen levels or hypoxia, or other negative changes to water quality (e.g., loss of water clarity because of high decomposition rates continuously during the growing season), 1 if deoxygenation or other water quality loss is likely based on seasonal growth cycles (e.g., macrophyte that gets to high density and dies off at end of summer), 0 otherwise. Default = 0 for this question if species has been in the trade globally for >30 years and no information is found or if the species is not established outside of its native range. |
| Negatively affect physical processes (9.3) | **(0-2)** Score 2 if species alters hydrology (e.g., increases the chance of flooding) or substrate stability (e.g., increases amount of sediment erosion or deposition), or other physical processes (e.g. abnormally high water use), 0 if the species has no history of modifying physical processes. Default = 0 for this question if species has been in the trade globally for >30 years and no information is found or if the species is not established outside of its native range. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Human health impairment (10.1) | **(0-2)** Score 2 for two or more effects, 1 for one effect, 0 if no documented effects. (e.g. drowning, toxic, mosquito habitat) |
| Weed of agriculture (10.2) | **(0-1)** Score 1 if a problem agricultural weed (i.e. rice paddies, cotton fields, etc.), 0 if no evidence that it is an agricultural weed, or if evidence states that species is in agricultural areas but not problematic. |
| Management - Ease of management implementation (11.1) | **(0-2)** Score 2 if accessibility to plant is difficult, e.g. dense tall impenetrable growths or growing in habitats which are difficult to access by roads or waterways (e.g., swamps). For species that have established outside of their native range, default to a score between 0-2 based upon evidence about habitat and/or growth form if there is no direct evidence from the literature. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |
| Management - Recognition of management problem (11.2) | **(0-1)** Score 1 if difficult to assess plant, e.g., submerged; looks like another species. For species that have established outside of their native range, default to a score between 0-1 based upon growth form evidence if there is no direct evidence from the literature. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |
| Management - Scope of control methods (11.3) | **(0-2)** Score 2 if no control method, 1 if only one control option, 0 if more than one control method available. If species has established outside of its native range, and there is no direct evidence for either 11.1 or 11.2, do not answer if there is no information. If there is direct evidence for 11.1 and/or 11.2, default to 0 if there is no information for this question. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |
| Management - Control method suitability (11.4) | **(0-1)** Score 1 if control method not always acceptable, e.g., grass carp, unregistered herbicide; 0 if acceptable control method exists. If species has established outside of its native range, and there is no direct evidence for either 11.1 or 11.2, do not answer if there is no information. If there is direct evidence for 11.1 and/or 11.2, default to 0 if there is no information for this question. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |

| Question – TXAqPRA | Scoring and guidance – TX APRA[1] |
|---|---|
| Management - Effectiveness of control (11.5) | **(0-2)** Score 2 if ineffective, 1 if partial control. If species has established outside of its native range, and there is no direct evidence for either 11.1 or 11.2, do not answer if there is no information. If there is direct evidence for 11.1 and/or 11.2, default to 0 if there is no information for this question. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |
| Management - Duration of control (11.6) | **(0-2)** Score 2 if no long-term control (e.g. species regrows rapidly following herbicide treatment or mechanical removal, or requires rapid repeated treatments), 1 if control for 3+ months. If species has established outside of its native range, and there is no direct evidence for either 11.1 or 11.2, do not answer if there is no information. If there is direct evidence for 11.1 and/or 11.2, default to 0 if there is no information for this question. Default = 0 if species has not established outside of its native range and has been in the trade globally for >30 years. |
| Problem in other states (12.1) [2] | **(0-4)** Score 4 if species has been reported to be invasive in 6 or more other states in the United States, 3 if species has been listed as an invasive in 5 or fewer states, 2 if adventive in 6 or more states, 1 if species has been reported as adventive in 5 or fewer states, 0 if species is not adventive in the United States. Default= 0 is no evidence exists suggesting establishment outside of cultivation in the United States. |
| Problem in other countries (12.2) | **(0, 1, 3, 4, 5)** Score 5 if species has been reported to be invasive in 6 or more countries, 4 if species has been reported to be invasive in 5 or fewer other countries, 3 if species has been reported to be adventive (but not invasive) in 6 or more other countries, 1 if species has been reported to be adventive in 5 or fewer countries, 0 if not adventive elsewhere. |

[1]A maximum of five questions may be left unanswered for the TXAqPRA to still be considered complete. Thus, no response for any or all of Q. 2.1-3 or Q. 11.1-6 should be considered one unanswered question each during scoring (see text for more information).

[2] These questions were new to the TXAqPRA (see text for more information).

APPENDIX B

LAKE CONROE INVASION MODEL

## Model Description

We developed a simulation model, programmed in NetLogo (89), to aid in the management of aquatic weeds in Texas reservoirs. The model is a spatially-explicit, individual-based model representing the invasion, growth, and senescence of aquatic weeds as functions of day length, water temperature and water depth, and the response of aquatic weeds to mechanical, chemical, and/or biological control. As a case study to evaluate its potential utility, we parameterized the model to represent the historical invasion and biological control (grass carp) of hydrilla in Lake Conroe. The lake and a portion of surrounding land area is represented spatially within a 148 x 183 lattice of 27,084, 1-ha patches, of which 9,332 represent the lake proper. Input to the model includes spatially-explicit data on water depth (106) and time series of data representing day lengths (107). The model calculates daily rates of growth and senescence of hydrilla, consumption of hydrilla by grass carp, and growth of grass carp based on Santha et al. (100) (Table B-1). The model represents grass carp mortality as a daily probability of dying based on an annual mortality rate of 32% (102). The model calculates the daily rates of invasion (spread among habitat patches) of hydrilla based on the assumption that an un-invaded habitat patch will be invaded by an initial biomass of hydrilla ($\alpha$) if the density of hydrilla in any of the eight neighboring patches has passed a threshold level ($\beta$), provided that the water depth in the un-invaded patch is < 6m (104, 105). The model represents the daily movements of grass carp based on the assumption that an individual will stay in a single habitat patch until there is no longer forage (hydrilla) in that patch, at which time it will move to another patch. The individual first tries to select randomly from among the neighboring patches that contain forage. If none of the neighboring patches contain forage, the individual tries to select randomly from among the patches within distance of 4 patch widths (400 m), and then 8 patch widths (800 m), that contain forage. If none of these patches contain forage, the individual tries to select randomly from among the patches at any distance that contain forage. If none of the patches contain forage, the individual moves to a randomly-selected patch with water. The model allows hydrilla to re-sprout in habitat patches from which all biomass has been removed by herbivory, with an initial re-sprouting biomass equal to $\alpha$, and a daily probability of re-sprouting ($\gamma$) that decreases by one-half after each extinction event.

**Model Calibration and Evaluation**

To calibrate and evaluate the model, we drew upon two studies describing the use of grass carp to control hydrilla in Lake Conroe from 1979 to 1983 (99) and from 2006 to 2007 (102). We first evaluated the growth rates of simulated grass carp, which were based on information in Santha et al. (100), by comparing them with the growth rates reported for grass carp stocked in Lake Conroe in September 1981 and sampled in May 1982 (99). We then ran a series of simulations to calibrate the invasion rate of hydrilla in which we initialized the coverage of hydrilla to represent the spatial distribution observed in 1979 (99) and simulated the time series of introductions of grass carp into the lake (mimicking the number and mean size released) during the period from October 1979 to October 1983 (99). We calibrated α, β, and γ such that the simulated spatial-temporal dynamics of hydrilla resembled the observed pattern of invasion as represented by the spatial distributions of hydrilla reported in 1980 and 1981 (99). Finally, we evaluated overall model performance by initializing the coverage of hydrilla to represent the coverage observed in 2006 (102) and simulating the time series of introductions of grass carp into the lake during the period from March 2006 to November 2007 (102). We compared the simulated invasion pattern with the pattern observed from May 2006 to November 2007 (102).

**Model Application**

To demonstrate application of the model, we simulated a variety of potential management scenarios in response to a hypothetical reintroduction of hydrilla into Lake Conroe. Scenarios involved different time lags between invasion by hydrilla and initial stocking with grass carp, and different stocking densities; an example of these results can be seen in Table B- 2.

**User Interface**

The user interface of the model is arranged such that users can simulate a four-year period, during which they can pause the simulation at any time, introduce hydrilla into a specified number of hectares within the lake, and then resume the simulation. The model will introduce the hydrilla into the specified number of hectares, with the invasion occurring in randomly-chosen habitat patches adjacent to the shoreline that currently are un-invaded. The user also can introduce a specified number of grass carp of a specified size (kg) into the lake at any time. The model will distribute the grass carp among randomly-chosen habitat patches that currently are invaded by hydrilla.

**Table B-1**. Equations used in the model to calculate daily rates of growth and senescence of hydrilla, consumption of hydrilla by grass carp, and growth of grass carp based on Santha et al. (1991).

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Growth (Gh) of hydrilla (kg fresh weight per ha per day):

Gh = ((0.03 * B) – (1.07E ^ -6) * (B ^ 2)) * tcp

where B is biomass of hydrilla (kg fresh weight per ha) and tcp is a plant growth temperature coefficient:

tcp = (-0.00004 * T ^ 3) + (0.0016 * T ^ 2) – (0.0127 * T) - 0.0127 when day length is increasing

tcp = (-0.00008 * T ^ 3) + (0.0043 * T ^ 2) – (0.0303 * T) - 0.0378 when day length is decreasing

where T is mean daily air temperature (C).

---

Senescence (S) of hydrilla (kg fresh weight per ha per day):

S = d * B * e

where d is degree-day senescence coefficient and e is a senescence temperature coefficient:

d = 0.009 when degree days accumulated since 1 April < 525

d = 0.0006 when degree days accumulated since 1 April ≥ 525

e = (0.00008 * T ^ 3) + (0.0002 * T ^ 2) – (0.2114 * T) + 4.9429

---

Consumption (herbivory, H) of hydrilla by grass carp (kg fresh weight of hydrilla per grass carp per day):

H = (0.871 * W ^ 0.27) * tch

where W is live weight (kg) of an individual grass carp and tch is a herbivory rate temperature coefficient:

tch = $-0.00016 * (T ^ 3) + 0.00802 * (T ^ 2) - 0.05481 * T - 0.16066$ when day length is increasing

tch = $-0.00005 * (T ^ 3) - 0.0008 * (T ^ 2) + 0.1444 * T - 1.3646$ when day length is decreasing

---

Growth (Gc) of grass carp (kg live weight per day):

$Gc = (0.013 * H)$ when $T \geq 11C$

$Gc = -M$ when $T < 11C$

where M is maintenance costs (kg live weight per day):

$M = 0.0021 * (W ^ 0.645)$

**Table B-2.** Sample of raw data from simulations run on the Lake Conroe Invasion Model. Data gathered from simulation to demonstrate removal of a hydrilla infestation within one year of grass carp stocking, given a one year time lag between time of invasion and time of grass carp stocking, using 60,000 triploid grass carp.

