

# **Aquatic Invasive Species Workshop: Exploring the Organisms in Trade Vector**

## *Workshop Summary*

Tuesday, June 10, 2008

### **Workshop Framework: Defining the challenges associated with the trade of live organisms in the Great Lakes region**

Tim Eder (Great Lakes Commission)

Eder introduced the Great Lakes Commission project focused on organisms in trade (OIT). He gave an overview of aquatic invasive species (AIS) problems in the Great Lakes, noting resulting environmental and economic impacts. He also noted that fishery management goals established for each of the Great Lakes are not being achieved. The trade of live organisms was discussed as a phenomenon that has increased in magnitude with globalization, resulting in higher risks for AIS introduction and spread. It was also pointed out that OIT is a more diffuse source of AIS, as compared to ships being a more discrete source, resulting in greater challenges for prevention and control efforts. Recognized was the importance of maintaining the economic viability of industries in developing solutions to stop the introduction and spread of AIS in the Great Lakes region through OIT.

### **Understanding OIT Pathways**

Moderator: Kathe Glassner-Shwayder (Great Lakes Commission)

Glassner-Shwayder acknowledged work of pathway teams and complexities involved in pulling information together. She introduced each of the presenters prior to their presentations.

- **Aquaculture Pathway**

Ted Batterson (North Central Regional Aquaculture Coordinator)

Paul Zajicek (National Association of State Aquaculture Coordinator)

Batterson gave a presentation focused on aquaculture in the Great Lakes region. Specifically, he discussed public/tribal fish stocking, hatcheries and private commercial fish farms (excluding aquaculture for ornamental industries, live food fish, etc.). He gave an overview of the industry explaining different methods of culture, giving production volumes at state and provincial levels, and highlighting the differences between public stocking and private commercial aquaculture. During his presentation he mentioned the potential of indoor recirculation systems in aquaculture in terms of improving biosecurity. Batterson also emphasized the interest of the aquaculture industry in protecting the Great Lakes from exotic invasions. For example, significant measures are being taken by farmers to avoid escapes of their stock and to prevent the spread of diseases. Batterson raised the issue of the Asian carp, noting that these species were being used in aquaculture facilities outside the Great Lakes basin. He brought up the importance of prevention through the use of risk assessment tools, as well as the implementation of AIS-HACCP (Hazard Analysis and Critical Control Point) planning and best management practices for aquaculture operations.

Zajicek concluded the presentation discussing risk assessment and risk mitigation strategies. He highlighted several important factors to consider when implementing such efforts including species; production systems; transport and handling; and consumer behavior. Also noted was the need to evaluate the extent to which this pathway was currently a source of risk, as well as tools available for management of existing risk.

### Discussion

*How do other regions compare to Great Lakes (in terms of risk)?*

The top five aquaculture states are located in southeast U.S. and are subject of a strong regulatory approach regarding invasive species. In addition, there is a tremendous variation in eco-regions across the U.S. and therefore, regulations and provisions targeting specific species differ from one state to another.

The Environmental Law Institute released a report in 2007, "Halting the invasion in the Chesapeake", which analyzes laws and regulations that affect AIS prevention efforts. It includes the pet trade, importation of aquarium fish, aquaculture, and other commercial enterprises, and makes recommendations intended to harmonize inter-state efforts in the Chesapeake Bay. This study also gives an overview of three states (Pennsylvania, Maryland, Virginia) regulations and provisions on AIS.

*What is the status on genetically modified organisms (GMO) & aquaculture?*

According to an informal survey of all 50 states from a few years ago, very few states have GMO regulations. Michigan is one of the few states that have a specific prohibition on production of genetically modified fish. It was also noted that most states have a prohibition on releasing non-native species and that the Food and Drug Administration (FDA) has taken the lead on GMOs.

*How consistent are the prohibited lists across the basin?*

Lists are not very consistent across the states. Each of the eight Great Lakes states and the two provinces also use different listing approaches. For example, Michigan has a specific prohibited/restricted species list; Ohio has a regional break-down for prohibitions (Great Lakes vs. Ohio River drainage basins); and Ontario has a specific list of what can be cultured. This project could be a good opportunity to catch up with state representatives to get most recently updated regulatory lists for inclusion in pathway summaries.