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0 | Jan | 1 | 11.04167 | 1014 | 6112.748 | 0 | 189 | 1973106 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | Jan | 2 | 11.65972 | 1014 | 6124.407 | 0 | 190 | 1979755 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 0 | Jan | 3 | 12.02381 | 1015 | 6136.431 | 0 | 192 | 1996569 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 | 0 | Jan | 4 | 11.76389 | 1016 | 6148.195 | 0 | 193 | 2003228 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 | 0 | Jan | 5 | 11.84028 | 1017 | 6160.035 | 0 | 193 | 1999913 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | Jan | 6 | 11.71528 | 1017 | 6171.751 | 0 | 195 | 2016542 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 | 0 | Jan | 7 | 11.33333 | 1018 | 6183.084 | 0 | 196 | 2022953 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 0 | Jan | 8 | 11.42361 | 1019 | 6194.508 | 0 | 196 | 2019397 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 | 0 | Jan | 9 | 11.80556 | 1019 | 6206.313 | 0 | 196 | 2016037 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | Jan | 10 | 12.45139 | 1020 | 6218.765 | 0 | 197 | 2023005 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | Jan | 11 | 11.52083 | 1021 | 6230.285 | 0 | 197 | 2019496 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 0 | Jan | 12 | 11.14583 | 1022 | 6241.431 | 0 | 197 | 2015807 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 0 | Jan | 13 | 10.52778 | 1023 | 6251.959 | 0 | 197 | 2011821 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14 | 0 | Jan | 14 | 10.46528 | 1024 | 6262.424 | 0 | 197 | 2007812 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | Jan | 15 | 10.50955 | 1025 | 6272.934 | 0 | 197 | 2003831 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 0 | Jan | 16 | 10.76389 | 1026 | 6283.698 | 0 | 197 | 1999981 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 | 0 | Jan | 17 | 10.65278 | 1027 | 6294.351 | 0 | 198 | 2006083 | 0 | 0 | 0 | 0 | 0 | 0 |
| 18 | 0 | Jan | 18 | 10.95139 | 1028 | 6305.302 | 0 | 198 | 2002319 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19 | 0 | Jan | 19 | 11.04861 | 1029 | 6316.351 | 0 | 198 | 1998609 | 0 | 0 | 0 | 0 | 0 | 0 |
| 20 | 0 | Jan | 20 | 11.13194 | 1030 | 6327.482 | 0 | 198 | 1994947 | 0 | 0 | 0 | 0 | 0 | 0 |
| 21 | 0 | Jan | 21 | 11.29861 | 1031 | 6338.781 | 0 | 198 | 1991372 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | Jan | 22 | 11.36111 | 1033 | 6350.142 | 0 | 198 | 1987835 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | Jan | 23 | 11.8125 | 1034 | 6361.955 | 0 | 198 | 1984527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 0 | Jan | 24 | 12.05556 | 1035 | 6374.01 | 0 | 198 | 1981345 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 0 | Jan | 25 | 12.38194 | 1037 | 6386.392 | 0 | 198 | 1978330 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 0 | Jan | 26 | 13.25694 | 1037 | 6399.649 | 0 | 198 | 1975754 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 0 | Jan | 27 | 14.59028 | 1039 | 6414.239 | 0 | 198 | 1973829 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 0 | Jan | 28 | 14.22917 | 1040 | 6428.469 | 0 | 198 | 1971734 | 0 | 0 | 0 | 0 | 0 | 0 |
| 29 | 0 | Jan | 29 | 14.04167 | 1042 | 6442.51 | 0 | 198 | 1969550 | 0 | 0 | 0 | 0 | 0 | 0 |
| 30 | 0 | Jan | 30 | 14 | 1043 | 6456.51 | 0 | 198 | 1967350 | 0 | 0 | 0 | 0 | 0 | 0 |
| 31 | 0 | Jan | 31 | 13.27778 | 1045 | 6469.788 | 0 | 198 | 1964799 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 0 | Feb | 32 | 13.25694 | 1046 | 6483.045 | 0 | 198 | 1962241 | 0 | 0 | 0 | 0 | 0 | 0 |
| 33 | 0 | Feb | 33 | 13.64583 | 1048 | 6496.691 | 0 | 198 | 1959878 | 0 | 0 | 0 | 0 | 0 | 0 |
| 34 | 0 | Feb | 34 | 13.63194 | 1049 | 6510.323 | 0 | 198 | 1957511 | 0 | 0 | 0 | 0 | 0 | 0 |
| 35 | 0 | Feb | 35 | 13.9375 | 1050 | 6524.26 | 0 | 198 | 1955296 | 0 | 0 | 0 | 0 | 0 | 0 |
| 36 | 0 | Feb | 36 | 14.53472 | 1052 | 6538.795 | 0 | 198 | 1953369 | 0 | 0 | 0 | 0 | 0 | 0 |
| 37 | 0 | Feb | 37 | 15.29167 | 1054 | 6554.087 | 0 | 198 | 1951798 | 0 | 0 | 0 | 0 | 0 | 0 |
| 38 | 0 | Feb | 38 | 15.99306 | 1055 | 6570.08 | 0 | 198 | 1950542 | 0 | 0 | 0 | 0 | 0 | 0 |
| 39 | 0 | Feb | 39 | 16.75694 | 1057 | 6586.837 | 0 | 198 | 1949612 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | Feb | 40 | 17.64583 | 1058 | 6604.482 | 0 | 198 | 1949031 | 0 | 0 | 0 | 0 | 0 | 0 |
| 41 | 0 | Feb | 41 | 17.63194 | 1100 | 6622.114 | 0 | 198 | 1948445 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | 0 | Feb | 42 | 17.77778 | 1102 | 6639.892 | 0 | 198 | 1947915 | 0 | 0 | 0 | 0 | 0 | 0 |
| 43 | 0 | Feb | 43 | 18.15278 | 1103 | 6658.045 | 0 | 198 | 1947518 | 0 | 0 | 0 | 0 | 0 | 0 |
| 44 | 0 | Feb | 44 | 18.65278 | 1105 | 6676.698 | 0 | 198 | 1947290 | 0 | 0 | 0 | 0 | 0 | 0 |
| 45 | 0 | Feb | 45 | 18.34028 | 1106 | 6695.038 | 0 | 198 | 1946959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 46 | 0 | Feb | 46 | 17.75694 | 1108 | 6712.795 | 0 | 198 | 1946422 | 0 | 0 | 0 | 0 | 0 | 0 |
| 47 | 0 | Feb | 47 | 17.83333 | 1110 | 6730.628 | 0 | 198 | 1945914 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48 | 0 | Feb | 48 | 18.0625 | 1112 | 6748.691 | 0 | 198 | 1945488 | 0 | 0 | 0 | 0 | 0 | 0 |
| 49 | 0 | Feb | 49 | 18.46991 | 1114 | 6767.161 | 0 | 198 | 1945202 | 0 | 0 | 0 | 0 | 0 | 0 |
| 50 | 0 | Feb | 50 | 19.71717 | 1115 | 6786.878 | 0 | 198 | 1945286 | 0 | 0 | 0 | 0 | 0 | 0 |
| 51 | 0 | Feb | 51 | 20.16667 | 1117 | 6807.045 | 0 | 198 | 1945479 | 0 | 0 | 0 | 0 | 0 | 0 |
| 52 | 0 | Feb | 52 | 19.76389 | 1119 | 6826.808 | 0 | 198 | 1945575 | 0 | 0 | 0 | 0 | 0 | 0 |
| 53 | 0 | Feb | 53 | 19.70833 | 1121 | 6846.517 | 0 | 198 | 1945657 | 0 | 0 | 0 | 0 | 0 | 0 |
| 54 | 0 | Feb | 54 | 19.92361 | 1122 | 6866.44 | 0 | 198 | 1945793 | 0 | 0 | 0 | 0 | 0 | 0 |
| 55 | 0 | Feb | 55 | 20.35417 | 1124 | 6886.795 | 0 | 198 | 1946029 | 0 | 0 | 0 | 0 | 0 | 0 |
| 56 | 0 | Feb | 56 | 21.10417 | 1126 | 6907.899 | 0 | 198 | 1946405 | 0 | 0 | 0 | 0 | 0 | 0 |
| 57 | 0 | Feb | 57 | 20.97917 | 1128 | 6928.878 | 0 | 198 | 1946762 | 0 | 0 | 0 | 0 | 0 | 0 |
| 58 | 0 | Feb | 58 | 21.09722 | 1129 | 6949.975 | 0 | 198 | 1947137 | 0 | 0 | 0 | 0 | 0 | 0 |
| 59 | 0 | Feb | 59 | 21.38889 | 1131 | 6971.364 | 0 | 198 | 1947557 | 0 | 0 | 0 | 0 | 0 | 0 |
| 60 | 0 | Mar | 60 | 21.77778 | 1133 | 6993.142 | 0 | 198 | 1948024 | 0 | 0 | 0 | 0 | 0 | 0 |
| 61 | 0 | Mar | 61 | 22.14583 | 1134 | 7015.288 | 0 | 198 | 1948525 | 0 | 0 | 0 | 0 | 0 | 0 |
| 62 | 0 | Mar | 62 | 22.28472 | 1136 | 7037.572 | 0 | 198 | 1949036 | 0 | 0 | 0 | 0 | 0 | 0 |
| 63 | 0 | Mar | 63 | 22.19444 | 1138 | 7059.767 | 0 | 198 | 1949541 | 0 | 0 | 0 | 0 | 0 | 0 |
| 64 | 0 | Mar | 64 | 22.04167 | 1141 | 7081.808 | 0 | 198 | 1950033 | 0 | 0 | 0 | 0 | 0 | 0 |
| 65 | 0 | Mar | 65 | 22.18056 | 1142 | 7103.989 | 0 | 198 | 1950537 | 0 | 0 | 0 | 0 | 0 | 0 |
| 66 | 0 | Mar | 66 | 22.30556 | 1144 | 7126.295 | 0 | 198 | 1951049 | 0 | 0 | 0 | 0 | 0 | 0 |
| 67 | 0 | Mar | 67 | 22.36111 | 1146 | 7148.656 | 0 | 198 | 1951564 | 0 | 0 | 0 | 0 | 0 | 0 |
| 68 | 0 | Mar | 68 | 22.86806 | 1147 | 7171.524 | 0 | 198 | 1952097 | 0 | 0 | 0 | 0 | 0 | 0 |
| 69 | 0 | Mar | 69 | 23.35417 | 1149 | 7194.878 | 0 | 198 | 1952625 | 0 | 0 | 0 | 0 | 0 | 0 |
| 70 | 0 | Mar | 70 | 23.36111 | 1152 | 7218.239 | 0 | 198 | 1953152 | 0 | 0 | 0 | 0 | 0 | 0 |
| 71 | 0 | Mar | 71 | 22.85417 | 1153 | 7241.093 | 0 | 198 | 1953684 | 0 | 0 | 0 | 0 | 0 | 0 |
| 72 | 0 | Mar | 72 | 22.93056 | 1155 | 7264.024 | 0 | 198 | 1954218 | 0 | 0 | 0 | 0 | 0 | 0 |
| 73 | 0 | Mar | 73 | 23.25 | 1157 | 7287.274 | 0 | 198 | 1954748 | 0 | 0 | 0 | 0 | 0 | 0 |
| 74 | 0 | Mar | 74 | 23.75694 | 1158 | 7311.031 | 0 | 198 | 1955254 | 0 | 0 | 0 | 0 | 0 | 0 |
| 75 | 0 | Mar | 75 | 24.3125 | 1201 | 7335.343 | 0 | 198 | 1955703 | 0 | 0 | 0 | 0 | 0 | 0 |
| 76 | 0 | Mar | 76 | 24.5873 | 1202 | 7359.93 | 0 | 198 | 1956111 | 0 | 0 | 0 | 0 | 0 | 0 |
| 77 | 0 | Mar | 77 | 25.00794 | 1204 | 7384.938 | 0 | 198 | 1956443 | 0 | 0 | 0 | 0 | 0 | 0 |
| 78 | 0 | Mar | 78 | 25.33333 | 1206 | 7410.272 | 0 | 198 | 1956701 | 0 | 0 | 0 | 0 | 0 | 0 |
| 79 | 0 | Mar | 79 | 25.27778 | 1207 | 7435.549 | 0 | 198 | 1956972 | 0 | 0 | 0 | 0 | 0 | 0 |
| 80 | 0 | Mar | 80 | 25.27778 | 1210 | 7460.827 | 0 | 198 | 1957244 | 0 | 0 | 0 | 0 | 0 | 0 |
| 81 | 0 | Mar | 81 | 25.22917 | 1212 | 7486.056 | 0 | 198 | 1957527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 82 | 0 | Mar | 82 | 25.22222 | 1213 | 7511.279 | 0 | 198 | 1957811 | 0 | 0 | 0 | 0 | 0 | 0 |
| 83 | 0 | Mar | 83 | 25.45833 | 1215 | 7536.737 | 0 | 198 | 1958038 | 0 | 0 | 0 | 0 | 0 | 0 |
| 84 | 0 | Mar | 84 | 25.88889 | 1216 | 7562.626 | 0 | 198 | 1958143 | 0 | 0 | 0 | 0 | 0 | 0 |
| 85 | 0 | Mar | 85 | 26.51389 | 1219 | 7589.14 | 0 | 198 | 1958031 | 0 | 0 | 0 | 0 | 0 | 0 |
| 86 | 0 | Mar | 86 | 26.54861 | 1221 | 7615.688 | 0 | 198 | 1957906 | 0 | 0 | 0 | 0 | 0 | 0 |
| 87 | 0 | Mar | 87 | 27.11806 | 1222 | 7642.806 | 0 | 198 | 1957538 | 0 | 0 | 0 | 0 | 0 | 0 |
| 88 | 0 | Mar | 88 | 28.125 | 1224 | 7670.931 | 0 | 198 | 1956637 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 89 | 0 | Mar | 89 | 27.04861 | 1227 | 7697.98 | 0 | 198 | 1956302 | 0 | 0 | 0 | 0 | 0 | 0 |
| 90 | 0 | Mar | 90 | 27.15278 | 1228 | 7725.133 | 0 | 198 | 1955919 | 0 | 0 | 0 | 0 | 0 | 0 |
| 91 | 0 | Apr | 91 | 27.125 | 1230 | 27.125 | 0 | 198 | 1939830 | 0 | 0 | 0 | 0 | 0 | 0 |
| 92 | 0 | Apr | 92 | 27.27778 | 1231 | 54.40278 | 0 | 198 | 1923863 | 0 | 0 | 0 | 0 | 0 | 0 |
| 93 | 0 | Apr | 93 | 27.76389 | 1233 | 82.16667 | 0 | 198 | 1907927 | 0 | 0 | 0 | 0 | 0 | 0 |
| 94 | 0 | Apr | 94 | 27.34722 | 1236 | 109.5139 | 0 | 198 | 1892219 | 0 | 0 | 0 | 0 | 0 | 0 |
| 95 | 0 | Apr | 95 | 27.20833 | 1237 | 136.7222 | 0 | 198 | 1876661 | 0 | 0 | 0 | 0 | 0 | 0 |
| 96 | 0 | Apr | 96 | 27.25694 | 1239 | 163.9792 | 0 | 198 | 1861228 | 0 | 0 | 0 | 0 | 0 | 0 |
| 97 | 0 | Apr | 97 | 27.72222 | 1240 | 191.7014 | 0 | 198 | 1845830 | 0 | 0 | 0 | 0 | 0 | 0 |
| 98 | 0 | Apr | 98 | 28.40278 | 1242 | 220.1042 | 0 | 198 | 1830286 | 0 | 0 | 0 | 0 | 0 | 0 |
| 99 | 0 | Apr | 99 | 28.85417 | 1244 | 248.9583 | 0 | 198 | 1814598 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100 | 0 | Apr | 100 | 27.91667 | 1246 | 276.875 | 0 | 198 | 1799528 | 0 | 0 | 0 | 0 | 0 | 0 |
| 101 | 0 | Apr | 101 | 27.81944 | 1248 | 304.6944 | 0 | 198 | 1784618 | 0 | 0 | 0 | 0 | 0 | 0 |
| 102 | 0 | Apr | 102 | 28.11111 | 1250 | 332.8056 | 0 | 198 | 1769724 | 0 | 0 | 0 | 0 | 0 | 0 |
| 103 | 0 | Apr | 103 | 28.5 | 1251 | 361.3056 | 0 | 198 | 1754765 | 0 | 0 | 0 | 0 | 0 | 0 |
| 104 | 0 | Apr | 104 | 28.75694 | 1253 | 390.0625 | 0 | 198 | 1739779 | 0 | 0 | 0 | 0 | 0 | 0 |
| 105 | 0 | Apr | 105 | 28.75 | 1254 | 418.8125 | 0 | 198 | 1724924 | 0 | 0 | 0 | 0 | 0 | 0 |
| 106 | 0 | Apr | 106 | 28.96296 | 1256 | 447.7755 | 0 | 198 | 1710051 | 0 | 0 | 0 | 0 | 0 | 0 |
| 107 | 0 | Apr | 107 | 29.01389 | 1259 | 476.7894 | 0 | 198 | 1695267 | 0 | 0 | 0 | 0 | 0 | 0 |
| 108 | 0 | Apr | 108 | 29.26389 | 1300 | 506.0532 | 0 | 198 | 1680418 | 0 | 0 | 0 | 0 | 0 | 0 |
| 109 | 0 | Apr | 109 | 29.81944 | 1302 | 535.8727 | 0 | 198 | 1678509 | 0 | 0 | 0 | 0 | 0 | 0 |
| 110 | 0 | Apr | 110 | 30.01389 | 1304 | 565.8866 | 0 | 198 | 1676442 | 0 | 0 | 0 | 0 | 0 | 0 |
| 111 | 0 | Apr | 111 | 29.02778 | 1305 | 594.9144 | 0 | 198 | 1675123 | 0 | 0 | 0 | 0 | 0 | 0 |
| 112 | 0 | Apr | 112 | 28.89583 | 1307 | 623.8102 | 0 | 198 | 1673894 | 0 | 0 | 0 | 0 | 0 | 0 |
| 113 | 0 | Apr | 113 | 28.92361 | 1309 | 652.7338 | 0 | 198 | 1672647 | 0 | 0 | 0 | 0 | 0 | 0 |
| 114 | 0 | Apr | 114 | 29.13889 | 1310 | 681.8727 | 0 | 198 | 1671254 | 0 | 0 | 0 | 0 | 0 | 0 |
| 115 | 0 | Apr | 115 | 29.24306 | 1312 | 711.1157 | 0 | 198 | 1669787 | 0 | 0 | 0 | 0 | 0 | 0 |
| 116 | 0 | Apr | 116 | 29.61806 | 1313 | 740.7338 | 0 | 198 | 1668044 | 0 | 0 | 0 | 0 | 0 | 0 |
| 117 | 0 | Apr | 117 | 29.75556 | 1315 | 770.4894 | 0 | 198 | 1666195 | 0 | 0 | 0 | 0 | 0 | 0 |
| 118 | 0 | Apr | 118 | 30.76389 | 1317 | 801.2532 | 0 | 198 | 1663480 | 0 | 0 | 0 | 0 | 0 | 0 |
| 119 | 0 | Apr | 119 | 31 | 1318 | 832.2532 | 0 | 198 | 1660544 | 0 | 0 | 0 | 0 | 0 | 0 |
| 120 | 0 | Apr | 120 | 30.375 | 1320 | 862.6282 | 0 | 198 | 1658187 | 0 | 0 | 0 | 0 | 0 | 0 |
| 121 | 0 | May | 121 | 29.60417 | 1321 | 892.2324 | 0 | 198 | 1656464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 122 | 0 | May | 122 | 29.33333 | 1322 | 921.5657 | 0 | 198 | 1654943 | 0 | 0 | 0 | 0 | 0 | 0 |
| 123 | 0 | May | 123 | 30.08333 | 1324 | 951.6491 | 0 | 198 | 1652841 | 0 | 0 | 0 | 0 | 0 | 0 |
| 124 | 0 | May | 124 | 30.84722 | 1326 | 982.4963 | 0 | 198 | 1650063 | 0 | 0 | 0 | 0 | 0 | 0 |
| 125 | 0 | May | 125 | 30.25694 | 1327 | 1012.753 | 0 | 198 | 1647818 | 0 | 0 | 0 | 0 | 0 | 0 |
| 126 | 0 | May | 126 | 29.17361 | 1329 | 1041.927 | 0 | 198 | 1646418 | 0 | 0 | 0 | 0 | 0 | 0 |
| 127 | 0 | May | 127 | 29.12698 | 1331 | 1071.054 | 0 | 198 | 1645050 | 0 | 0 | 0 | 0 | 0 | 0 |
| 128 | 0 | May | 128 | 29.41667 | 1331 | 1100.471 | 0 | 198 | 1643477 | 0 | 0 | 0 | 0 | 0 | 0 |
| 129 | 0 | May | 129 | 30.77778 | 1333 | 1131.248 | 0 | 198 | 1640775 | 0 | 0 | 0 | 0 | 0 | 0 |
| 130 | 0 | May | 130 | 30.61111 | 1335 | 1161.859 | 0 | 198 | 1638228 | 0 | 0 | 0 | 0 | 0 | 0 |
| 131 | 0 | May | 131 | 29.84722 | 1336 | 1191.707 | 0 | 198 | 1636332 | 0 | 0 | 0 | 0 | 0 | 0 |
| 132 | 0 | May | 132 | 29.80556 | 1337 | 1221.512 | 0 | 198 | 1634471 | 0 | 0 | 0 | 0 | 0 | 0 |
| 133 | 0 | May | 133 | 29.44444 | 1339 | 1250.957 | 0 | 198 | 1632885 | 0 | 0 | 0 | 0 | 0 | 0 |
| 134 | 0 | May | 134 | 30.02083 | 1340 | 1280.977 | 0 | 198 | 1630854 | 0 | 0 | 0 | 0 | 0 | 0 |
| 135 | 0 | May | 135 | 30.67361 | 1341 | 1311.651 | 0 | 198 | 1628262 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 136 | 0 | May | 136 | 30.24306 | 1343 | 1341.894 | 0 | 198 | 1626050 | 0 | 0 | 0 | 0 | 0 | 0 |
| 137 | 0 | May | 137 | 30.125 | 1343 | 1372.019 | 0 | 198 | 1623940 | 0 | 0 | 0 | 0 | 0 | 0 |
| 138 | 0 | May | 138 | 30.19444 | 1345 | 1402.214 | 0 | 198 | 1621773 | 0 | 0 | 0 | 0 | 0 | 0 |
| 139 | 0 | May | 139 | 30.95833 | 1346 | 1433.172 | 0 | 198 | 1618926 | 0 | 0 | 0 | 0 | 0 | 0 |
| 140 | 0 | May | 140 | 31.07639 | 1347 | 1464.248 | 0 | 198 | 1615969 | 0 | 0 | 0 | 0 | 0 | 0 |
| 141 | 0 | May | 141 | 30.5 | 1349 | 1494.748 | 0 | 198 | 1613548 | 0 | 0 | 0 | 0 | 0 | 0 |
| 142 | 0 | May | 142 | 30.00694 | 1349 | 1524.755 | 0 | 198 | 1611545 | 0 | 0 | 0 | 0 | 0 | 0 |
| 143 | 0 | May | 143 | 30.10417 | 1350 | 1554.859 | 0 | 198 | 1609466 | 0 | 0 | 0 | 0 | 0 | 0 |
| 144 | 0 | May | 144 | 30.52083 | 1352 | 1585.38 | 0 | 198 | 1607033 | 0 | 0 | 0 | 0 | 0 | 0 |
| 145 | 0 | May | 145 | 29.84028 | 1352 | 1615.221 | 0 | 198 | 1605170 | 0 | 0 | 0 | 0 | 0 | 0 |
| 146 | 0 | May | 146 | 29.95833 | 1354 | 1645.179 | 0 | 198 | 1603214 | 0 | 0 | 0 | 0 | 0 | 0 |
| 147 | 0 | May | 147 | 29.98611 | 1354 | 1675.165 | 0 | 198 | 1601238 | 0 | 0 | 0 | 0 | 0 | 0 |
| 148 | 0 | May | 148 | 30.125 | 1355 | 1705.29 | 0 | 198 | 1599151 | 0 | 0 | 0 | 0 | 0 | 0 |
| 149 | 0 | May | 149 | 30.02778 | 1356 | 1735.318 | 0 | 198 | 1597146 | 0 | 0 | 0 | 0 | 0 | 0 |
| 150 | 0 | May | 150 | 29.84028 | 1357 | 1765.158 | 0 | 198 | 1595291 | 0 | 0 | 0 | 0 | 0 | 0 |
| 151 | 0 | May | 151 | 30.375 | 1358 | 1795.533 | 0 | 198 | 1593000 | 0 | 0 | 0 | 0 | 0 | 0 |
| 152 | 0 | Jun | 152 | 30.58333 | 1358 | 1826.116 | 0 | 198 | 1590529 | 0 | 0 | 0 | 0 | 0 | 0 |
| 153 | 0 | Jun | 153 | 30.30556 | 1400 | 1856.422 | 0 | 198 | 1588302 | 0 | 0 | 0 | 0 | 0 | 0 |
| 154 | 0 | Jun | 154 | 29.47917 | 1400 | 1885.901 | 0 | 198 | 1586727 | 0 | 0 | 0 | 0 | 0 | 0 |
| 155 | 0 | Jun | 155 | 29.30952 | 1401 | 1915.211 | 0 | 198 | 1585275 | 0 | 0 | 0 | 0 | 0 | 0 |
| 156 | 0 | Jun | 156 | 29.51389 | 1401 | 1944.724 | 0 | 198 | 1583677 | 0 | 0 | 0 | 0 | 0 | 0 |
| 157 | 0 | Jun | 157 | 29.73611 | 1402 | 1974.461 | 0 | 198 | 1581914 | 0 | 0 | 0 | 0 | 0 | 0 |
| 158 | 0 | Jun | 158 | 29.69444 | 1402 | 2004.155 | 0 | 198 | 1580184 | 0 | 0 | 0 | 0 | 0 | 0 |
| 159 | 0 | Jun | 159 | 30.35417 | 1404 | 2034.509 | 0 | 198 | 1577926 | 0 | 0 | 0 | 0 | 0 | 0 |
| 160 | 0 | Jun | 160 | 29.3125 | 1404 | 2063.822 | 0 | 198 | 1576479 | 0 | 0 | 0 | 0 | 0 | 0 |
| 161 | 0 | Jun | 161 | 28.96825 | 1404 | 2092.79 | 0 | 198 | 1575266 | 0 | 0 | 0 | 0 | 0 | 0 |
| 162 | 0 | Jun | 162 | 28.72917 | 1405 | 2121.519 | 0 | 198 | 1574208 | 0 | 0 | 0 | 0 | 0 | 0 |
| 163 | 0 | Jun | 163 | 28.64583 | 1405 | 2150.165 | 0 | 198 | 1573202 | 0 | 0 | 0 | 0 | 0 | 0 |
| 164 | 0 | Jun | 164 | 29.00694 | 1406 | 2179.172 | 0 | 198 | 1571966 | 0 | 0 | 0 | 0 | 0 | 0 |
| 165 | 0 | Jun | 165 | 29.03472 | 1405 | 2208.207 | 0 | 198 | 1597176 | 0 | 0 | 0 | 0 | 0 | 0 |
| 166 | 0 | Jun | 166 | 28.82639 | 1405 | 2237.033 | 0 | 198 | 1596043 | 0 | 0 | 0 | 0 | 0 | 0 |
| 167 | 0 | Jun | 167 | 28.84722 | 1406 | 2265.88 | 0 | 198 | 1594896 | 0 | 0 | 0 | 0 | 0 | 0 |
| 168 | 0 | Jun | 168 | 29.07143 | 1406 | 2294.952 | 0 | 198 | 1593602 | 0 | 0 | 0 | 0 | 0 | 0 |
| 169 | 0 | Jun | 169 | 29.59722 | 1406 | 2324.549 | 0 | 198 | 1591936 | 0 | 0 | 0 | 0 | 0 | 0 |
| 170 | 0 | Jun | 170 | 30.36806 | 1406 | 2354.917 | 0 | 198 | 1589653 | 0 | 0 | 0 | 0 | 0 | 0 |
| 171 | 0 | Jun | 171 | 30.93056 | 1407 | 2385.847 | 0 | 198 | 1586869 | 0 | 0 | 0 | 0 | 0 | 0 |
| 172 | 0 | Jun | 172 | 31.43651 | 1406 | 2417.284 | 0 | 198 | 1612946 | 0 | 0 | 0 | 0 | 0 | 0 |
| 173 | 0 | Jun | 173 | 30.13194 | 1406 | 2447.416 | 0 | 198 | 1610841 | 0 | 0 | 0 | 0 | 0 | 0 |
| 174 | 0 | Jun | 174 | 29.7037 | 1406 | 2477.12 | 0 | 198 | 1609079 | 0 | 0 | 0 | 0 | 0 | 0 |
| 175 | 0 | Jun | 175 | 28.72222 | 1406 | 2505.842 | 0 | 198 | 1608004 | 0 | 0 | 0 | 0 | 0 | 0 |
| 176 | 0 | Jun | 176 | 28.94444 | 1405 | 2534.786 | 0 | 198 | 1633481 | 0 | 0 | 0 | 0 | 0 | 0 |
| 177 | 0 | Jun | 177 | 28.96528 | 1406 | 2563.752 | 0 | 198 | 1632232 | 0 | 0 | 0 | 0 | 0 | 0 |
| 178 | 0 | Jun | 178 | 29.59028 | 1406 | 2593.342 | 0 | 198 | 1630538 | 0 | 0 | 0 | 0 | 0 | 0 |
| 179 | 0 | Jun | 179 | 30.22222 | 1405 | 2623.564 | 0 | 198 | 1656769 | 0 | 0 | 0 | 0 | 0 | 0 |
| 180 | 0 | Jun | 180 | 30.13889 | 1405 | 2653.703 | 0 | 198 | 1654616 | 0 | 0 | 0 | 0 | 0 | 0 |
| 181 | 0 | Jun | 181 | 30.61905 | 1405 | 2684.322 | 0 | 198 | 1652045 | 0 | 0 | 0 | 0 | 0 | 0 |
| 182 | 0 | Jul | 182 | 31.15741 | 1404 | 2715.479 | 0 | 198 | 1678661 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 183 | 0 | Jul | 183 | 30.64583 | 1404 | 2746.125 | 0 | 198 | 1676038 | 0 | 0 | 0 | 0 | 0 | 0 |
| 184 | 0 | Jul | 184 | 31.4375 | 1404 | 2777.563 | 0 | 198 | 1672641 | 0 | 0 | 0 | 0 | 0 | 0 |
| 185 | 0 | Jul | 185 | 31.77778 | 1403 | 2809.341 | 0 | 198 | 1699457 | 0 | 0 | 0 | 0 | 0 | 0 |
| 186 | 0 | Jul | 186 | 30.99306 | 1402 | 2840.334 | 0 | 198 | 1726434 | 0 | 0 | 0 | 0 | 0 | 0 |
| 187 | 0 | Jul | 187 | 30.05556 | 1401 | 2870.389 | 0 | 198 | 1753376 | 0 | 0 | 0 | 0 | 0 | 0 |
| 188 | 0 | Jul | 188 | 29.21429 | 1401 | 2899.603 | 0 | 198 | 1751871 | 0 | 0 | 0 | 0 | 0 | 0 |
| 189 | 0 | Jul | 189 | 28.70833 | 1400 | 2928.312 | 0 | 198 | 1778330 | 0 | 0 | 0 | 0 | 0 | 0 |
| 190 | 0 | Jul | 190 | 28.88889 | 1400 | 2957.201 | 0 | 198 | 1777039 | 0 | 0 | 0 | 0 | 0 | 0 |
| 191 | 0 | Jul | 191 | 28.98611 | 1359 | 2986.187 | 0 | 198 | 1803846 | 0 | 0 | 0 | 0 | 0 | 0 |
| 192 | 0 | Jul | 192 | 28.70833 | 1358 | 3014.895 | 0 | 198 | 1830667 | 0 | 0 | 0 | 0 | 0 | 0 |
| 193 | 0 | Jul | 193 | 29.11806 | 1357 | 3044.013 | 0 | 198 | 1857914 | 0 | 0 | 0 | 0 | 0 | 0 |
| 194 | 0 | Jul | 194 | 29.28472 | 1357 | 3073.298 | 0 | 198 | 1856282 | 0 | 0 | 0 | 0 | 0 | 0 |
| 195 | 0 | Jul | 195 | 29.74297 | 1355 | 3103.041 | 0 | 198 | 1884012 | 0 | 0 | 0 | 0 | 0 | 0 |
| 196 | 0 | Jul | 196 | 29.17361 | 1355 | 3132.214 | 0 | 198 | 1882446 | 0 | 0 | 0 | 0 | 0 | 0 |
| 197 | 0 | Jul | 197 | 30.26389 | 1354 | 3162.478 | 0 | 198 | 1910543 | 0 | 0 | 0 | 0 | 0 | 0 |
| 198 | 0 | Jul | 198 | 30.39583 | 1353 | 3192.874 | 0 | 198 | 1938856 | 0 | 0 | 0 | 0 | 0 | 0 |
| 199 | 0 | Jul | 199 | 30.07639 | 1352 | 3222.951 | 0 | 198 | 1967228 | 0 | 0 | 0 | 0 | 0 | 0 |
| 200 | 0 | Jul | 200 | 29.25694 | 1350 | 3252.208 | 0 | 198 | 1995379 | 0 | 0 | 0 | 0 | 0 | 0 |
| 201 | 0 | Jul | 201 | 28.19444 | 1350 | 3280.402 | 0 | 198 | 1994419 | 0 | 0 | 0 | 0 | 0 | 0 |
| 202 | 0 | Jul | 202 | 27.81944 | 1348 | 3308.221 | 0 | 198 | 2021709 | 0 | 0 | 0 | 0 | 0 | 0 |
| 203 | 0 | Jul | 203 | 27.78472 | 1348 | 3336.006 | 0 | 198 | 2020980 | 0 | 0 | 0 | 0 | 0 | 0 |
| 204 | 0 | Jul | 204 | 28 | 1346 | 3364.006 | 0 | 198 | 2048553 | 0 | 0 | 0 | 0 | 0 | 0 |
| 205 | 0 | Jul | 205 | 28.59722 | 1345 | 3392.603 | 0 | 198 | 2076711 | 0 | 0 | 0 | 0 | 0 | 0 |
| 206 | 0 | Jul | 206 | 28.74306 | 1344 | 3421.346 | 0 | 198 | 2105100 | 0 | 0 | 0 | 0 | 0 | 0 |
| 207 | 0 | Jul | 207 | 28.40278 | 1343 | 3449.749 | 0 | 198 | 2133374 | 0 | 0 | 0 | 0 | 0 | 0 |
| 208 | 0 | Jul | 208 | 27.25694 | 1342 | 3477.006 | 0 | 198 | 2160780 | 0 | 0 | 0 | 0 | 0 | 0 |
| 209 | 0 | Jul | 209 | 27.83333 | 1340 | 3504.839 | 0 | 198 | 2188820 | 0 | 0 | 0 | 0 | 0 | 0 |
| 210 | 0 | Jul | 210 | 27.96528 | 1339 | 3532.805 | 0 | 198 | 2217077 | 0 | 0 | 0 | 0 | 0 | 0 |
| 211 | 0 | Jul | 211 | 26.50694 | 1338 | 3559.312 | 0 | 198 | 2243999 | 0 | 0 | 0 | 0 | 0 | 0 |
| 212 | 0 | Jul | 212 | 25.92361 | 1336 | 3585.235 | 0 | 198 | 2270325 | 0 | 0 | 0 | 0 | 0 | 0 |
| 213 | 0 | Aug | 213 | 25.59722 | 1336 | 3610.833 | 0 | 198 | 2270423 | 0 | 0 | 0 | 0 | 0 | 0 |
| 214 | 0 | Aug | 214 | 24.79861 | 1334 | 3635.631 | 0 | 198 | 2295358 | 0 | 0 | 0 | 0 | 0 | 0 |
| 215 | 0 | Aug | 215 | 24.57639 | 1332 | 3660.208 | 0 | 198 | 2320041 | 0 | 0 | 0 | 0 | 0 | 0 |
| 216 | 0 | Aug | 216 | 24.34028 | 1331 | 3684.548 | 0 | 198 | 2344439 | 0 | 0 | 0 | 0 | 0 | 0 |
| 217 | 0 | Aug | 217 | 24.55556 | 1329 | 3709.103 | 0 | 198 | 2369197 | 0 | 0 | 0 | 0 | 0 | 0 |
| 218 | 0 | Aug | 218 | 24.6875 | 1329 | 3733.791 | 0 | 198 | 2369464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 219 | 0 | Aug | 219 | 24.65972 | 1327 | 3758.451 | 0 | 198 | 2394421 | 0 | 0 | 0 | 0 | 0 | 0 |
| 220 | 0 | Aug | 220 | 24.53472 | 1325 | 3782.985 | 0 | 198 | 2419241 | 0 | 0 | 0 | 0 | 0 | 0 |
| 221 | 0 | Aug | 221 | 24.75 | 1324 | 3807.735 | 0 | 198 | 2444409 | 0 | 0 | 0 | 0 | 0 | 0 |
| 222 | 0 | Aug | 222 | 24.68056 | 1322 | 3832.416 | 0 | 198 | 2469514 | 0 | 0 | 0 | 0 | 0 | 0 |
| 223 | 0 | Aug | 223 | 23.52778 | 1321 | 3855.944 | 0 | 198 | 2492909 | 0 | 0 | 0 | 0 | 0 | 0 |
| 224 | 0 | Aug | 224 | 22.85417 | 1319 | 3878.798 | 0 | 198 | 2515231 | 0 | 0 | 0 | 0 | 0 | 0 |
| 225 | 0 | Aug | 225 | 22.375 | 1317 | 3901.173 | 0 | 202 | 2576759 | 0 | 0 | 0 | 0 | 0 | 0 |
| 226 | 0 | Aug | 226 | 22.51389 | 1316 | 3923.687 | 0 | 202 | 2598988 | 0 | 0 | 0 | 0 | 0 | 0 |
| 227 | 0 | Aug | 227 | 22.03472 | 1314 | 3945.721 | 0 | 202 | 2620382 | 0 | 0 | 0 | 0 | 0 | 0 |
| 228 | 0 | Aug | 228 | 21.27083 | 1313 | 3966.992 | 0 | 203 | 2650390 | 0 | 0 | 0 | 0 | 0 | 0 |
| 229 | 0 | Aug | 229 | 21.3125 | 1311 | 3988.305 | 0 | 203 | 2670580 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 230 | 0 | Aug | 230 | 22.03472 | 1309 | 4010.339 | 0 | 205 | 2712098 | 0 | 0 | 0 | 0 | 0 | 0 |
| 231 | 0 | Aug | 231 | 22.72917 | 1308 | 4033.069 | 0 | 208 | 2765077 | 0 | 0 | 0 | 0 | 0 | 0 |
| 232 | 0 | Aug | 232 | 22.86806 | 1306 | 4055.937 | 0 | 210 | 2808646 | 0 | 0 | 0 | 0 | 0 | 0 |
| 233 | 0 | Aug | 233 | 22.11806 | 1305 | 4078.055 | 0 | 214 | 2871076 | 0 | 0 | 0 | 0 | 0 | 0 |
| 234 | 0 | Aug | 234 | 20.75 | 1303 | 4098.805 | 0 | 218 | 2931252 | 0 | 0 | 0 | 0 | 0 | 0 |
| 235 | 0 | Aug | 235 | 20.36111 | 1301 | 4119.166 | 0 | 218 | 2951004 | 0 | 0 | 0 | 0 | 0 | 0 |
| 236 | 0 | Aug | 236 | 20.65278 | 1300 | 4139.819 | 0 | 219 | 2981356 | 0 | 0 | 0 | 0 | 0 | 0 |
| 237 | 0 | Aug | 237 | 22.61806 | 1258 | 4162.437 | 0 | 225 | 3065715 | 0 | 0 | 0 | 0 | 0 | 0 |
| 238 | 0 | Aug | 238 | 21.125 | 1256 | 4183.562 | 0 | 228 | 3117720 | 0 | 0 | 0 | 0 | 0 | 0 |
| 239 | 0 | Aug | 239 | 20.5625 | 1254 | 4204.124 | 0 | 229 | 3148805 | 0 | 0 | 0 | 0 | 0 | 0 |
| 240 | 0 | Aug | 240 | 20.54167 | 1253 | 4224.666 | 0 | 231 | 3189928 | 0 | 0 | 0 | 0 | 0 | 0 |
| 241 | 0 | Aug | 241 | 20.70833 | 1251 | 4245.374 | 0 | 234 | 3241597 | 0 | 0 | 0 | 0 | 0 | 0 |
| 242 | 0 | Aug | 242 | 20.44444 | 1249 | 4265.819 | 0 | 234 | 3262951 | 0 | 0 | 0 | 0 | 0 | 0 |
| 243 | 0 | Aug | 243 | 19.45139 | 1248 | 4285.27 | 0 | 237 | 3312027 | 0 | 0 | 0 | 0 | 0 | 0 |
| 244 | 0 | Sep | 244 | 19.1875 | 1245 | 4304.458 | 0 | 239 | 3350722 | 0 | 0 | 0 | 0 | 0 | 0 |
| 245 | 0 | Sep | 245 | 19.40972 | 1244 | 4323.867 | 0 | 241 | 3390092 | 0 | 0 | 0 | 0 | 0 | 0 |
| 246 | 0 | Sep | 246 | 19.27083 | 1242 | 4343.138 | 0 | 244 | 3439284 | 0 | 0 | 0 | 0 | 0 | 0 |
| 247 | 0 | Sep | 247 | 18.95833 | 1241 | 4362.096 | 0 | 247 | 3487948 | 0 | 0 | 0 | 0 | 0 | 0 |
| 248 | 0 | Sep | 248 | 18.88194 | 1239 | 4380.978 | 0 | 249 | 3526647 | 0 | 0 | 0 | 0 | 0 | 0 |
| 249 | 0 | Sep | 249 | 19.06944 | 1237 | 4400.048 | 0 | 249 | 3545953 | 0 | 0 | 0 | 0 | 0 | 0 |
| 250 | 0 | Sep | 250 | 18.96528 | 1235 | 4419.013 | 0 | 250 | 3574981 | 0 | 0 | 0 | 0 | 0 | 0 |
| 251 | 0 | Sep | 251 | 19.14583 | 1234 | 4438.159 | 0 | 251 | 3604520 | 0 | 0 | 0 | 0 | 0 | 0 |
| 252 | 0 | Sep | 252 | 19.125 | 1232 | 4457.284 | 0 | 252 | 3634068 | 0 | 0 | 0 | 0 | 0 | 0 |
| 253 | 0 | Sep | 253 | 18.875 | 1229 | 4476.159 | 0 | 254 | 3673045 | 0 | 0 | 0 | 0 | 0 | 0 |
| 254 | 0 | Sep | 254 | 18.81313 | 1228 | 4494.972 | 0 | 255 | 3702002 | 0 | 0 | 0 | 0 | 0 | 0 |
| 255 | 0 | Sep | 255 | 18.43056 | 1226 | 4513.403 | 0 | 260 | 3770032 | 0 | 0 | 0 | 0 | 0 | 0 |
| 256 | 0 | Sep | 256 | 18.375 | 1225 | 4531.778 | 0 | 263 | 3818270 | 0 | 0 | 0 | 0 | 0 | 0 |
| 257 | 0 | Sep | 257 | 18.52778 | 1222 | 4550.305 | 0 | 265 | 3857113 | 0 | 0 | 0 | 0 | 0 | 0 |
| 258 | 0 | Sep | 258 | 19.34722 | 1221 | 4569.653 | 0 | 268 | 3908257 | 0 | 0 | 0 | 0 | 0 | 0 |
| 259 | 0 | Sep | 259 | 18.24306 | 1219 | 4587.896 | 0 | 269 | 3936660 | 0 | 0 | 0 | 0 | 0 | 0 |
| 260 | 0 | Sep | 260 | 18.35417 | 1218 | 4606.25 | 0 | 276 | 4025414 | 0 | 0 | 0 | 0 | 0 | 0 |
| 261 | 0 | Sep | 261 | 17.85417 | 1215 | 4624.104 | 0 | 283 | 4113268 | 0 | 0 | 0 | 0 | 0 | 0 |
| 262 | 0 | Sep | 262 | 17.41667 | 1213 | 4641.521 | 0 | 287 | 4170330 | 0 | 0 | 0 | 0 | 0 | 0 |
| 263 | 0 | Sep | 263 | 17.15278 | 1212 | 4658.673 | 0 | 290 | 4216862 | 0 | 0 | 0 | 0 | 0 | 0 |
| 264 | 0 | Sep | 264 | 17.28472 | 1210 | 4675.958 | 0 | 292 | 4253952 | 0 | 0 | 0 | 0 | 0 | 0 |
| 265 | 0 | Sep | 265 | 17.72222 | 1208 | 4693.68 | 0 | 293 | 4282444 | 0 | 0 | 0 | 0 | 0 | 0 |
| 266 | 0 | Sep | 266 | 17.15972 | 1206 | 4710.84 | 0 | 297 | 4339310 | 0 | 0 | 0 | 0 | 0 | 0 |
| 267 | 0 | Sep | 267 | 17.54861 | 1205 | 4728.389 | 0 | 301 | 4397577 | 0 | 0 | 0 | 0 | 0 | 0 |
| 268 | 0 | Sep | 268 | 17.48611 | 1203 | 4745.875 | 0 | 307 | 4475896 | 0 | 0 | 0 | 0 | 0 | 0 |
| 269 | 0 | Sep | 269 | 17.75 | 1201 | 4763.625 | 0 | 313 | 4555409 | 0 | 0 | 0 | 0 | 0 | 0 |
| 270 | 0 | Sep | 270 | 17.57639 | 1159 | 4781.201 | 0 | 314 | 4584759 | 0 | 0 | 0 | 0 | 0 | 0 |
| 271 | 0 | Sep | 271 | 17.14583 | 1157 | 4798.347 | 0 | 320 | 4662780 | 0 | 0 | 0 | 0 | 0 | 0 |
| 272 | 0 | Sep | 272 | 16.75 | 1156 | 4815.097 | 0 | 322 | 4699870 | 0 | 0 | 0 | 0 | 0 | 0 |