*How do we reconcile culturing from outside the basin with interconnected waterways? Case in point: Asian carp used in aquaculture facilities in the Mississippi River Basin. After escapement during flood events in the early 1990s, the carp have been migrating towards the Great Lakes basin which is connected to the Mississippi River Basin through the Chicago Sanitary and Ship Canal.*

It will be necessary to put in place uniform regulations and policies among the Great Lakes states and provinces. In the case of escapement, there are no fail-safe operations. Net pens exist only in Ontario for rainbow trout which are already naturalized; however there is a concern over mixing domestic strains with wild populations. In the case of Michigan, they have had problems with internet sales of AIS – and phantom operations – making it challenging to identify when or from where species are coming.

*Has there ever been any effort to hold operations accountable for escapement (Onus on government vs. operator?)*

The report “Best Management Practices for Aquaculture in Wisconsin and the Great Lakes Region” (Malison and Hartleb 2005) gives an overview of this issue. There has not been a history of a significant environmental impact from escapement that would create a significant response. The U.S. government has taken a position against the “polluter pays” principle in terms of international negotiations for biological diversity, specifically related to invasive species. This stems from the difficulty in pinpointing the source of the organisms as they move through the pathways. Michigan state law has established fines and penalties for possession of species on their list of invasive species.

*Another potential for risk is related to “hitchhiker” or unwanted organisms in the production facilities*  
AIS-HACCP is trying to address this and educate operators of these issues.

- **Live Bait Pathway**

Ron Kinnunen (Michigan Sea Grant), Gary Whelan (Michigan Dept. of Natural Resources), Nick Mandrak (Fisheries and Oceans Canada), and Beth Brownson (Ontario Ministry of Natural Resources)

Kinnunen began the team's presentation on the live bait pathway, first describing the scope of live bait trade in the Great Lakes region and giving examples of species in trade for live bait purpose. He mentioned that some species are used for recreational fishing by anglers while others are used as “feeders” for piscivorous ornamental animals. He gave an overview of production methods (wild harvest, semi-aquaculture, and aquaculture) and broke down species by type of productions. He also provided numbers on the wholesale and retail markets values and prices. He noted during his presentation that some of the industry statistics he was providing might be outdated and that an update would be necessary to get a more representative idea of this industry. Kinnunen highlighted the difficulties of differentiating baitfish aquaculture from wild harvest; to determine species sold and to get good production estimates.

Whelan gave an overview of wild harvest of live bait. He showed with a map the major bait harvest locations in Michigan and illustrated Michigan Lower Peninsula wholesale movements and sales locations. Whelan explained that many harvesters have their own area that they like to utilize for harvesting activities. In addition, he mentioned that live bait can be moved all over the state from harvester to wholesaler and other distributors who sell it to a broad range of retailers.

Glassner-Shwayder and Kinnunen discussed the risks associated to live bait operations for each of the entities actively engaged in the trade of baitfish. Kinnunen also explained the potential risks of introduction and spread of pathogens and hitchhikers and the negative impacts of using AIS for bait.

Mandrak discussed the bait industry in Ontario which is co-managed by the Ontario Ministry of Natural Resources (OMNR) and Ontario Bait Industry Association. Both organizations collect information on harvesters and their markets. He highlighted that live bait production in Ontario comes almost exclusively from wild harvest and that there are two components: the Great Lakes and inland lakes and tributaries. Information gathered on the differences in where bait is purchased and where it is used suggests northward movement of bait within the province. Mandrak also

talked about risks associated to live bait operations focusing in Ontario. He shared the preliminary results of a Canadian survey targeting end users that assessed angler's behavior. Results (125 online respondents, found to be representative of broader angler population) have shown issues with the ability of anglers to correctly identify species; and comparisons with past surveys have shown that release rates from consumers have not gone down despite the high number of education/outreach programs in Ontario. Viral disease was a significant issue particularly with wild harvest which can be transported uncertified by unauthorized means. There is also an ongoing study in partnership with a student at Michigan State University to analyze the human dimensions of bait industry. Brownson (OMNR) gave an overview of VHS management zones in Ontario and the restrictions related to VHS regulations regarding bait wholesalers and distributors (but not anglers).

Whelan provided an overview of fish health issues focused on VHS. He mentioned the difficulties associated with the movement of unregulated and uncertified live bait within the region and the risks associated with viral diseases. According to Whelan's analysis, the risk associated with VHS/pathogen vectors range from almost non-existent to medium-high level, dependent on several conditions (e.g., amount of fish, timing, transport, and susceptibility of environment/organism). He added that the number of anglers (millions) is a major dispersal mechanism for pathogens/AIS and that state agencies feel that they have done a poor job of educating anglers (uncontrolled behavior). Noted was the need to focus efforts on anglers to encourage proper practices. He emphasized that appropriately regulated live bait was characterized with low risk of spreading pathogens compared to the non-regulated/illegal movement of live bait which represents the highest risk. It will be critical to focus on individuals involved in the bait industry who don't want to follow best practices. Finally, Whelan suggested that it was important to make anglers and industry part of the solution instead of the problem. He cited Michigan regulation as an example where retailers started demanding certified bait since significant restrictions on uncertified bait have been imposed.