| 273 | 0 | Sep | 273 | 16.65972 | 1153 | 4831.757 | 0 | 327 | 4766762 | 0 | 0 | 0 | 0 | 0 | 0 |
| 274 | 0 | Oct | 274 | 16.88889 | 1152 | 4848.646 | 0 | 331 | 4824683 | 0 | 0 | 0 | 0 | 0 | 0 |
| 275 | 0 | Oct | 275 | 17.13194 | 1150 | 4865.778 | 0 | 332 | 4853639 | 0 | 0 | 0 | 0 | 0 | 0 |
| 276 | 0 | Oct | 276 | 17.29167 | 1148 | 4883.069 | 0 | 338 | 4933174 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 277 | 0 | Oct | 277 | 18.06944 | 1146 | 4901.139 | 0 | 339 | 4965731 | 0 | 0 | 0 | 0 | 0 | 0 |
| 278 | 0 | Oct | 278 | 18.43056 | 1144 | 4919.569 | 0 | 342 | 5019569 | 0 | 0 | 0 | 0 | 0 | 0 |
| 279 | 0 | Oct | 279 | 17.77083 | 1143 | 4937.34 | 0 | 344 | 5061323 | 0 | 0 | 0 | 0 | 0 | 0 |
| 280 | 0 | Oct | 280 | 17.36806 | 1141 | 4954.708 | 0 | 347 | 5111784 | 0 | 0 | 0 | 0 | 0 | 0 |
| 281 | 0 | Oct | 281 | 17.3125 | 1139 | 4972.021 | 0 | 353 | 5192217 | 0 | 0 | 0 | 0 | 0 | 0 |
| 282 | 0 | Oct | 282 | 17.79167 | 1138 | 4989.812 | 0 | 357 | 5254724 | 0 | 0 | 0 | 0 | 0 | 0 |
| 283 | 0 | Oct | 283 | 17.69444 | 1135 | 5007.507 | 0 | 359 | 5297128 | 0 | 0 | 0 | 0 | 0 | 0 |
| 284 | 0 | Oct | 284 | 15.71528 | 1134 | 5023.222 | 0 | 359 | 5312443 | 0 | 0 | 0 | 0 | 0 | 0 |
| 285 | 0 | Oct | 285 | 15.34722 | 1132 | 5038.569 | 0 | 361 | 5346413 | 0 | 0 | 0 | 0 | 0 | 0 |
| 286 | 0 | Oct | 286 | 15.08333 | 1130 | 5053.653 | 0 | 361 | 5359504 | 0 | 0 | 0 | 0 | 0 | 0 |
| 287 | 0 | Oct | 287 | 15.31944 | 1129 | 5068.972 | 0 | 362 | 5383432 | 0 | 0 | 0 | 0 | 0 | 0 |
| 288 | 0 | Oct | 288 | 16.34028 | 1127 | 5085.312 | 0 | 366 | 5441111 | 0 | 0 | 0 | 0 | 0 | 0 |
| 289 | 0 | Oct | 289 | 15.54861 | 1125 | 5100.861 | 0 | 368 | 5476062 | 0 | 0 | 0 | 0 | 0 | 0 |
| 290 | 0 | Oct | 290 | 15.01389 | 1124 | 5115.875 | 0 | 372 | 5529119 | 0 | 0 | 0 | 0 | 0 | 0 |
| 291 | 0 | Oct | 291 | 14.99306 | 1122 | 5130.868 | 0 | 375 | 5572249 | 0 | 0 | 0 | 0 | 0 | 0 |
| 292 | 0 | Oct | 292 | 14.34722 | 1119 | 5145.215 | 0 | 379 | 5623097 | 0 | 0 | 0 | 0 | 0 | 0 |
| 293 | 0 | Oct | 293 | 14.01389 | 1118 | 5159.229 | 0 | 383 | 5672841 | 0 | 0 | 0 | 0 | 0 | 0 |
| 294 | 0 | Oct | 294 | 14.22917 | 1116 | 5173.458 | 0 | 383 | 5683507 | 0 | 0 | 0 | 0 | 0 | 0 |
| 295 | 0 | Oct | 295 | 14.5625 | 1114 | 5188.021 | 0 | 384 | 5705412 | 0 | 0 | 0 | 0 | 0 | 0 |
| 296 | 0 | Oct | 296 | 14.43651 | 1112 | 5202.457 | 0 | 386 | 5736866 | 0 | 0 | 0 | 0 | 0 | 0 |
| 297 | 0 | Oct | 297 | 13.88194 | 1111 | 5216.339 | 0 | 388 | 5766291 | 0 | 0 | 0 | 0 | 0 | 0 |
| 298 | 0 | Oct | 298 | 13.69444 | 1109 | 5230.034 | 0 | 388 | 5775066 | 0 | 0 | 0 | 0 | 0 | 0 |
| 299 | 0 | Oct | 299 | 13.93056 | 1108 | 5243.964 | 0 | 389 | 5794716 | 0 | 0 | 0 | 0 | 0 | 0 |
| 300 | 0 | Oct | 300 | 14.41667 | 1107 | 5258.381 | 0 | 392 | 5836232 | 0 | 0 | 0 | 0 | 0 | 0 |
| 301 | 0 | Oct | 301 | 14.125 | 1105 | 5272.506 | 0 | 392 | 5846723 | 0 | 0 | 0 | 0 | 0 | 0 |
| 302 | 0 | Oct | 302 | 14.56944 | 1103 | 5287.075 | 0 | 394 | 5878911 | 0 | 0 | 0 | 0 | 0 | 0 |
| 303 | 0 | Oct | 303 | 14.48611 | 1101 | 5301.561 | 0 | 395 | 5900836 | 0 | 0 | 0 | 0 | 0 | 0 |
| 304 | 0 | Oct | 304 | 14.79167 | 1100 | 5316.353 | 0 | 397 | 5933976 | 0 | 0 | 0 | 0 | 0 | 0 |
| 305 | 0 | Nov | 305 | 14.90972 | 1058 | 5331.263 | 0 | 397 | 5947645 | 0 | 0 | 0 | 0 | 0 | 0 |
| 306 | 0 | Nov | 306 | 15.22917 | 1057 | 5346.492 | 0 | 399 | 5982563 | 0 | 0 | 0 | 0 | 0 | 0 |
| 307 | 0 | Nov | 307 | 14.8125 | 1055 | 5361.304 | 0 | 401 | 6015890 | 0 | 0 | 0 | 0 | 0 | 0 |
| 308 | 0 | Nov | 308 | 14.67361 | 1053 | 5375.978 | 0 | 403 | 6048728 | 0 | 0 | 0 | 0 | 0 | 0 |
| 309 | 0 | Nov | 309 | 14.42361 | 1052 | 5390.402 | 0 | 406 | 6090632 | 0 | 0 | 0 | 0 | 0 | 0 |
| 310 | 0 | Nov | 310 | 14.65278 | 1050 | 5405.054 | 0 | 408 | 6123548 | 0 | 0 | 0 | 0 | 0 | 0 |
| 311 | 0 | Nov | 311 | 14.59028 | 1049 | 5419.645 | 0 | 409 | 6146272 | 0 | 0 | 0 | 0 | 0 | 0 |
| 312 | 0 | Nov | 312 | 14.52778 | 1047 | 5434.172 | 0 | 410 | 6168765 | 0 | 0 | 0 | 0 | 0 | 0 |
| 313 | 0 | Nov | 313 | 14.72917 | 1045 | 5448.902 | 0 | 411 | 6192096 | 0 | 0 | 0 | 0 | 0 | 0 |
| 314 | 0 | Nov | 314 | 14.94444 | 1045 | 5463.846 | 0 | 411 | 6185989 | 0 | 0 | 0 | 0 | 0 | 0 |
| 315 | 0 | Nov | 315 | 15.08333 | 1043 | 5478.929 | 0 | 412 | 6210808 | 0 | 0 | 0 | 0 | 0 | 0 |
| 316 | 0 | Nov | 316 | 14.64583 | 1042 | 5493.575 | 0 | 412 | 6223856 | 0 | 0 | 0 | 0 | 0 | 0 |
| 317 | 0 | Nov | 317 | 14.82639 | 1040 | 5508.402 | 0 | 414 | 6257626 | 0 | 0 | 0 | 0 | 0 | 0 |
| 318 | 0 | Nov | 318 | 15.04167 | 1039 | 5523.443 | 0 | 416 | 6292345 | 0 | 0 | 0 | 0 | 0 | 0 |
| 319 | 0 | Nov | 319 | 14.78472 | 1037 | 5538.228 | 0 | 419 | 6336064 | 0 | 0 | 0 | 0 | 0 | 0 |
| 320 | 0 | Nov | 320 | 14.6875 | 1037 | 5552.915 | 0 | 419 | 6329486 | 0 | 0 | 0 | 0 | 0 | 0 |
| 321 | 0 | Nov | 321 | 15.54861 | 1035 | 5568.464 | 0 | 420 | 6356528 | 0 | 0 | 0 | 0 | 0 | 0 |
| 322 | 0 | Nov | 322 | 14.36806 | 1034 | 5582.832 | 0 | 420 | 6368648 | 0 | 0 | 0 | 0 | 0 | 0 |
| 323 | 0 | Nov | 323 | 13.8254 | 1032 | 5596.658 | 0 | 420 | 6378525 | 0 | 0 | 0 | 0 | 0 | 0 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 324 | 0 | Nov | 324 | 14.34444 | 1031 | 5611.002 | 0 | 420 | 6390519 | 0 | 0 | 0 | 0 | 0 | 0 |
| 325 | 0 | Nov | 325 | 14.09259 | 1030 | 5625.095 | 0 | 423 | 6431459 | 0 | 0 | 0 | 0 | 0 | 0 |
| 326 | 0 | Nov | 326 | 14.38194 | 1029 | 5639.477 | 0 | 423 | 6443686 | 0 | 0 | 0 | 0 | 0 | 0 |
| 327 | 0 | Nov | 327 | 13.84028 | 1028 | 5653.317 | 0 | 424 | 6463655 | 0 | 0 | 0 | 0 | 0 | 0 |
| 328 | 0 | Nov | 328 | 13.49306 | 1027 | 5666.81 | 0 | 424 | 6472221 | 0 | 0 | 0 | 0 | 0 | 0 |
| 329 | 0 | Nov | 329 | 13.53968 | 1026 | 5680.35 | 0 | 424 | 6480967 | 0 | 0 | 0 | 0 | 0 | 0 |
| 330 | 0 | Nov | 330 | 14.14583 | 1024 | 5694.495 | 0 | 424 | 6492197 | 0 | 0 | 0 | 0 | 0 | 0 |
| 331 | 0 | Nov | 331 | 12.58333 | 1023 | 5707.079 | 0 | 424 | 6497090 | 0 | 0 | 0 | 0 | 0 | 0 |
| 332 | 0 | Nov | 332 | 12.48611 | 1023 | 5719.565 | 0 | 424 | 6487395 | 0 | 0 | 0 | 0 | 0 | 0 |
| 333 | 0 | Nov | 333 | 12.50926 | 1022 | 5732.074 | 0 | 424 | 6492017 | 0 | 0 | 0 | 0 | 0 | 0 |
| 334 | 0 | Nov | 334 | 11.13889 | 1021 | 5743.213 | 0 | 424 | 6491473 | 0 | 0 | 0 | 0 | 0 | 0 |
| 335 | 0 | Dec | 335 | 11 | 1020 | 5754.213 | 0 | 424 | 6490435 | 0 | 0 | 0 | 0 | 0 | 0 |
| 336 | 0 | Dec | 336 | 10.97222 | 1019 | 5765.185 | 0 | 424 | 6489303 | 0 | 0 | 0 | 0 | 0 | 0 |
| 337 | 0 | Dec | 337 | 11.10417 | 1019 | 5776.289 | 0 | 424 | 6477743 | 0 | 0 | 0 | 0 | 0 | 0 |
| 338 | 0 | Dec | 338 | 11.09028 | 1018 | 5787.38 | 0 | 424 | 6477065 | 0 | 0 | 0 | 0 | 0 | 0 |
| 339 | 0 | Dec | 339 | 10.85417 | 1017 | 5798.234 | 0 | 424 | 6475547 | 0 | 0 | 0 | 0 | 0 | 0 |
| 340 | 0 | Dec | 340 | 11.20139 | 1016 | 5809.435 | 0 | 424 | 6475282 | 0 | 0 | 0 | 0 | 0 | 0 |
| 341 | 0 | Dec | 341 | 11.70833 | 1016 | 5821.144 | 0 | 424 | 6464562 | 0 | 0 | 0 | 0 | 0 | 0 |
| 342 | 0 | Dec | 342 | 12.33333 | 1015 | 5833.477 | 0 | 424 | 6468583 | 0 | 0 | 0 | 0 | 0 | 0 |
| 343 | 0 | Dec | 343 | 11.93056 | 1015 | 5845.407 | 0 | 424 | 6458175 | 0 | 0 | 0 | 0 | 0 | 0 |
| 344 | 0 | Dec | 344 | 11.86806 | 1014 | 5857.275 | 0 | 424 | 6460432 | 0 | 0 | 0 | 0 | 0 | 0 |
| 345 | 0 | Dec | 345 | 11.84722 | 1014 | 5869.123 | 0 | 424 | 6449922 | 0 | 0 | 0 | 0 | 0 | 0 |
| 346 | 0 | Dec | 346 | 11.41667 | 1013 | 5880.539 | 0 | 424 | 6450514 | 0 | 0 | 0 | 0 | 0 | 0 |
| 347 | 0 | Dec | 347 | 11.18056 | 1013 | 5891.72 | 0 | 424 | 6439116 | 0 | 0 | 0 | 0 | 0 | 0 |
| 348 | 0 | Dec | 348 | 11.1875 | 1013 | 5902.907 | 0 | 424 | 6427746 | 0 | 0 | 0 | 0 | 0 | 0 |
| 349 | 0 | Dec | 349 | 11.27083 | 1012 | 5914.178 | 0 | 424 | 6427854 | 0 | 0 | 0 | 0 | 0 | 0 |
| 350 | 0 | Dec | 350 | 11.3125 | 1013 | 5925.491 | 0 | 424 | 6416670 | 0 | 0 | 0 | 0 | 0 | 0 |
| 351 | 0 | Dec | 351 | 11.48611 | 1012 | 5936.977 | 0 | 424 | 6417598 | 0 | 0 | 0 | 0 | 0 | 0 |
| 352 | 0 | Dec | 352 | 11.65972 | 1011 | 5948.637 | 0 | 424 | 6419174 | 0 | 0 | 0 | 0 | 0 | 0 |
| 353 | 0 | Dec | 353 | 11.97222 | 1012 | 5960.609 | 0 | 424 | 6408898 | 0 | 0 | 0 | 0 | 0 | 0 |
| 354 | 0 | Dec | 354 | 12.51389 | 1011 | 5973.123 | 0 | 424 | 6413778 | 0 | 0 | 0 | 0 | 0 | 0 |
| 355 | 0 | Dec | 355 | 11.52222 | 1012 | 5984.645 | 0 | 424 | 6402900 | 0 | 0 | 0 | 0 | 0 | 0 |
| 356 | 0 | Dec | 356 | 12.45 | 1011 | 5997.095 | 0 | 424 | 6407549 | 0 | 0 | 0 | 0 | 0 | 0 |
| 357 | 0 | Dec | 357 | 11.80556 | 1012 | 6008.9 | 0 | 424 | 6397063 | 0 | 0 | 0 | 0 | 0 | 0 |
| 358 | 0 | Dec | 358 | 11.42222 | 1011 | 6020.323 | 0 | 424 | 6397813 | 0 | 0 | 0 | 0 | 0 | 0 |
| 359 | 0 | Dec | 359 | 11.33333 | 1012 | 6031.656 | 0 | 424 | 6386704 | 0 | 0 | 0 | 0 | 0 | 0 |
| 360 | 0 | Dec | 360 | 11.71667 | 1011 | 6043.373 | 0 | 424 | 6388578 | 0 | 0 | 0 | 0 | 0 | 0 |
| 361 | 0 | Dec | 361 | 11.83889 | 1012 | 6055.212 | 0 | 424 | 6378167 | 0 | 0 | 0 | 0 | 0 | 0 |
| 362 | 0 | Dec | 362 | 11.76667 | 1013 | 6066.978 | 0 | 424 | 6367674 | 0 | 0 | 0 | 0 | 0 | 0 |
| 363 | 0 | Dec | 363 | 12.02222 | 1012 | 6079 | 0 | 424 | 6370756 | 0 | 0 | 0 | 0 | 0 | 0 |
| 364 | 0 | Dec | 364 | 11.66111 | 1013 | 6090.662 | 0 | 424 | 6360131 | 0 | 0 | 0 | 0 | 0 | 0 |
| 365 | 0 | Dec | 365 | 11.04444 | 1014 | 6101.706 | 0 | 424 | 6348692 | 0 | 0 | 0 | 0 | 0 | 0 |
| 366 | 1 | Jan | 1 | 11.04167 | 1014 | 6112.748 | 0 | 424 | 6337267 | 0 | 0 | 0 | 0 | 0 | 0 |
| 367 | 1 | Jan | 2 | 11.65972 | 1014 | 6124.407 | 0 | 424 | 6325287 | 59948 | 0.309305 | 7.58758 | 0.098639 | 1405.518 | 1405.518 |
| 368 | 1 | Jan | 3 | 12.02381 | 1015 | 6136.431 | 0 | 424 | 6312881 | 59885 | 0.309813 | 12.64716 | 0.164413 | 2342.598 | 3748.116 |
| 369 | 1 | Jan | 4 | 11.76389 | 1016 | 6148.195 | 0 | 424 | 6300816 | 59810 | 0.310176 | 9.007396 | 0.117096 | 1669.065 | 5417.181 |
| 370 | 1 | Jan | 5 | 11.84028 | 1017 | 6160.035 | 0 | 424 | 6288678 | 59752 | 0.310582 | 10.05738 | 0.130746 | 1864 | 7281.181 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 371 | 1 | Jan | 6 | 11.71528 | 1017 | 6171.751 | 0 | 424 | 6276711 | 59686 | 0.310918 | 8.32164 | 0.108181 | 1542.614 | 8823.794 |
| 372 | 1 | Jan | 7 | 11.33333 | 1018 | 6183.084 | 0 | 424 | 6265210 | 59612 | 0.311045 | 3.141328 | 0.040837 | 582.2269 | 9406.021 |
| 373 | 1 | Jan | 8 | 11.42361 | 1019 | 6194.508 | 0 | 424 | 6253625 | 59547 | 0.31122 | 4.34944 | 0.056543 | 805.5935 | 10211.61 |
| 374 | 1 | Jan | 9 | 11.80556 | 1019 | 6206.313 | 0 | 424 | 6241609 | 59482 | 0.311607 | 9.552455 | 0.124182 | 1768.352 | 11979.97 |
| 375 | 1 | Jan | 10 | 12.45139 | 1020 | 6218.765 | 0 | 424 | 6228795 | 59416 | 0.312362 | 18.64968 | 0.242446 | 3452.884 | 15432.85 |
| 376 | 1 | Jan | 11 | 11.52083 | 1021 | 6230.285 | 0 | 424 | 6217157 | 59365 | 0.312592 | 5.643491 | 0.073365 | 1046.495 | 16479.35 |
| 377 | 1 | Jan | 12 | 11.14583 | 1022 | 6241.431 | 0 | 424 | 6205961 | 59302 | 0.312618 | 0.654532 | 0.008509 | 121.3327 | 16600.68 |
| 378 | 1 | Jan | 13 | 10.52778 | 1023 | 6251.959 | 0 | 424 | 6194086 | 59238 | 0.311626 | 0 | 0 | 0 | 16600.68 |
| 379 | 1 | Jan | 14 | 10.46528 | 1024 | 6262.424 | 0 | 424 | 6182149 | 59178 | 0.310636 | 0 | 0 | 0 | 16600.68 |
| 380 | 1 | Jan | 15 | 10.50955 | 1025 | 6272.934 | 0 | 424 | 6170289 | 59108 | 0.309648 | 0 | 0 | 0 | 16600.68 |
| 381 | 1 | Jan | 16 | 10.76389 | 1026 | 6283.698 | 0 | 424 | 6158784 | 59033 | 0.308662 | 0 | 0 | 0 | 16600.68 |
| 382 | 1 | Jan | 17 | 10.65278 | 1027 | 6294.351 | 0 | 424 | 6147151 | 58979 | 0.307679 | 0 | 0 | 0 | 16600.68 |
| 383 | 1 | Jan | 18 | 10.95139 | 1028 | 6305.302 | 0 | 424 | 6135931 | 58932 | 0.306697 | 0 | 0 | 0 | 16600.68 |
| 384 | 1 | Jan | 19 | 11.04861 | 1029 | 6316.351 | 0 | 424 | 6124857 | 58866 | 0.306697 | 0 | 0 | 0 | 16600.68 |
| 385 | 1 | Jan | 20 | 11.13194 | 1030 | 6327.482 | 0 | 424 | 6113826 | 58812 | 0.306716 | 0.479356 | 0.006232 | 86.46358 | 16687.14 |
| 386 | 1 | Jan | 21 | 11.29861 | 1031 | 6338.781 | 0 | 424 | 6102632 | 58753 | 0.306824 | 2.705187 | 0.035167 | 487.4876 | 17174.63 |
| 387 | 1 | Jan | 22 | 11.36111 | 1033 | 6350.142 | 0 | 424 | 6091387 | 58698 | 0.306965 | 3.546697 | 0.046107 | 638.758 | 17813.39 |
| 388 | 1 | Jan | 23 | 11.8125 | 1034 | 6361.955 | 0 | 424 | 6079645 | 58652 | 0.307354 | 9.745875 | 0.126696 | 1754.659 | 19568.05 |
| 389 | 1 | Jan | 24 | 12.05556 | 1035 | 6374.01 | 0 | 424 | 6067631 | 58586 | 0.30788 | 13.15535 | 0.17102 | 2368.838 | 21936.88 |
| 390 | 1 | Jan | 25 | 12.38194 | 1037 | 6386.392 | 0 | 424 | 6055230 | 58525 | 0.308593 | 17.80868 | 0.231513 | 3208.887 | 25145.77 |
| 391 | 1 | Jan | 26 | 13.25694 | 1037 | 6399.649 | 0 | 424 | 6041677 | 58460 | 0.309824 | 30.706 | 0.399178 | 5539.46 | 30685.23 |
| 392 | 1 | Jan | 27 | 14.59028 | 1039 | 6414.239 | 0 | 424 | 6026145 | 58403 | 0.311887 | 51.21361 | 0.665777 | 9266.935 | 39952.17 |
| 393 | 1 | Jan | 28 | 14.22917 | 1040 | 6428.469 | 0 | 424 | 6011191 | 58352 | 0.313725 | 45.32261 | 0.589194 | 8248.368 | 48200.53 |
| 394 | 1 | Jan | 29 | 14.04167 | 1042 | 6442.51 | 0 | 424 | 5996539 | 58301 | 0.315447 | 42.23518 | 0.549057 | 7725.01 | 55925.54 |
| 395 | 1 | Jan | 30 | 14 | 1043 | 6456.51 | 0 | 424 | 5981968 | 58235 | 0.317146 | 41.42869 | 0.538573 | 7610.48 | 63536.02 |
| 396 | 1 | Jan | 31 | 13.27778 | 1045 | 6469.788 | 0 | 424 | 5968476 | 58179 | 0.3184 | 30.40767 | 0.3953 | 5610.593 | 69146.62 |
| 397 | 1 | Feb | 32 | 13.25694 | 1046 | 6483.045 | 0 | 424 | 5955033 | 58118 | 0.319642 | 30.01265 | 0.390164 | 5553.77 | 74700.39 |
| 398 | 1 | Feb | 33 | 13.64583 | 1048 | 6496.691 | 0 | 424 | 5941047 | 58044 | 0.321126 | 35.698 | 0.464074 | 6623.16 | 81323.55 |
| 399 | 1 | Feb | 34 | 13.63194 | 1049 | 6510.323 | 0 | 424 | 5927101 | 57977 | 0.322602 | 35.37056 | 0.459817 | 6585.253 | 87908.8 |
| 400 | 1 | Feb | 35 | 13.9375 | 1050 | 6524.26 | 0 | 424 | 5912716 | 57910 | 0.324272 | 39.81614 | 0.51761 | 7438.407 | 95347.21 |
| 401 | 1 | Feb | 36 | 14.53472 | 1052 | 6538.795 | 0 | 424 | 5897417 | 57844 | 0.326324 | 48.69017 | 0.632972 | 9132.904 | 104480.1 |
| 402 | 1 | Feb | 37 | 15.29167 | 1054 | 6554.087 | 0 | 424 | 5880883 | 57786 | 0.328872 | 60.05679 | 0.780738 | 11324.9 | 115805 |
| 403 | 1 | Feb | 38 | 15.99306 | 1055 | 6570.08 | 0 | 424 | 5863137 | 57723 | 0.331888 | 70.53392 | 0.916941 | 13389.8 | 129194.8 |
| 404 | 1 | Feb | 39 | 16.75694 | 1057 | 6586.837 | 0 | 424 | 5844001 | 57657 | 0.335419 | 81.841 | 1.063933 | 15660.81 | 144855.6 |
| 405 | 1 | Feb | 40 | 17.64583 | 1058 | 6604.482 | 0 | 424 | 5823161 | 57593 | 0.339552 | 94.79578 | 1.232345 | 18312.44 | 163168.1 |
| 406 | 1 | Feb | 41 | 17.63194 | 1100 | 6622.114 | 0 | 424 | 5802331 | 57525 | 0.34369 | 93.74232 | 1.21865 | 18310.45 | 181478.5 |
| 407 | 1 | Feb | 42 | 17.77778 | 1102 | 6639.892 | 0 | 424 | 5781191 | 57471 | 0.347939 | 95.09739 | 1.236266 | 18783.85 | 200262.4 |
| 408 | 1 | Feb | 43 | 18.15278 | 1103 | 6658.045 | 0 | 424 | 5759277 | 57422 | 0.352453 | 99.7845 | 1.297198 | 19936.31 | 220198.7 |
| 409 | 1 | Feb | 44 | 18.65278 | 1105 | 6676.698 | 0 | 424 | 5736313 | 57362 | 0.357314 | 106.1044 | 1.379358 | 21451.55 | 241650.2 |
| 410 | 1 | Feb | 45 | 18.34028 | 1106 | 6695.038 | 0 | 424 | 5713960 | 57296 | 0.361986 | 100.5684 | 1.30739 | 20589.06 | 262239.3 |
| 411 | 1 | Feb | 46 | 17.75694 | 1108 | 6712.795 | 0 | 424 | 5692764 | 57236 | 0.366281 | 91.26457 | 1.186439 | 18908.76 | 281148 |
| 412 | 1 | Feb | 47 | 17.83333 | 1110 | 6730.628 | 0 | 424 | 5671395 | 57176 | 0.370641 | 91.57113 | 1.190425 | 19177.24 | 300325.3 |
| 413 | 1 | Feb | 48 | 18.0625 | 1112 | 6748.691 | 0 | 424 | 5649535 | 57119 | 0.375171 | 94.01519 | 1.222197 | 19903.61 | 320228.9 |
| 414 | 1 | Feb | 49 | 18.46991 | 1114 | 6767.161 | 0 | 424 | 5626807 | 57057 | 0.379992 | 98.84835 | 1.285029 | 21159.6 | 341388.5 |
| 415 | 1 | Feb | 50 | 19.71717 | 1115 | 6786.878 | 0 | 424 | 5601382 | 56996 | 0.38566 | 114.7511 | 1.491765 | 24852.81 | 366241.3 |
| 416 | 1 | Feb | 51 | 20.16667 | 1117 | 6807.045 | 0 | 424 | 5574918 | 56934 | 0.391644 | 119.3385 | 1.551401 | 26203.38 | 392444.7 |
| 417 | 1 | Feb | 52 | 19.76389 | 1119 | 6826.808 | 0 | 424 | 5549285 | 56868 | 0.397389 | 112.852 | 1.467076 | 25134.38 | 417579.1 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 418 | 1 | Feb | 53 | 19.70833 | 1121 | 6846.517 | 0 | 424 | 5523726 | 56799 | 0.403121 | 110.9487 | 1.442333 | 25042.57 | 442621.6 |
| 419 | 1 | Feb | 54 | 19.92361 | 1122 | 6866.44 | 0 | 424 | 5497643 | 56731 | 0.409017 | 112.5083 | 1.462608 | 25730.04 | 468351.7 |
| 420 | 1 | Feb | 55 | 20.35417 | 1124 | 6886.795 | 0 | 424 | 5470541 | 56669 | 0.415218 | 116.6183 | 1.516038 | 27030.47 | 495382.1 |
| 421 | 1 | Feb | 56 | 21.10417 | 1126 | 6907.899 | 0 | 424 | 5441674 | 56602 | 0.421922 | 124.2054 | 1.61467 | 29190.96 | 524573.1 |
| 422 | 1 | Feb | 57 | 20.97917 | 1128 | 6928.878 | 0 | 424 | 5413012 | 56553 | 0.428577 | 121.327 | 1.577252 | 28949.81 | 553522.9 |
| 423 | 1 | Feb | 58 | 21.09722 | 1129 | 6949.975 | 0 | 424 | 5384002 | 56500 | 0.435335 | 121.2886 | 1.576751 | 29369.55 | 582892.4 |
| 424 | 1 | Feb | 59 | 21.38889 | 1131 | 6971.364 | 0 | 424 | 5354233 | 56454 | 0.442304 | 123.1428 | 1.600856 | 30264.04 | 613156.5 |
| 425 | 1 | Mar | 60 | 21.77778 | 1133 | 6993.142 | 0 | 424 | 5323481 | 56383 | 0.449542 | 125.8877 | 1.63654 | 31394.4 | 644550.9 |
| 426 | 1 | Mar | 61 | 22.14583 | 1134 | 7015.288 | 0 | 424 | 5291770 | 56336 | 0.457034 | 128.1939 | 1.666521 | 32465.64 | 677016.5 |
| 427 | 1 | Mar | 62 | 22.28472 | 1136 | 7037.572 | 0 | 424 | 5259633 | 56283 | 0.464641 | 128.0413 | 1.664537 | 32936.37 | 709952.9 |
| 428 | 1 | Mar | 63 | 22.19444 | 1138 | 7059.767 | 0 | 424 | 5227617 | 56222 | 0.472229 | 125.62 | 1.63306 | 32815.79 | 742768.7 |
| 429 | 1 | Mar | 64 | 22.04167 | 1141 | 7081.808 | 0 | 424 | 5195879 | 56155 | 0.479758 | 122.6442 | 1.594375 | 32522.83 | 775291.5 |
| 430 | 1 | Mar | 65 | 22.18056 | 1142 | 7103.989 | 0 | 424 | 5163717 | 56102 | 0.487404 | 122.584 | 1.593592 | 32993.99 | 808285.5 |
| 431 | 1 | Mar | 66 | 22.30556 | 1144 | 7126.295 | 0 | 424 | 5131164 | 56044 | 0.495157 | 122.3638 | 1.590729 | 33424.96 | 841710.5 |
| 432 | 1 | Mar | 67 | 22.36111 | 1146 | 7148.656 | 0 | 424 | 5098381 | 55994 | 0.502977 | 121.4795 | 1.579233 | 33681.18 | 875391.6 |
| 433 | 1 | Mar | 68 | 22.86806 | 1147 | 7171.524 | 0 | 424 | 5064281 | 55932 | 0.511127 | 124.6507 | 1.62046 | 35067.36 | 910459 |
| 434 | 1 | Mar | 69 | 23.35417 | 1149 | 7194.878 | 0 | 424 | 5028897 | 55882 | 0.519586 | 127.3087 | 1.655014 | 36362.96 | 946822 |
| 435 | 1 | Mar | 70 | 23.36111 | 1152 | 7218.239 | 0 | 424 | 4993381 | 55835 | 0.528087 | 125.8489 | 1.636036 | 36510.16 | 983332.1 |
| 436 | 1 | Mar | 71 | 22.85417 | 1153 | 7241.093 | 0 | 424 | 4959001 | 55772 | 0.536337 | 120.178 | 1.562314 | 35395.38 | 1018727 |
| 437 | 1 | Mar | 72 | 22.93056 | 1155 | 7264.024 | 0 | 424 | 4924332 | 55720 | 0.544667 | 119.4634 | 1.553025 | 35701.32 | 1054429 |
| 438 | 1 | Mar | 73 | 23.25 | 1157 | 7287.274 | 0 | 424 | 4888778 | 55666 | 0.553214 | 120.7126 | 1.569263 | 36599.36 | 1091028 |
| 439 | 1 | Mar | 74 | 23.75694 | 1158 | 7311.031 | 0 | 424 | 4851879 | 55605 | 0.562076 | 123.2268 | 1.601948 | 37906.38 | 1128935 |
| 440 | 1 | Mar | 75 | 24.3125 | 1201 | 7335.343 | 0 | 424 | 4813522 | 55535 | 0.571264 | 125.7414 | 1.634638 | 39250.07 | 1168185 |
| 441 | 1 | Mar | 76 | 24.5873 | 1202 | 7359.93 | 0 | 424 | 4774383 | 55473 | 0.580627 | 126.078 | 1.639014 | 39953.8 | 1208138 |
| 442 | 1 | Mar | 77 | 25.00794 | 1204 | 7384.938 | 0 | 424 | 4734100 | 55428 | 0.590228 | 127.1936 | 1.653516 | 40934.72 | 1249073 |
| 443 | 1 | Mar | 78 | 25.33333 | 1206 | 7410.272 | 0 | 424 | 4692923 | 55359 | 0.600015 | 127.5462 | 1.658101 | 41675.02 | 1290748 |
| 444 | 1 | Mar | 79 | 25.27778 | 1207 | 7435.549 | 0 | 424 | 4651760 | 55289 | 0.609821 | 125.7171 | 1.634322 | 41705.67 | 1332454 |
| 445 | 1 | Mar | 80 | 25.27778 | 1210 | 7460.827 | 0 | 424 | 4610480 | 55220 | 0.61967 | 124.2381 | 1.615096 | 41836.34 | 1374290 |
| 446 | 1 | Mar | 81 | 25.22917 | 1212 | 7486.056 | 0 | 424 | 4569188 | 55170 | 0.629541 | 122.5285 | 1.59287 | 41889.05 | 1416179 |
| 447 | 1 | Mar | 82 | 25.22222 | 1213 | 7511.279 | 0 | 424 | 4527794 | 55108 | 0.63945 | 121.0854 | 1.574111 | 42007.84 | 1458187 |
| 448 | 1 | Mar | 83 | 25.45833 | 1215 | 7536.737 | 0 | 424 | 4485711 | 55052 | 0.649505 | 120.9504 | 1.572356 | 42578.2 | 1500765 |
| 449 | 1 | Mar | 84 | 25.88889 | 1216 | 7562.626 | 0 | 424 | 4442483 | 54994 | 0.659778 | 121.6673 | 1.581674 | 43458.16 | 1544223 |
| 450 | 1 | Mar | 85 | 26.51389 | 1219 | 7589.14 | 0 | 424 | 4397687 | 54925 | 0.670322 | 122.9303 | 1.598093 | 44547.83 | 1588771 |
| 451 | 1 | Mar | 86 | 26.54861 | 1221 | 7615.688 | 0 | 424 | 4352679 | 54874 | 0.680922 | 121.6488 | 1.581435 | 44746.37 | 1633518 |
| 452 | 1 | Mar | 87 | 27.11806 | 1222 | 7642.806 | 0 | 423 | 4306294 | 54821 | 0.691734 | 122.1381 | 1.587795 | 45592.74 | 1679110 |
| 453 | 1 | Mar | 88 | 28.125 | 1224 | 7670.931 | 0 | 423 | 4257595 | 54765 | 0.702827 | 123.357 | 1.60364 | 46731.08 | 1725841 |
| 454 | 1 | Mar | 89 | 27.04861 | 1227 | 7697.98 | 0 | 423 | 4211072 | 54705 | 0.71372 | 119.2231 | 1.549901 | 45839.08 | 1771681 |
| 455 | 1 | Mar | 90 | 27.15278 | 1228 | 7725.133 | 0 | 422 | 4164247 | 54654 | 0.724674 | 118.0584 | 1.534759 | 46051.81 | 1817732 |
| 456 | 1 | Apr | 91 | 27.125 | 1230 | 27.125 | 0 | 422 | 4083921 | 54590 | 0.735679 | 116.8199 | 1.518658 | 46213.88 | 1863946 |
| 457 | 1 | Apr | 92 | 27.27778 | 1231 | 54.40278 | 0 | 422 | 4003915 | 54533 | 0.746772 | 115.9801 | 1.507741 | 46529.82 | 1910476 |
| 458 | 1 | Apr | 93 | 27.76389 | 1233 | 82.16667 | 0 | 422 | 3923715 | 54469 | 0.758026 | 115.9286 | 1.507071 | 47154.97 | 1957631 |
| 459 | 1 | Apr | 94 | 27.34722 | 1236 | 109.5139 | 0 | 422 | 3844692 | 54393 | 0.769226 | 113.6608 | 1.477591 | 46863.82 | 2004495 |
| 460 | 1 | Apr | 95 | 27.20833 | 1237 | 136.7222 | 0 | 422 | 3766388 | 54343 | 0.780434 | 112.0757 | 1.456984 | 46849.95 | 2051345 |
| 461 | 1 | Apr | 96 | 27.25694 | 1239 | 163.9792 | 0 | 422 | 3688537 | 54282 | 0.791699 | 111.0305 | 1.443397 | 47036.43 | 2098381 |
| 462 | 1 | Apr | 97 | 27.72222 | 1240 | 191.7014 | 0 | 422 | 3610501 | 54223 | 0.803123 | 110.9991 | 1.442989 | 47650 | 2146031 |
| 463 | 1 | Apr | 98 | 28.40278 | 1242 | 220.1042 | 0 | 422 | 3531856 | 54172 | 0.814717 | 111.0472 | 1.443614 | 48313.04 | 2194344 |
| 464 | 1 | Apr | 99 | 28.85417 | 1244 | 248.9583 | 0 | 422 | 3452944 | 54115 | 0.826409 | 110.3927 | 1.435105 | 48670.37 | 2243015 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 465 | 1 | Apr | 100 | 27.91667 | 1246 | 276.875 | 0 | 422 | 3376154 | 54055 | 0.838008 | 107.9641 | 1.403533 | 48229.2 | 2291244 |
| 466 | 1 | Apr | 101 | 27.81944 | 1248 | 304.6944 | 0 | 422 | 3300027 | 54000 | 0.84963 | 106.6842 | 1.386894 | 48277.15 | 2339521 |
| 467 | 1 | Apr | 102 | 28.11111 | 1250 | 332.8056 | 0 | 422 | 3223940 | 53938 | 0.861354 | 106.1423 | 1.37985 | 48642.17 | 2388163 |
| 468 | 1 | Apr | 103 | 28.5 | 1251 | 361.3056 | 0 | 422 | 3147718 | 53881 | 0.873183 | 105.6382 | 1.373296 | 49027.3 | 2437190 |
| 469 | 1 | Apr | 104 | 28.75694 | 1253 | 390.0625 | 0 | 422 | 3071583 | 53816 | 0.885086 | 104.863 | 1.363219 | 49276.37 | 2486467 |
| 470 | 1 | Apr | 105 | 28.75 | 1254 | 418.8125 | 0 | 422 | 2995978 | 53757 | 0.897032 | 103.8253 | 1.349729 | 49399.62 | 2535866 |
| 471 | 1 | Apr | 106 | 28.96296 | 1256 | 447.7755 | 0 | 422 | 2920521 | 53711 | 0.909041 | 102.9818 | 1.338764 | 49617.14 | 2585484 |
| 472 | 1 | Apr | 107 | 29.01389 | 1259 | 476.7894 | 0 | 422 | 2845512 | 53638 | 0.921097 | 102.0193 | 1.326251 | 49743.72 | 2635227 |
| 473 | 1 | Apr | 108 | 29.26389 | 1300 | 506.0532 | 0 | 421 | 2770664 | 53589 | 0.933196 | 101.0348 | 1.313452 | 49871.46 | 2685099 |
| 474 | 1 | Apr | 109 | 29.81944 | 1302 | 535.8727 | 0 | 421 | 2717271 | 53535 | 0.945352 | 100.2061 | 1.30268 | 50061.6 | 2735160 |
| 475 | 1 | Apr | 110 | 30.01389 | 1304 | 565.8866 | 0 | 421 | 2663580 | 53464 | 0.957542 | 99.18351 | 1.289386 | 50129.63 | 2785290 |
| 476 | 1 | Apr | 111 | 29.02778 | 1305 | 594.9144 | 0 | 421 | 2611175 | 53409 | 0.969769 | 98.22876 | 1.276974 | 50235.49 | 2835525 |
| 477 | 1 | Apr | 112 | 28.89583 | 1307 | 623.8102 | 0 | 421 | 2558890 | 53354 | 0.982028 | 97.23941 | 1.264112 | 50312.68 | 2885838 |
| 478 | 1 | Apr | 113 | 28.92361 | 1309 | 652.7338 | 0 | 421 | 2506478 | 53301 | 0.994331 | 96.37074 | 1.25282 | 50443.39 | 2936282 |
| 479 | 1 | Apr | 114 | 29.13889 | 1310 | 681.8727 | 0 | 421 | 2453680 | 53237 | 1.006691 | 95.61742 | 1.243026 | 50615.26 | 2986897 |
| 480 | 1 | Apr | 115 | 29.24306 | 1312 | 711.1157 | 0 | 421 | 2400660 | 53184 | 1.019097 | 94.79871 | 1.232383 | 50755.07 | 3037652 |
| 481 | 1 | Apr | 116 | 29.61806 | 1313 | 740.7338 | 0 | 421 | 2347087 | 53126 | 1.031551 | 94.00301 | 1.222039 | 50893.74 | 3088546 |
| 482 | 1 | Apr | 117 | 29.75556 | 1315 | 770.4894 | 0 | 420 | 2293309 | 53067 | 1.044039 | 93.12415 | 1.210614 | 50977.36 | 3139523 |
| 483 | 1 | Apr | 118 | 30.76389 | 1317 | 801.2532 | 0 | 419 | 2238555 | 53012 | 1.056455 | 91.47711 | 1.189202 | 50629.45 | 3190152 |
| 484 | 1 | Apr | 119 | 31 | 1318 | 832.2532 | 0 | 419 | 2183567 | 52953 | 1.068876 | 90.44586 | 1.175796 | 50597.6 | 3240750 |
| 485 | 1 | Apr | 120 | 30.375 | 1320 | 862.6282 | 0 | 419 | 2129023 | 52895 | 1.081443 | 90.43571 | 1.175664 | 51130.72 | 3291881 |
| 486 | 1 | May | 121 | 29.60417 | 1321 | 892.2324 | 0 | 419 | 2075199 | 52837 | 1.094098 | 90.01619 | 1.17021 | 51435.4 | 3343316 |
| 487 | 1 | May | 122 | 29.33333 | 1322 | 921.5657 | 0 | 419 | 2031675 | 52770 | 1.106782 | 89.17896 | 1.159327 | 51487.94 | 3394804 |
| 488 | 1 | May | 123 | 30.08333 | 1324 | 951.6491 | 0 | 418 | 1987393 | 52717 | 1.119467 | 88.16497 | 1.146145 | 51440.9 | 3446245 |
| 489 | 1 | May | 124 | 30.84722 | 1326 | 982.4963 | 0 | 417 | 1932606 | 52665 | 1.132066 | 86.57157 | 1.12543 | 51040.08 | 3497285 |
| 490 | 1 | May | 125 | 30.25694 | 1327 | 1012.753 | 0 | 415 | 1878114 | 52609 | 1.144811 | 86.59668 | 1.125757 | 51574.2 | 3548859 |
| 491 | 1 | May | 126 | 29.17361 | 1329 | 1041.927 | 0 | 411 | 1824736 | 52554 | 1.157594 | 85.89381 | 1.11662 | 51677.36 | 3600537 |
| 492 | 1 | May | 127 | 29.12698 | 1331 | 1071.054 | 0 | 410 | 1771118 | 52509 | 1.170469 | 85.55852 | 1.112261 | 52005.87 | 3652542 |
| 493 | 1 | May | 128 | 29.41667 | 1331 | 1100.471 | 0 | 405 | 1717446 | 52449 | 1.183317 | 84.44099 | 1.097733 | 51838.1 | 3704381 |
| 494 | 1 | May | 129 | 30.77778 | 1333 | 1131.248 | 0 | 401 | 1662635 | 52398 | 1.196122 | 83.23661 | 1.082076 | 51609.51 | 3755990 |
| 495 | 1 | May | 130 | 30.61111 | 1335 | 1161.859 | 0 | 395 | 1608331 | 52340 | 1.208885 | 82.07438 | 1.066967 | 51382.77 | 3807373 |
| 496 | 1 | May | 131 | 29.84722 | 1336 | 1191.707 | 0 | 387 | 1554573 | 52276 | 1.221739 | 81.79869 | 1.063383 | 51693.95 | 3859067 |
| 497 | 1 | May | 132 | 29.80556 | 1337 | 1221.512 | 0 | 380 | 1500951 | 52233 | 1.234597 | 80.94984 | 1.052348 | 51658.93 | 3910726 |
| 498 | 1 | May | 133 | 29.44444 | 1339 | 1250.957 | 0 | 372 | 1447329 | 52175 | 1.24756 | 80.77273 | 1.050046 | 52030.53 | 3962756 |
| 499 | 1 | May | 134 | 30.02083 | 1340 | 1280.977 | 0 | 367 | 1393113 | 52122 | 1.260578 | 80.26767 | 1.04348 | 52194.51 | 4014951 |