Kinnunen finalized the presentation with an overview of AIS-HACCP. He described this management effort aimed to address AIS risks. He qualified HACCP as a proactive approach that is easy to implement because it concentrates on points in the process that are critical to the safety of the product. In Michigan, HACCP is not a requirement; however, harvesters and dealers are adopting it in the implementation of VHS regulations. Brownson also gave a summary of AIS-HACCP program progress in Ontario where the approach is becoming mandatory. She explained that voluntary training yielded a limited response, driving the decision to make HACCP a requirement for licensing. Since training has been required, compliance has increased to 100 percent. It is expected that by 2010 all bait harvesters and dealers will have completed an AIS-HACCP plan.

## Discussion

### *Estimated amount of unlicensed harvest?*

In Ontario, unlicensed harvesting is an ongoing issue. In addition, the magnitude of the problem is unknown and there have been limited attempts to address the problem, as more inspectors would be needed to enforce regulations. Michigan has a considerable number of conservation officers, however it is still difficult to identify when and where an unlicensed harvest is occurring. Currently the primary mechanism is through citizen reports of unusual activities.

Activities and funding should target educating anglers and harvesters in order to change their behaviors. Minnesota Sea Grant, as part of the Great Lakes Sea Grant Network, has led several surveys of anglers and boaters. The outcomes of these surveys show that education can work if we make such programs a priority. There is a need to communicate consistently and specifically what the boater/angler population needs to do as individuals and a community. In general, anglers don't associate bait release with the AIS issue, but if education is offered they will be conscious of the problem and they will make necessary behavior changes (i.e. tie consequences of their behavior to conservation issue).

### *What are the barriers to shifting to farm intensive production (instead of wild harvest) in order to reduce risks related to wild harvest of live bait?*

The problem is that culturing techniques for the most desirable bait species (e.g., emerald and spottail shiners) can be difficult and have not been worked out yet. Climate and cost are also important issues. Producers in the Great Lakes recognize the need to raise more live bait, but capital investment issues and uncertainties of return elevate economic risks to culturing live bait. All of these may prevent the industry from meeting emerging demands.

Pennsylvania bans certain species from aquaculture. Some non-native species may be raised in a closed system, while native species may be raised in open systems.

It was mentioned that bait dealers do not use AIS in their operations, education on best practices through HACCP is well received by dealers and that they are currently investing a significant amount of time to inspecting bait.

- **Live Food Fish**  
Becky Cudmore (Centre of Expertise for Aquatic Risk Assessment)

Cudmore opened her presentation by defining the live food trade and explaining why it was considered as a potential pathway for the introduction of non-native species into the Great Lakes. She indicated that little is known about the live food trade and that it may be one of the least studied pathways under the OIT vector. Cudmore focused her remarks on Canada's live food trade. She shared preliminary outcomes of a study undertaken by the Canadian Border Service Agency and OMNR. Results indicated that identification of fish species is a significant problem (e.g., swamp eel is being sold as yellow eel in Toronto). She showed some live fish imports statistics and a list of species of special interest for the Canadian government (most of which are coming from the U.S.). She commented that Canada is specifically interested in species that are imported/bought for food and are then released live (unintended use). Thusfar, the study has identified 39 species (e.g. swamp eel, snakeheads, Asian carp) that are of concern in Canada. These species are entering to the country by plane and truck and sold primarily in Asian markets (can also be bought in grocery stores) in large cities. She mentioned that ceremonial and activist behavior could be considered as sub-pathways. She added that the "fellow travelers" captured with wild caught species may also pose a potential risk (e.g., silver carp with bighead). Live food fish can also carry pathogens (e.g., Viral Hemorrhagic Septicemia, SVC). Trucking accidents may also be a concern and she gave an example of a trucking accident transporting tilapia. She emphasized the need for quantifying the risk posed by this pathway by determining the probability for an accident to occur and mapping out the proximity to natural lakes and rivers. Presently, the Canadian federal government does not prohibit importation on any live fish for reason of invasiveness, but there are two banned species based on human health concern. Cudmore finalized her presentation by giving an update of the work that is being undertaken by the Centre of Expertise for Aquatic Risk Assessment in live trade for Asian carps and snakeheads.