| 500 | 1 | May | 135 | 30.67361 | 1341 | 1311.651 | 0 | 358 | 1338860 | 52066 | 1.273491 | 78.78851 | 1.024251 | 51711.51 | 4066662 |
| 501 | 1 | May | 136 | 30.24306 | 1343 | 1341.894 | 0 | 349 | 1304866 | 52013 | 1.28647 | 78.39418 | 1.019124 | 51926.52 | 4118589 |
| 502 | 1 | May | 137 | 30.125 | 1343 | 1372.019 | 0 | 347 | 1250215 | 51941 | 1.299668 | 78.91734 | 1.025925 | 52732.29 | 4171321 |
| 503 | 1 | May | 138 | 30.19444 | 1345 | 1402.214 | 0 | 341 | 1195830 | 51890 | 1.312818 | 77.82546 | 1.011731 | 52485.73 | 4223807 |
| 504 | 1 | May | 139 | 30.95833 | 1346 | 1433.172 | 0 | 330 | 1141660 | 51836 | 1.325791 | 76.01023 | 0.988133 | 51725.92 | 4275533 |
| 505 | 1 | May | 140 | 31.07639 | 1347 | 1464.248 | 0 | 321 | 1087474 | 51770 | 1.338785 | 75.39368 | 0.980118 | 51746.4 | 4327279 |
| 506 | 1 | May | 141 | 30.5 | 1349 | 1494.748 | 0 | 314 | 1043373 | 51710 | 1.351912 | 75.42524 | 0.980528 | 52215.96 | 4379495 |
| 507 | 1 | May | 142 | 30.00694 | 1349 | 1524.755 | 0 | 306 | 989586.5 | 51656 | 1.365076 | 74.90511 | 0.973766 | 52311.46 | 4431807 |
| 508 | 1 | May | 143 | 30.10417 | 1350 | 1554.859 | 0 | 291 | 936557 | 51599 | 1.378068 | 73.20903 | 0.951717 | 51566.21 | 4483373 |
| 509 | 1 | May | 144 | 30.52083 | 1352 | 1585.38 | 0 | 279 | 883027 | 51540 | 1.391154 | 73.0492 | 0.94964 | 51882.23 | 4535255 |
| 510 | 1 | May | 145 | 29.84028 | 1352 | 1615.221 | 0 | 268 | 829696.3 | 51476 | 1.404328 | 72.8449 | 0.946984 | 52164.85 | 4587420 |
| 511 | 1 | May | 146 | 29.95833 | 1354 | 1645.179 | 0 | 257 | 776452.2 | 51420 | 1.417497 | 72.13001 | 0.93769 | 52084.73 | 4639505 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 512 | 1 | May | 147 | 29.98611 | 1354 | 1675.165 | 0 | 246 | 724763.8 | 51374 | 1.430297 | 69.4536 | 0.902897 | 50586.85 | 4690091 |
| 513 | 1 | May | 148 | 30.125 | 1355 | 1705.29 | 0 | 237 | 682182.8 | 51312 | 1.443343 | 70.14909 | 0.911938 | 51484.69 | 4741576 |
| 514 | 1 | May | 149 | 30.02778 | 1356 | 1735.318 | 0 | 225 | 651136.3 | 51259 | 1.45604 | 67.64081 | 0.879331 | 50057.05 | 4791633 |
| 515 | 1 | May | 150 | 29.84028 | 1357 | 1765.158 | 0 | 214 | 619929.5 | 51201 | 1.468823 | 67.51766 | 0.87773 | 50341.4 | 4841975 |
| 516 | 1 | May | 151 | 30.375 | 1358 | 1795.533 | 0 | 200 | 588681.2 | 51150 | 1.481584 | 66.81752 | 0.868628 | 50211.3 | 4892186 |
| 517 | 1 | Jun | 152 | 30.58333 | 1358 | 1826.116 | 0 | 188 | 547788.2 | 51084 | 1.494262 | 65.82711 | 0.855752 | 49827.83 | 4942014 |
| 518 | 1 | Jun | 153 | 30.30556 | 1400 | 1856.422 | 0 | 175 | 529176.7 | 51033 | 1.506421 | 62.57525 | 0.813478 | 47725.1 | 4989739 |
| 519 | 1 | Jun | 154 | 29.47917 | 1400 | 1885.901 | 0 | 163 | 530260.4 | 50978 | 1.518752 | 62.91146 | 0.817849 | 48333.08 | 5038072 |
| 520 | 1 | Jun | 155 | 29.30952 | 1401 | 1915.211 | 0 | 155 | 509394 | 50923 | 1.531601 | 65.0883 | 0.846148 | 50336.71 | 5088409 |
| 521 | 1 | Jun | 156 | 29.51389 | 1401 | 1944.724 | 0 | 147 | 468458.9 | 50868 | 1.544479 | 64.65325 | 0.840492 | 50370.97 | 5138780 |
| 522 | 1 | Jun | 157 | 29.73611 | 1402 | 1974.461 | 0 | 131 | 441356.7 | 50816 | 1.556382 | 59.26674 | 0.770468 | 46524.9 | 5185304 |
| 523 | 1 | Jun | 158 | 29.69444 | 1402 | 2004.155 | 0 | 122 | 422087.3 | 50752 | 1.568865 | 61.69295 | 0.802008 | 48739.06 | 5234044 |
| 524 | 1 | Jun | 159 | 30.35417 | 1404 | 2034.509 | 0 | 114 | 445573.7 | 50711 | 1.580616 | 57.58987 | 0.748668 | 45845.13 | 5279889 |
| 525 | 1 | Jun | 160 | 29.3125 | 1404 | 2063.822 | 0 | 102 | 437367 | 50662 | 1.592873 | 59.65557 | 0.775522 | 47772.22 | 5327661 |
| 526 | 1 | Jun | 161 | 28.96825 | 1404 | 2092.79 | 0 | 93 | 439638.4 | 50603 | 1.605044 | 58.76196 | 0.763906 | 47377.83 | 5375039 |
| 527 | 1 | Jun | 162 | 28.72917 | 1405 | 2121.519 | 0 | 94 | 488275.5 | 50535 | 1.618177 | 62.96608 | 0.818559 | 51059.27 | 5426098 |
| 528 | 1 | Jun | 163 | 28.64583 | 1405 | 2150.165 | 0 | 87 | 461329.9 | 50483 | 1.630184 | 57.09813 | 0.742276 | 46627.58 | 5472726 |
| 529 | 1 | Jun | 164 | 29.00694 | 1406 | 2179.172 | 0 | 75 | 427837.3 | 50428 | 1.641298 | 52.4637 | 0.682028 | 43120.37 | 5515846 |
| 530 | 1 | Jun | 165 | 29.03472 | 1405 | 2208.207 | 0 | 70 | 445295.4 | 50372 | 1.651573 | 48.16601 | 0.626158 | 39800.68 | 5555647 |
| 531 | 1 | Jun | 166 | 28.82639 | 1405 | 2237.033 | 0 | 63 | 404462.2 | 50314 | 1.664621 | 60.80713 | 0.790493 | 50509.8 | 5606156 |
| 532 | 1 | Jun | 167 | 28.84722 | 1406 | 2265.88 | 0 | 58 | 386430.5 | 50256 | 1.676968 | 57.09932 | 0.742291 | 47733.49 | 5653890 |
| 533 | 1 | Jun | 168 | 29.07143 | 1406 | 2294.952 | 0 | 52 | 401531.5 | 50204 | 1.688511 | 52.96642 | 0.688563 | 44574.98 | 5698465 |
| 534 | 1 | Jun | 169 | 29.59722 | 1406 | 2324.549 | 0 | 59 | 457724.5 | 50159 | 1.702343 | 63.01404 | 0.819182 | 53371.27 | 5751836 |
| 535 | 1 | Jun | 170 | 30.36806 | 1406 | 2354.917 | 0 | 62 | 452734.8 | 50096 | 1.716431 | 63.69332 | 0.828013 | 54306.89 | 5806143 |
| 536 | 1 | Jun | 171 | 30.93056 | 1407 | 2385.847 | 0 | 64 | 485193.3 | 50035 | 1.728562 | 54.42056 | 0.707467 | 46708.83 | 5852852 |
| 537 | 1 | Jun | 172 | 31.43651 | 1406 | 2417.284 | 0 | 67 | 529247.8 | 49985 | 1.737516 | 39.84052 | 0.517927 | 34414.06 | 5887266 |
| 538 | 1 | Jun | 173 | 30.13194 | 1406 | 2447.416 | 0 | 71 | 534343 | 49931 | 1.751624 | 62.46779 | 0.812081 | 54185.94 | 5941452 |
| 539 | 1 | Jun | 174 | 29.7037 | 1406 | 2477.12 | 0 | 74 | 540177.1 | 49851 | 1.765594 | 61.34047 | 0.797426 | 53557.48 | 5995009 |
| 540 | 1 | Jun | 175 | 28.72222 | 1406 | 2505.842 | 0 | 78 | 550065.9 | 49800 | 1.778589 | 56.58481 | 0.735603 | 49743.05 | 6044752 |
| 541 | 1 | Jun | 176 | 28.94444 | 1405 | 2534.786 | 0 | 78 | 523850.4 | 49746 | 1.790501 | 51.5473 | 0.670115 | 45597.54 | 6090350 |
| 542 | 1 | Jun | 177 | 28.96528 | 1406 | 2563.752 | 0 | 78 | 534216.4 | 49698 | 1.803375 | 55.33328 | 0.719333 | 49221.43 | 6139571 |
| 543 | 1 | Jun | 178 | 29.59028 | 1406 | 2593.342 | 0 | 76 | 513034.5 | 49634 | 1.816621 | 56.5492 | 0.73514 | 50604.66 | 6190176 |
| 544 | 1 | Jun | 179 | 30.22222 | 1405 | 2623.564 | 0 | 75 | 529907.1 | 49578 | 1.827654 | 46.73544 | 0.607561 | 42078.02 | 6232254 |
| 545 | 1 | Jun | 180 | 30.13889 | 1405 | 2653.703 | 0 | 76 | 552525.7 | 49528 | 1.839899 | 51.55055 | 0.670157 | 46657.98 | 6278912 |
| 546 | 1 | Jun | 181 | 30.61905 | 1405 | 2684.322 | 0 | 77 | 553473 | 49481 | 1.852547 | 52.89609 | 0.687649 | 48149.09 | 6327061 |
| 547 | 1 | Jul | 182 | 31.15741 | 1404 | 2715.479 | 0 | 77 | 586467.4 | 49429 | 1.862205 | 40.06205 | 0.520807 | 36692.09 | 6363753 |
| 548 | 1 | Jul | 183 | 30.64583 | 1404 | 2746.125 | 0 | 82 | 615052.8 | 49365 | 1.875488 | 54.86 | 0.71318 | 50445.64 | 6414199 |
| 549 | 1 | Jul | 184 | 31.4375 | 1404 | 2777.563 | 0 | 79 | 571264.1 | 49314 | 1.889321 | 56.73849 | 0.7376 | 52460.91 | 6466660 |
| 550 | 1 | Jul | 185 | 31.77778 | 1403 | 2809.341 | 0 | 83 | 590497.7 | 49265 | 1.900119 | 43.97839 | 0.571719 | 40925.81 | 6507586 |
| 551 | 1 | Jul | 186 | 30.99306 | 1402 | 2840.334 | 0 | 85 | 612835.7 | 49220 | 1.910183 | 40.71008 | 0.529231 | 38091.99 | 6545678 |
| 552 | 1 | Jul | 187 | 30.05556 | 1401 | 2870.389 | 0 | 88 | 618187.1 | 49168 | 1.922165 | 48.27027 | 0.627514 | 45326.63 | 6591004 |
| 553 | 1 | Jul | 188 | 29.21429 | 1401 | 2899.603 | 0 | 93 | 611808.7 | 49127 | 1.936934 | 59.12467 | 0.768621 | 55821.95 | 6646826 |
| 554 | 1 | Jul | 189 | 28.70833 | 1400 | 2928.312 | 0 | 94 | 608021.9 | 49069 | 1.948637 | 46.45974 | 0.603977 | 44190.26 | 6691016 |
| 555 | 1 | Jul | 190 | 28.88889 | 1400 | 2957.201 | 0 | 90 | 596790.6 | 49021 | 1.962107 | 53.17736 | 0.691306 | 50774.71 | 6741791 |
| 556 | 1 | Jul | 191 | 28.98611 | 1359 | 2986.187 | 0 | 80 | 564417.3 | 48974 | 1.973361 | 44.16508 | 0.574146 | 42416.15 | 6784207 |
| 557 | 1 | Jul | 192 | 28.70833 | 1358 | 3014.895 | 0 | 75 | 543875.8 | 48926 | 1.983973 | 41.32659 | 0.537246 | 39937.2 | 6824144 |
| 558 | 1 | Jul | 193 | 29.11806 | 1357 | 3044.013 | 0 | 72 | 531056.7 | 48877 | 1.995122 | 43.25112 | 0.562265 | 41922.67 | 6866067 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 559 | 1 | Jul | 194 | 29.28472 | 1357 | 3073.298 | 0 | 71 | 509801.3 | 48830 | 2.008646 | 52.12228 | 0.67759 | 50763.6 | 6916831 |
| 560 | 1 | Jul | 195 | 29.74297 | 1355 | 3103.041 | 0 | 70 | 495846.9 | 48791 | 2.020015 | 43.55252 | 0.566183 | 42669.11 | 6959500 |
| 561 | 1 | Jul | 196 | 29.17361 | 1355 | 3132.214 | 0 | 72 | 495740.8 | 48745 | 2.03327 | 50.45252 | 0.655883 | 49669.79 | 7009170 |
| 562 | 1 | Jul | 197 | 30.26389 | 1354 | 3162.478 | 0 | 66 | 462470.3 | 48692 | 2.044445 | 42.28995 | 0.549769 | 41850.23 | 7051020 |
| 563 | 1 | Jul | 198 | 30.39583 | 1353 | 3192.874 | 0 | 65 | 462772.8 | 48642 | 2.054538 | 37.98291 | 0.493778 | 37752.39 | 7088772 |
| 564 | 1 | Jul | 199 | 30.07639 | 1352 | 3222.951 | 0 | 68 | 486245.4 | 48597 | 2.066457 | 44.65036 | 0.580455 | 44568.25 | 7133341 |
| 565 | 1 | Jul | 200 | 29.25694 | 1350 | 3252.208 | 0 | 68 | 490213.6 | 48546 | 2.078327 | 44.22413 | 0.574914 | 44352.38 | 7177693 |
| 566 | 1 | Jul | 201 | 28.19444 | 1350 | 3280.402 | 0 | 69 | 479542.5 | 48499 | 2.091847 | 50.05018 | 0.650652 | 50439.6 | 7228132 |
| 567 | 1 | Jul | 202 | 27.81944 | 1348 | 3308.221 | 0 | 70 | 490998.2 | 48448 | 2.104349 | 45.97255 | 0.597643 | 46575.53 | 7274708 |
| 568 | 1 | Jul | 203 | 27.78472 | 1348 | 3336.006 | 0 | 69 | 466986.7 | 48385 | 2.118823 | 52.90289 | 0.687738 | 53853.21 | 7328561 |
| 569 | 1 | Jul | 204 | 28 | 1346 | 3364.006 | 0 | 69 | 459952.5 | 48341 | 2.130904 | 43.87704 | 0.570401 | 44935.78 | 7373497 |
| 570 | 1 | Jul | 205 | 28.59722 | 1345 | 3392.603 | 0 | 71 | 484637.8 | 48289 | 2.142526 | 41.9685 | 0.54559 | 43183.02 | 7416680 |
| 571 | 1 | Jul | 206 | 28.74306 | 1344 | 3421.346 | 0 | 69 | 467925.7 | 48241 | 2.15464 | 43.47767 | 0.56521 | 44933.05 | 7461613 |
| 572 | 1 | Jul | 207 | 28.40278 | 1343 | 3449.749 | 0 | 67 | 455467.8 | 48188 | 2.165508 | 38.78375 | 0.504189 | 40276.51 | 7501890 |
| 573 | 1 | Jul | 208 | 27.25694 | 1342 | 3477.006 | 0 | 63 | 449696.9 | 48149 | 2.177136 | 41.3265 | 0.537244 | 43090.27 | 7544980 |
| 574 | 1 | Jul | 209 | 27.83333 | 1340 | 3504.839 | 0 | 62 | 429583 | 48092 | 2.189963 | 45.31523 | 0.589098 | 47433.48 | 7592413 |
| 575 | 1 | Jul | 210 | 27.96528 | 1339 | 3532.805 | 0 | 62 | 407817.7 | 48055 | 2.203184 | 46.4242 | 0.603515 | 48846.4 | 7641260 |
| 576 | 1 | Jul | 211 | 26.50694 | 1338 | 3559.312 | 0 | 53 | 393036.3 | 48001 | 2.214329 | 38.94982 | 0.506348 | 41173.21 | 7682433 |
| 577 | 1 | Jul | 212 | 25.92361 | 1336 | 3585.235 | 0 | 55 | 402241.8 | 47940 | 2.227026 | 44.10838 | 0.573409 | 46807.69 | 7729241 |
| 578 | 1 | Aug | 213 | 25.59722 | 1336 | 3610.833 | 0 | 56 | 383166.9 | 47888 | 2.240373 | 46.11609 | 0.599509 | 49170.39 | 7778411 |
| 579 | 1 | Aug | 214 | 24.79861 | 1334 | 3635.631 | 0 | 58 | 395151.9 | 47841 | 2.252254 | 40.79056 | 0.530277 | 43718.66 | 7822130 |
| 580 | 1 | Aug | 215 | 24.57639 | 1332 | 3660.208 | 0 | 55 | 354913.2 | 47784 | 2.264778 | 42.77667 | 0.556097 | 46025.69 | 7868155 |
| 581 | 1 | Aug | 216 | 24.34028 | 1331 | 3684.548 | 0 | 52 | 335125.9 | 47736 | 2.277018 | 41.60202 | 0.540826 | 44960.64 | 7913116 |
| 582 | 1 | Aug | 217 | 24.55556 | 1329 | 3709.103 | 0 | 48 | 319609.5 | 47689 | 2.288045 | 37.26571 | 0.484454 | 40450.88 | 7953567 |
| 583 | 1 | Aug | 218 | 24.6875 | 1329 | 3733.791 | 0 | 52 | 341420.6 | 47637 | 2.301237 | 44.33523 | 0.576358 | 48313.36 | 8001880 |
| 584 | 1 | Aug | 219 | 24.65972 | 1327 | 3758.451 | 0 | 52 | 318802.8 | 47585 | 2.314256 | 43.52222 | 0.565789 | 47649.11 | 8049529 |
| 585 | 1 | Aug | 220 | 24.53472 | 1325 | 3782.985 | 0 | 46 | 316089.3 | 47530 | 2.324472 | 33.98136 | 0.441758 | 37363.05 | 8086892 |
| 586 | 1 | Aug | 221 | 24.75 | 1324 | 3807.735 | 0 | 45 | 307089.3 | 47476 | 2.336418 | 39.55822 | 0.514257 | 43642.88 | 8130535 |
| 587 | 1 | Aug | 222 | 24.68056 | 1322 | 3832.416 | 0 | 45 | 304006.2 | 47430 | 2.349466 | 42.97578 | 0.558685 | 47610.41 | 8178146 |
| 588 | 1 | Aug | 223 | 23.52778 | 1321 | 3855.944 | 0 | 41 | 276460.7 | 47371 | 2.360911 | 37.50314 | 0.487541 | 41730.48 | 8219876 |
| 589 | 1 | Aug | 224 | 22.85417 | 1319 | 3878.798 | 0 | 42 | 277311.2 | 47329 | 2.372678 | 38.34278 | 0.498456 | 42837.77 | 8262714 |
| 590 | 1 | Aug | 225 | 22.375 | 1317 | 3901.173 | 0 | 40 | 256379.2 | 47278 | 2.384915 | 39.67067 | 0.515719 | 44487.89 | 8307202 |
| 591 | 1 | Aug | 226 | 22.51389 | 1316 | 3923.687 | 0 | 37 | 240875.5 | 47236 | 2.395608 | 34.48188 | 0.448264 | 38830.67 | 8346033 |
| 592 | 1 | Aug | 227 | 22.03472 | 1314 | 3945.721 | 0 | 32 | 210166.3 | 47187 | 2.407649 | 38.68673 | 0.502928 | 43723.19 | 8389756 |
| 593 | 1 | Aug | 228 | 21.27083 | 1313 | 3966.992 | 0 | 32 | 191675.1 | 47146 | 2.418964 | 36.14243 | 0.469852 | 41013.61 | 8430769 |
| 594 | 1 | Aug | 229 | 21.3125 | 1311 | 3988.305 | 0 | 32 | 181960.2 | 47075 | 2.430592 | 36.98077 | 0.48075 | 42100.97 | 8472870 |
| 595 | 1 | Aug | 230 | 22.03472 | 1309 | 4010.339 | 0 | 31 | 148351.2 | 47023 | 2.443309 | 40.27814 | 0.523616 | 46026.1 | 8518896 |
| 596 | 1 | Aug | 231 | 22.72917 | 1308 | 4033.069 | 0 | 24 | 136997.4 | 46974 | 2.452562 | 29.15555 | 0.379022 | 33458.27 | 8552355 |
| 597 | 1 | Aug | 232 | 22.86806 | 1306 | 4055.937 | 0 | 22 | 117287.6 | 46908 | 2.464105 | 36.20035 | 0.470605 | 41631.59 | 8593986 |
| 598 | 1 | Aug | 233 | 22.11806 | 1305 | 4078.055 | 0 | 18 | 99707.77 | 46852 | 2.474959 | 33.91368 | 0.440878 | 39140.36 | 8633127 |
| 599 | 1 | Aug | 234 | 20.75 | 1303 | 4098.805 | 0 | 14 | 88728.83 | 46805 | 2.483901 | 27.78248 | 0.361172 | 32182.38 | 8665309 |
| 600 | 1 | Aug | 235 | 20.36111 | 1301 | 4119.166 | 0 | 14 | 83046.14 | 46758 | 2.494114 | 31.60852 | 0.410911 | 36706.06 | 8702015 |
| 601 | 1 | Aug | 236 | 20.65278 | 1300 | 4139.819 | 0 | 12 | 55574.58 | 46705 | 2.504822 | 33.03657 | 0.429475 | 38471.09 | 8740486 |
| 602 | 1 | Aug | 237 | 22.61806 | 1258 | 4162.437 | 0 | 10 | 45301.11 | 46657 | 2.513498 | 26.64148 | 0.346339 | 31121.72 | 8771608 |
| 603 | 1 | Aug | 238 | 21.125 | 1256 | 4183.562 | 0 | 8 | 46957.57 | 46616 | 2.521572 | 24.73416 | 0.321544 | 28966.29 | 8800574 |
| 604 | 1 | Aug | 239 | 20.5625 | 1254 | 4204.124 | 0 | 6 | 26470.44 | 46556 | 2.530258 | 26.48123 | 0.344256 | 31078.24 | 8831652 |
| 605 | 1 | Aug | 240 | 20.54167 | 1253 | 4224.666 | 0 | 7 | 57418.11 | 46503 | 2.538487 | 25.03269 | 0.325425 | 29443.67 | 8861096 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 606 | 1 | Aug | 241 | 20.70833 | 1251 | 4245.374 | 0 | 11 | 67699.02 | 46453 | 2.549781 | 34.24565 | 0.445194 | 40373.45 | 8901470 |
| 607 | 1 | Aug | 242 | 20.44444 | 1249 | 4265.819 | 0 | 9 | 77359.27 | 46402 | 2.558503 | 26.332 | 0.342316 | 31145.44 | 8932615 |
| 608 | 1 | Aug | 243 | 19.45139 | 1248 | 4285.27 | 0 | 13 | 77866.87 | 46350 | 2.569791 | 33.94206 | 0.441247 | 40242.2 | 8972857 |
| 609 | 1 | Sep | 244 | 19.1875 | 1245 | 4304.458 | 0 | 15 | 95308.97 | 46289 | 2.576355 | 19.63832 | 0.255298 | 23357.22 | 8996214 |
| 610 | 1 | Sep | 245 | 19.40972 | 1244 | 4323.867 | 0 | 12 | 75748.89 | 46250 | 2.584932 | 25.62124 | 0.333076 | 30513.89 | 9026728 |
| 611 | 1 | Sep | 246 | 19.27083 | 1242 | 4343.138 | 0 | 13 | 89991.11 | 46198 | 2.592394 | 22.21863 | 0.288842 | 26513.73 | 9053242 |
| 612 | 1 | Sep | 247 | 18.95833 | 1241 | 4362.096 | 0 | 13 | 52158.47 | 46159 | 2.603318 | 32.3672 | 0.420774 | 38723.32 | 9091965 |
| 613 | 1 | Sep | 248 | 18.88194 | 1239 | 4380.978 | 0 | 11 | 85226.26 | 46113 | 2.611073 | 22.9308 | 0.2981 | 27521.41 | 9119487 |
| 614 | 1 | Sep | 249 | 19.06944 | 1237 | 4400.048 | 0 | 15 | 98228.06 | 46064 | 2.621748 | 31.44248 | 0.408752 | 37808.54 | 9157295 |
| 615 | 1 | Sep | 250 | 18.96528 | 1235 | 4419.013 | 0 | 14 | 89656.86 | 46020 | 2.630096 | 24.4738 | 0.318159 | 29523.55 | 9186819 |
| 616 | 1 | Sep | 251 | 19.14583 | 1234 | 4438.159 | 0 | 14 | 91096.94 | 45972 | 2.638418 | 24.3567 | 0.316637 | 29438.23 | 9216257 |
| 617 | 1 | Sep | 252 | 19.125 | 1232 | 4457.284 | 0 | 13 | 88800.6 | 45921 | 2.647819 | 27.41426 | 0.356385 | 33203.79 | 9249461 |
| 618 | 1 | Sep | 253 | 18.875 | 1229 | 4476.159 | 0 | 16 | 81221.66 | 45882 | 2.658704 | 31.65586 | 0.411526 | 38449.43 | 9287910 |
| 619 | 1 | Sep | 254 | 18.81313 | 1228 | 4494.972 | 0 | 10 | 67504.66 | 45842 | 2.665668 | 20.12966 | 0.261686 | 24526.01 | 9312436 |
| 620 | 1 | Sep | 255 | 18.43056 | 1226 | 4513.403 | 0 | 11 | 54298.08 | 45796 | 2.675286 | 27.72541 | 0.36043 | 33839.22 | 9346275 |
| 621 | 1 | Sep | 256 | 18.375 | 1225 | 4531.778 | 0 | 10 | 53904.29 | 45747 | 2.681227 | 17.10326 | 0.222342 | 20919.64 | 9367195 |
| 622 | 1 | Sep | 257 | 18.52778 | 1222 | 4550.305 | 0 | 9 | 37244.25 | 45700 | 2.688958 | 22.20505 | 0.288666 | 27194.23 | 9394389 |
| 623 | 1 | Sep | 258 | 19.34722 | 1221 | 4569.653 | 0 | 6 | 29864.82 | 45661 | 2.694043 | 14.52357 | 0.188806 | 17825.76 | 9412215 |
| 624 | 1 | Sep | 259 | 18.24306 | 1219 | 4587.896 | 0 | 5 | 31735.14 | 45624 | 2.702142 | 23.16179 | 0.301103 | 28459.24 | 9440674 |
| 625 | 1 | Sep | 260 | 18.35417 | 1218 | 4606.25 | 0 | 6 | 34854.92 | 45566 | 2.709905 | 22.09947 | 0.287293 | 27204.26 | 9467879 |
| 626 | 1 | Sep | 261 | 17.85417 | 1215 | 4624.104 | 0 | 4 | 21839.83 | 45517 | 2.716571 | 18.93614 | 0.24617 | 23350.94 | 9491230 |
| 627 | 1 | Sep | 262 | 17.41667 | 1213 | 4641.521 | 0 | 1 | -4878.62 | 45474 | 2.724277 | 21.81674 | 0.283618 | 26945.02 | 9518175 |
| 628 | 1 | Sep | 263 | 17.15278 | 1212 | 4658.673 | 0 | 2 | 11180.65 | 45422 | 2.725424 | 3.212475 | 0.041762 | 3975.068 | 9522150 |
| 629 | 1 | Sep | 264 | 17.28472 | 1210 | 4675.958 | 0 | 5 | 41180.65 | 45370 | 2.731182 | 16.2834 | 0.211684 | 20127.6 | 9542277 |
| 630 | 1 | Sep | 265 | 17.72222 | 1208 | 4693.68 | 0 | 8 | 37091.87 | 45325 | 2.741057 | 27.81861 | 0.361642 | 34429.2 | 9576706 |
| 631 | 1 | Sep | 266 | 17.15972 | 1206 | 4710.84 | 0 | 4 | 31368.38 | 45289 | 2.745666 | 12.93498 | 0.168155 | 16054.9 | 9592761 |
| 632 | 1 | Sep | 267 | 17.54861 | 1205 | 4728.389 | 0 | 5 | 7841.683 | 45245 | 2.755368 | 27.20838 | 0.353709 | 33792.68 | 9626554 |
| 633 | 1 | Sep | 268 | 17.48611 | 1203 | 4745.875 | 0 | 1 | 1246.424 | 45195 | 2.757304 | 5.403967 | 0.070252 | 6728.34 | 9633282 |
| 634 | 1 | Sep | 269 | 17.75 | 1201 | 4763.625 | 0 | 4 | 31180.65 | 45147 | 2.760216 | 8.143878 | 0.10587 | 10134.29 | 9643417 |
| 635 | 1 | Sep | 270 | 17.57639 | 1159 | 4781.201 | 0 | 11 | 67620.29 | 45092 | 2.769961 | 27.18441 | 0.353397 | 33826.99 | 9677244 |
| 636 | 1 | Sep | 271 | 17.14583 | 1157 | 4798.347 | 0 | 9 | 81617.73 | 45055 | 2.771836 | 5.211066 | 0.067744 | 6501.773 | 9683745 |
| 637 | 1 | Sep | 272 | 16.75 | 1156 | 4815.097 | 0 | 9 | 61703.63 | 44999 | 2.780636 | 24.41198 | 0.317356 | 30442.07 | 9714187 |
| 638 | 1 | Sep | 273 | 16.65972 | 1153 | 4831.757 | 0 | 11 | 51834.83 | 44949 | 2.78942 | 24.27343 | 0.315555 | 30331.9 | 9744519 |
| 639 | 1 | Oct | 274 | 16.88889 | 1152 | 4848.646 | 0 | 14 | 51054.28 | 44911 | 2.798465 | 24.92904 | 0.324078 | 31223.12 | 9775742 |
| 640 | 1 | Oct | 275 | 17.13194 | 1150 | 4865.778 | 0 | 8 | 68266.59 | 44864 | 2.799375 | 2.52929 | 0.032881 | 3174.858 | 9778917 |
| 641 | 1 | Oct | 276 | 17.29167 | 1148 | 4883.069 | 0 | 9 | 57464.94 | 44809 | 2.808468 | 24.95923 | 0.32447 | 31301.39 | 9810219 |
| 642 | 1 | Oct | 277 | 18.06944 | 1146 | 4901.139 | 0 | 11 | 57847.59 | 44760 | 2.817224 | 23.99428 | 0.311926 | 30155.74 | 9840374 |
| 643 | 1 | Oct | 278 | 18.43056 | 1144 | 4919.569 | 0 | 6 | 43738.63 | 44719 | 2.824394 | 19.59417 | 0.254724 | 24677.01 | 9865051 |
| 644 | 1 | Oct | 279 | 17.77083 | 1143 | 4937.34 | 0 | 7 | 19711.27 | 44671 | 2.834408 | 27.28186 | 0.354664 | 34413.41 | 9899465 |
| 645 | 1 | Oct | 280 | 17.36806 | 1141 | 4954.708 | 0 | 3 | 11939.37 | 44632 | 2.839646 | 14.23576 | 0.185065 | 18003.12 | 9917468 |
| 646 | 1 | Oct | 281 | 17.3125 | 1139 | 4972.021 | 0 | 4 | 12639.98 | 44589 | 2.845317 | 15.35657 | 0.199635 | 19434.8 | 9936903 |
| 647 | 1 | Oct | 282 | 17.79167 | 1138 | 4989.812 | 0 | 3 | 13909.91 | 44540 | 2.847904 | 7.02124 | 0.091276 | 8883.563 | 9945786 |
| 648 | 1 | Oct | 283 | 17.69444 | 1135 | 5007.507 | 0 | 3 | 12351.1 | 44498 | 2.85426 | 17.15438 | 0.223007 | 21733.01 | 9967519 |
| 649 | 1 | Oct | 284 | 15.71528 | 1134 | 5023.222 | 0 | 5 | 28361.85 | 44452 | 2.858383 | 11.11531 | 0.144499 | 14095.4 | 9981615 |
| 650 | 1 | Oct | 285 | 15.34722 | 1132 | 5038.569 | 0 | 5 | 33785.46 | 44404 | 2.862701 | 11.63266 | 0.151225 | 14758.15 | 9996373 |
| 651 | 1 | Oct | 286 | 15.08333 | 1130 | 5053.653 | 0 | 7 | 30384.23 | 44355 | 2.869626 | 18.58964 | 0.241665 | 23598.98 | 1.00E+07 |
| 652 | 1 | Oct | 287 | 15.31944 | 1129 | 5068.972 | 0 | 4 | 27934.65 | 44311 | 2.873329 | 9.951492 | 0.129369 | 12651.43 | 1.00E+07 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 653 | 1 | Oct | 288 | 16.34028 | 1127 | 5085.312 | 0 | 5 | 21438.67 | 44258 | 2.881183 | 21.00338 | 0.273044 | 26704.35 | 1.01E+07 |
| 654 | 1 | Oct | 289 | 15.54861 | 1125 | 5100.861 | 0 | 6 | 48157.29 | 44204 | 2.885131 | 10.56147 | 0.137299 | 13445.36 | 1.01E+07 |
| 655 | 1 | Oct | 290 | 15.01389 | 1124 | 5115.875 | 0 | 8 | 45163.68 | 44163 | 2.891971 | 18.24303 | 0.237159 | 23239.31 | 1.01E+07 |
| 656 | 1 | Oct | 291 | 14.99306 | 1122 | 5130.868 | 0 | 8 | 44354.94 | 44114 | 2.898183 | 16.52233 | 0.21479 | 21074.02 | 1.01E+07 |
| 657 | 1 | Oct | 292 | 14.34722 | 1119 | 5145.215 | 0 | 6 | 47247.29 | 44071 | 2.903299 | 13.56271 | 0.176315 | 17319.78 | 1.01E+07 |
| 658 | 1 | Oct | 293 | 14.01389 | 1118 | 5159.229 | 0 | 9 | 58807.61 | 44034 | 2.908805 | 14.57581 | 0.189485 | 18630.14 | 1.02E+07 |
| 659 | 1 | Oct | 294 | 14.22917 | 1116 | 5173.458 | 0 | 11 | 59442.67 | 43992 | 2.914607 | 15.34611 | 0.199499 | 19633.14 | 1.02E+07 |
| 660 | 1 | Oct | 295 | 14.5625 | 1114 | 5188.021 | 0 | 8 | 55741.83 | 43954 | 2.918742 | 10.92201 | 0.141986 | 13988.81 | 1.02E+07 |
| 661 | 1 | Oct | 296 | 14.43651 | 1112 | 5202.457 | 0 | 6 | 39452.06 | 43915 | 2.923639 | 12.90244 | 0.167732 | 16532.53 | 1.02E+07 |
| 662 | 1 | Oct | 297 | 13.88194 | 1111 | 5216.339 | 0 | 8 | 52511.13 | 43879 | 2.928711 | 13.34156 | 0.17344 | 17111.74 | 1.02E+07 |
| 663 | 1 | Oct | 298 | 13.69444 | 1109 | 5230.034 | 0 | 10 | 55654.77 | 43831 | 2.933763 | 13.29664 | 0.172856 | 17064.84 | 1.02E+07 |
| 664 | 1 | Oct | 299 | 13.93056 | 1108 | 5243.964 | 0 | 9 | 37760.78 | 43780 | 2.939149 | 14.11859 | 0.183542 | 18130.02 | 1.03E+07 |
| 665 | 1 | Oct | 300 | 14.41667 | 1107 | 5258.381 | 0 | 7 | 52737.03 | 43734 | 2.940686 | 4.049332 | 0.052641 | 5203.331 | 1.03E+07 |
| 666 | 1 | Oct | 301 | 14.125 | 1105 | 5272.506 | 0 | 8 | 43890.75 | 43686 | 2.946365 | 14.84634 | 0.193002 | 19068.43 | 1.03E+07 |
| 667 | 1 | Oct | 302 | 14.56944 | 1103 | 5287.075 | 0 | 7 | 24012.72 | 43639 | 2.952352 | 15.64921 | 0.20344 | 20117.35 | 1.03E+07 |
| 668 | 1 | Oct | 303 | 14.48611 | 1101 | 5301.561 | 0 | 6 | 30079.13 | 43594 | 2.956549 | 10.94684 | 0.142309 | 14085.09 | 1.03E+07 |
| 669 | 1 | Oct | 304 | 14.79167 | 1100 | 5316.353 | 0 | 3 | 13580.07 | 43542 | 2.961525 | 12.95466 | 0.168411 | 16674.02 | 1.03E+07 |
| 670 | 1 | Nov | 305 | 14.90972 | 1058 | 5331.263 | 0 | 4 | 12773.54 | 43497 | 2.96776 | 16.23973 | 0.211117 | 20914.19 | 1.04E+07 |
| 671 | 1 | Nov | 306 | 15.22917 | 1057 | 5346.492 | 0 | 5 | 36939.37 | 43454 | 2.969525 | 4.602851 | 0.059837 | 5933.361 | 1.04E+07 |
| 672 | 1 | Nov | 307 | 14.8125 | 1055 | 5361.304 | 0 | 5 | 15001.42 | 43408 | 2.976165 | 17.17195 | 0.223235 | 22130.05 | 1.04E+07 |
| 673 | 1 | Nov | 308 | 14.67361 | 1053 | 5375.978 | 0 | 6 | 30088.21 | 43361 | 2.980662 | 11.65573 | 0.151525 | 15034.58 | 1.04E+07 |
| 674 | 1 | Nov | 309 | 14.42361 | 1052 | 5390.402 | 0 | 4 | 26147.66 | 43321 | 2.984889 | 10.92057 | 0.141967 | 14098.44 | 1.04E+07 |
| 675 | 1 | Nov | 310 | 14.65278 | 1050 | 5405.054 | 0 | 5 | 14912.61 | 43279 | 2.991303 | 16.55464 | 0.21521 | 21381.03 | 1.04E+07 |
| 676 | 1 | Nov | 311 | 14.59028 | 1049 | 5419.645 | 0 | 3 | 13344.93 | 43231 | 2.994805 | 9.034568 | 0.117449 | 11680.08 | 1.04E+07 |
| 677 | 1 | Nov | 312 | 14.52778 | 1047 | 5434.172 | 0 | 3 | 10039.83 | 43189 | 2.99882 | 10.35732 | 0.134645 | 13392.02 | 1.05E+07 |
| 678 | 1 | Nov | 313 | 14.72917 | 1045 | 5448.902 | 0 | 4 | 27916.34 | 43130 | 3.002499 | 9.444166 | 0.122774 | 12211.36 | 1.05E+07 |
| 679 | 1 | Nov | 314 | 14.94444 | 1045 | 5463.846 | 0 | 5 | 23879.18 | 43087 | 3.00672 | 10.82928 | 0.140781 | 14006.6 | 1.05E+07 |
| 680 | 1 | Nov | 315 | 15.08333 | 1043 | 5478.929 | 0 | 4 | 7712.412 | 43043 | 3.011656 | 12.62061 | 0.164068 | 16328.7 | 1.05E+07 |
| 681 | 1 | Nov | 316 | 14.64583 | 1042 | 5493.575 | 0 | 2 | 9327.05 | 42993 | 3.014214 | 6.538854 | 0.085005 | 8462.953 | 1.05E+07 |
| 682 | 1 | Nov | 317 | 14.82639 | 1040 | 5508.402 | 0 | 4 | 21219.67 | 42944 | 3.019714 | 14.05209 | 0.182677 | 18184.35 | 1.05E+07 |
| 683 | 1 | Nov | 318 | 15.04167 | 1039 | 5523.443 | 0 | 3 | 21264.71 | 42897 | 3.022788 | 7.786842 | 0.101229 | 10081.33 | 1.05E+07 |
| 684 | 1 | Nov | 319 | 14.78472 | 1037 | 5538.228 | 0 | 3 | -444.8 | 42851 | 3.029406 | 16.85576 | 0.219125 | 21828.36 | 1.06E+07 |
| 685 | 1 | Nov | 320 | 14.6875 | 1037 | 5552.915 | 0 | 1 | 1180.652 | 42813 | 3.03196 | 6.452878 | 0.083887 | 8368.162 | 1.06E+07 |
| 686 | 1 | Nov | 321 | 15.54861 | 1035 | 5568.464 | 0 | 2 | 11180.65 | 42774 | 3.035018 | 7.748936 | 0.100736 | 10046.89 | 1.06E+07 |
| 687 | 1 | Nov | 322 | 14.36806 | 1034 | 5582.832 | 0 | 2 | -8669.36 | 42725 | 3.041079 | 15.36634 | 0.199762 | 19921.33 | 1.06E+07 |
| 688 | 1 | Nov | 323 | 13.8254 | 1032 | 5596.658 | 0 | 3 | 21180.65 | 42674 | 3.041124 | 0.116322 | 0.001512 | 150.8099 | 1.06E+07 |
| 689 | 1 | Nov | 324 | 14.34444 | 1031 | 5611.002 | 0 | 3 | 1507.675 | 42627 | 3.047156 | 15.26114 | 0.198395 | 19779.29 | 1.06E+07 |
| 690 | 1 | Nov | 325 | 14.09259 | 1030 | 5625.095 | 0 | 3 | 21180.65 | 42583 | 3.050329 | 8.000613 | 0.104008 | 10378.67 | 1.06E+07 |
| 691 | 1 | Nov | 326 | 14.38194 | 1029 | 5639.477 | 0 | 6 | 31361.68 | 42543 | 3.056432 | 15.35839 | 0.199659 | 19926.34 | 1.06E+07 |
| 692 | 1 | Nov | 327 | 13.84028 | 1028 | 5653.317 | 0 | 6 | 51272.92 | 42496 | 3.059563 | 7.877493 | 0.102407 | 10228.92 | 1.07E+07 |
| 693 | 1 | Nov | 328 | 13.49306 | 1027 | 5666.81 | 0 | 9 | 65667.71 | 42459 | 3.064398 | 12.14275 | 0.157856 | 15770.75 | 1.07E+07 |
| 694 | 1 | Nov | 329 | 13.53968 | 1026 | 5680.35 | 0 | 16 | 119922 | 42409 | 3.069284 | 12.29986 | 0.159898 | 15981.11 | 1.07E+07 |
| 695 | 1 | Nov | 330 | 14.14583 | 1024 | 5694.495 | 0 | 18 | 121594.4 | 42357 | 3.075061 | 14.46306 | 0.18802 | 18798.77 | 1.07E+07 |
| 696 | 1 | Nov | 331 | 12.58333 | 1023 | 5707.079 | 0 | 12 | 111834.4 | 42300 | 3.078152 | 7.712189 | 0.100258 | 10029.12 | 1.07E+07 |
| 697 | 1 | Nov | 332 | 12.48611 | 1023 | 5719.565 | 0 | 15 | 136975.2 | 42257 | 3.079577 | 3.598513 | 0.046781 | 4679.678 | 1.07E+07 |
| 698 | 1 | Nov | 333 | 12.50926 | 1022 | 5732.074 | 0 | 18 | 156363 | 42218 | 3.082942 | 8.381187 | 0.108955 | 10894.37 | 1.07E+07 |
| 699 | 1 | Nov | 334 | 11.13889 | 1021 | 5743.213 | 0 | 21 | 182743.3 | 42180 | 3.084111 | 2.891075 | 0.037584 | 3758.713 | 1.07E+07 |