#### Discussion

Federal policies that can be used to regulate live food fish trade include:

- U.S. Lacey Act: Listing of injurious species in prohibiting importation
- Canada: Release of live fish prohibited including Asian carp (bighead, grass, silver) and snakeheads

Reliable information is not available identifying cultures or specific practices linked to ceremonial releases of live organisms. Gaps in regulations are a problem, for example, Pennsylvania makes it illegal to transport species, but does not prohibit possession. Because of this markets still include species like Asian carp and snakehead. Enforcement at ports of entry such as airports is difficult. Misidentification of fish is another significant problem.

Biological risk assessments are generally based on the premise that the species "may cause harm", which is subjective and not necessarily appropriate as a foundation for laws and regulations. Therefore, risk assessments need to be strictly biologically based with a high level of certainty, given the economic implications of resulting regulatory decisions.

A better understanding of the Asian fish market and incentives are needed to encourage compliance/behavior change.

- **Aquarium/Pet Pathway**  
Jamie Reaser (Pet Industry Joint Advisory Council)

Reaser gave a presentation on the role of the pet and aquarium industry in conservation and aquatic invasive species issues. She highlighted the economic value of the pet industry, as well as the significance of the human-animal bond. For example, pet ownership can enhance self esteem, sense of responsibility, connection to animals, empathy and compassion, and concern for future generations. She discussed the role of the industry in driving conservation and sustainability, using the example of Project Piaba ([www.projectpiaba.org](http://www.projectpiaba.org)).

Reaser provided an overview of why people may choose to give up their pets and what they do with unwanted pets. A diagram illustrating the pet release pathway was also discussed, although Reaser noted that the diagram was generic and not necessarily representative of the pathway in the Great Lakes. She emphasized that there are many biosecurity measures in place for points in the pathway prior to organisms reaching the consumer and that the industry is generally protective of its stock. She highlighted consumers and unlicensed sales (e.g. internet, mail order, consumer-to-consumer) as concerns for risk of introduction/spread. Introduction concerns stem primarily from the release of unwanted pets, aquarium/terrarium plants, or water garden plants/animals; spread of pathogens, parasites, or other "hitchhikers"; and escape/release of live pet food. Reaser discussed a significant challenge with assessing the pathway which is determining which non-native or invasive species are associated with the trade. Several information sources exist, but there is a lack of consistency in definitions, approach, and direct evidence, making the assessment unclear. She noted that there is a general lack of direct evidence of establishment and invasiveness (e.g., evidence of harm). Of the 1700-2000 fish in trade, there is only small percentage reported introduced and established as invasive. In addition, it was noted that many of the species are moving through multiple pathways.

Reaser identified several needs to determining the role of the industry in invasive species introduction and spread in the Great Lakes region, including resolving data issues and assessing propagule pressure and relative risks from all pathways. Noted was the importance of risk assessment including the organisms' tolerance to the cold water temperatures (of the Great Lakes). In terms of management or response to risk, Reaser discussed various regulatory, voluntary best management practices for pets and education initiatives. Habitattitude™ was noted as a significant outreach initiative that involves both industry and consumers in attempts to minimize the potential for species release from the pet, aquarium and water garden pathways. Finally, opportunities for future work were identified, including data needs (improved quality, quantity and consistency), addressing internet sales, reducing hitchhiker risks, and increasing support for existing non-regulatory tools.

#### Discussion

*A study on captive raised birds shows they do not establish wild populations; does this apply to aquatic species?*  
Unsure if the findings would hold true for "lower" vertebrate animals, although there are examples of captive "herps" (i.e. reptiles and amphibians) that have established populations in the wild.

#### *Information on unwanted pets*

It was suggested that there may be a difference in attitudes regarding unwanted pets based on the type of pet (i.e. fish vs. pets that can be held and touched). This could be an area for future work. In addition, the investment that hobbyists make in their aquariums or water gardens may also have an impact. For example, the more some one spends on their hobby, the less likely they might be to release the inhabitants.

#### *Ornamental fish production/importation in the Great Lakes*

Fish propagation is not as great in the Great Lakes region as it is in other parts of the country such as the southeast and Florida. Most ornamental fish are probably coming from Florida, or imported through the Kennedy airport.

#### *Hitchhikers*

The issue of "hitchhikers" is an issue that should be considered as part of this pathway. Tropical fish may be carriers of bacterial or viral pathogens that would survive, even if the fish themselves did not. Direct shipment maybe more of a risk in terms of hitchhikers than those that are imported to Florida and held in holding facilities.