| Tick | Year | Month | Day | Temp | Day length | Degree days | Hydrilla(ha) From data | Sim Inv (ha) | Total biomass | Number of carp | Mean weight | Mean-%-weight consumed | Mean-%-weight gained | Herbivory today | Total herbivory |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | 1 | Dec | 335 | 11 | 1020 | 5754.213 | 0 | 23 | 199876.4 | 42134 | 3.085052 | 2.31435 | 0.030087 | 3006.77 | 1.07E+07 |
| 701 | 1 | Dec | 336 | 10.97222 | 1019 | 5765.185 | 0 | 29 | 260024.4 | 42092 | 3.080695 | 0 | 0 | 0 | 1.07E+07 |
| 702 | 1 | Dec | 337 | 11.10417 | 1019 | 5776.289 | 0 | 31 | 279497.3 | 42043 | 3.080712 | 0.020666 | 2.69E-04 | 26.76079 | 1.07E+07 |
| 703 | 1 | Dec | 338 | 11.09028 | 1018 | 5787.38 | 0 | 35 | 316240.3 | 42001 | 3.081797 | 2.691284 | 0.034987 | 3481.589 | 1.07E+07 |
| 704 | 1 | Dec | 339 | 10.85417 | 1017 | 5798.234 | 0 | 36 | 326430.9 | 41948 | 3.077462 | 0 | 0 | 0 | 1.07E+07 |
| 705 | 1 | Dec | 340 | 11.20139 | 1016 | 5809.435 | 0 | 38 | 342655.1 | 41907 | 3.078744 | 3.153208 | 0.040992 | 4065.755 | 1.07E+07 |
| 706 | 1 | Dec | 341 | 11.70833 | 1016 | 5821.144 | 0 | 39 | 350071.3 | 41861 | 3.07936 | 1.541897 | 0.020045 | 1986.757 | 1.07E+07 |
| 707 | 1 | Dec | 342 | 12.33333 | 1015 | 5833.477 | 0 | 42 | 370821.4 | 41809 | 3.082445 | 7.698009 | 0.100074 | 9908.675 | 1.08E+07 |
| 708 | 1 | Dec | 343 | 11.93056 | 1015 | 5845.407 | 0 | 44 | 397783 | 41763 | 3.083203 | 1.877258 | 0.024404 | 2416.199 | 1.08E+07 |
| 709 | 1 | Dec | 344 | 11.86806 | 1014 | 5857.275 | 0 | 44 | 390835.1 | 41721 | 3.085558 | 5.854536 | 0.076109 | 7529.346 | 1.08E+07 |
| 710 | 1 | Dec | 345 | 11.84722 | 1014 | 5869.123 | 0 | 46 | 407729.8 | 41687 | 3.08632 | 1.898324 | 0.024678 | 2441.246 | 1.08E+07 |
| 711 | 1 | Dec | 346 | 11.41667 | 1013 | 5880.539 | 0 | 47 | 412994.5 | 41644 | 3.087948 | 4.02903 | 0.052377 | 5177.288 | 1.08E+07 |
| 712 | 1 | Dec | 347 | 11.18056 | 1013 | 5891.72 | 0 | 50 | 441949.9 | 41579 | 3.088036 | 0.208569 | 0.002711 | 267.7327 | 1.08E+07 |
| 713 | 1 | Dec | 348 | 11.1875 | 1013 | 5902.907 | 0 | 51 | 450831.3 | 41530 | 3.088141 | 0.225708 | 0.002934 | 289.4013 | 1.08E+07 |
| 714 | 1 | Dec | 349 | 11.27083 | 1012 | 5914.178 | 0 | 51 | 446869.7 | 41479 | 3.089533 | 3.430742 | 0.0446 | 4393.621 | 1.08E+07 |
| 715 | 1 | Dec | 350 | 11.3125 | 1013 | 5925.491 | 0 | 52 | 455360.9 | 41432 | 3.089753 | 0.53577 | 0.006965 | 685.6699 | 1.08E+07 |
| 716 | 1 | Dec | 351 | 11.48611 | 1012 | 5936.977 | 0 | 54 | 470374.8 | 41386 | 3.091491 | 4.308294 | 0.056008 | 5507.957 | 1.08E+07 |
| 717 | 1 | Dec | 352 | 11.65972 | 1011 | 5948.637 | 0 | 54 | 464584.9 | 41334 | 3.093502 | 5.008492 | 0.06511 | 6398.663 | 1.08E+07 |
| 718 | 1 | Dec | 353 | 11.97222 | 1012 | 5960.609 | 0 | 55 | 470978.6 | 41296 | 3.094399 | 2.220122 | 0.028862 | 2835.587 | 1.08E+07 |
| 719 | 1 | Dec | 354 | 12.51389 | 1011 | 5973.123 | 0 | 56 | 471266.1 | 41257 | 3.097754 | 8.369731 | 0.108806 | 10682.94 | 1.08E+07 |
| 720 | 1 | Dec | 355 | 11.52222 | 1012 | 5984.645 | 0 | 60 | 509071.3 | 41228 | 3.098186 | 1.060974 | 0.013793 | 1354.727 | 1.08E+07 |
| 721 | 1 | Dec | 356 | 12.45 | 1011 | 5997.095 | 0 | 60 | 499727.1 | 41196 | 3.101455 | 8.115862 | 0.105506 | 10356.3 | 1.08E+07 |
| 722 | 1 | Dec | 357 | 11.80556 | 1012 | 6008.9 | 0 | 61 | 506601.1 | 41142 | 3.102159 | 1.783584 | 0.023187 | 2275.358 | 1.08E+07 |
| 723 | 1 | Dec | 358 | 11.42222 | 1011 | 6020.323 | 0 | 61 | 502001.4 | 41099 | 3.103799 | 4.036567 | 0.052475 | 5145.371 | 1.08E+07 |
| 724 | 1 | Dec | 359 | 11.33333 | 1012 | 6031.656 | 0 | 62 | 510335.8 | 41053 | 3.104033 | 0.58579 | 0.007615 | 746.2562 | 1.08E+07 |
| 725 | 1 | Dec | 360 | 11.71667 | 1011 | 6043.373 | 0 | 63 | 514365.7 | 41012 | 3.106138 | 5.221995 | 0.067886 | 6646.318 | 1.08E+07 |
| 726 | 1 | Dec | 361 | 11.83889 | 1012 | 6055.212 | 0 | 63 | 511119.7 | 40963 | 3.106886 | 1.867606 | 0.024279 | 2375.77 | 1.08E+07 |
| 727 | 1 | Dec | 362 | 11.76667 | 1013 | 6066.978 | 0 | 64 | 518107.9 | 40918 | 3.10758 | 1.681243 | 0.021856 | 2136.879 | 1.08E+07 |
| 728 | 1 | Dec | 363 | 12.02222 | 1012 | 6079 | 0 | 65 | 520762.4 | 40860 | 3.110184 | 6.430743 | 0.0836 | 8163.763 | 1.08E+07 |
| 729 | 1 | Dec | 364 | 11.66111 | 1013 | 6090.662 | 0 | 65 | 518066.8 | 40822 | 3.110738 | 1.409976 | 0.01833 | 1789.772 | 1.08E+07 |
| 730 | 1 | Dec | 365 | 11.04444 | 1014 | 6101.706 | 0 | 66 | 527079.1 | 40775 | 3.11073 | 0 | 0 | 0 | 1.08E+07 |