In summary, it is critical to determine which species cause ecological and economic harm; focus resources where risk has been demonstrated, identifying those populations that are viable; and involve hobbyist groups and associations.

- **Horticulture and Water Garden Pathway**

Amy Frankmann (Michigan Nursery and Landscape Association)

Frankmann gave a brief overview of the horticulture industry. She listed the various points associated with this pathway that an organism might go through before reaching its final destination, including producer, distributor, landscape contractor, retailer, consumer, dispersal agents (i.e. wind, water, animals), and finally disposal. The primary products of the horticulture and water garden industry are plants, but may include some fish or other aquatic organisms. Frankmann gave information on the number of farms in Great Lakes states selling aquatic plants, based on the 2002 U.S. Department of Agriculture Census of Agriculture. She indicated that aquatic plants represent only a small segment of the industry. Frankmann also mentioned a number of initiatives to address the potential introduction or spread of invasive species from the horticulture and water garden trade. One significant effort was the convening of two stakeholder workshops to develop codes of conduct and management practices for the industry and its consumers. Typically, the industry is regulated by state departments of agriculture.

Frankmann discussed some gaps in terms of addressing the trade as a pathway for invasive species which included improving understanding of consumer motivations and behavior; evaluating the success of outreach campaigns; implementing risk assessment tools; and determining non-invasive alternatives. In conclusion, she presented concerns on behalf of the horticulture industry regarding differences and consistency in terminology (e.g., nuisance vs. invasive) and methodologies for assessing risk.

#### Discussion

#### *Terminology*

The National Invasive Species Council, in collaboration with the Aquatic Nuisance Species Task Force has developed a white paper specifically addressing the definitions of invasive, nuisance and other terms (available at: <http://www.invasivespeciesinfo.gov/docs/council/isacdef.pdf>).

### *Listing approaches*

Many current listing approaches are reactive on the part of governments and have shown to be hard to implement (e.g., Lacey Act). Other countries appear to be shifting towards a “white” list approach which shifts the “burden of proof” to the importer or producer. In the U.S., federal legislation (Non-native Wildlife Invasion Prevention Act) is in development that would establish a national risk assessment process. Australia currently implements a risk assessment model for new introductions of species. What is more controversial is the assessment or lack of assessment of species that are already here.

### *Opportunities*

Suggestions for future work included building on current outreach efforts to focus on water gardeners and promoting alternatives to desirable invasive species (e.g. have had some success with this for purple loosestrife). Work could also build on the results of a survey that is underway by Ontario focused on the water garden trade in process.

An initiative led by The Nature Conservancy in cooperation with Meijer stores was raised as a model process whereby alternative species are being promoted for sale, replacing invasive species. Ontario Federation of Anglers and Hunters is also working with the horticulture industry on a similar process in Canada. Also noted was the risk assessment being developed by Indiana DNR with industry stakeholders to identify high risk species.

## **Discussion: Moving Forward on OIT**

The goal of this section of the workshop was 1) to identify gaps and solutions towards development of more consistent management of OIT to prevent future aquatic invasions and 2) to determine priority areas where industry, resource managers and consumers can work together to reduce the risks associated to OIT pathways. In addition, the discussion tried to identify mechanisms to improve operational elements of trade (import, sales, transport, and end use) in order to reduce the risk of AIS invasions. Main points from this discussion follow.

### General

- Need to compile a list of species in trade, including quantities
- Importance of uniform and constant definitions (e.g. invasive vs. exotic vs. nuisance)
- Need for a consistent, regional regulatory framework applicable across state lines when feasible
- Important for industry and agencies to reach agreement on best management practices
- Benchmark successful regulatory models: e.g. Michigan, Australia, New Zealand
- Current regulatory approach is reactionary; states need to move towards a proactive approach
- Develop a list of potential AIS and develop risk assessment studies as Canada has done
- Consider hitchhikers when compiling the list of potential AIS
- Recognize the value of building partnerships and integrate into OIT work
- Consumer education for all pathways is imperative
- Consider applying successful programs across multiple pathways (e.g. apply AIS-HACCP to other industries)
- Model trade routes related to the movement of live fish and other pathways
- Risk vs. cost trade offs; important to quantify risks
- Economic incentives are applicable to all pathways

### Aquaculture and Live Bait Pathway

- Need to considerer out of basin production
- Consumer education needs to be promoted on a broader scale
- Private aquaculture is a highly regulated industry in almost all the Great Lakes states
- Private commercial aquaculture needs to be differentiated from public aquaculture
- Unlicensed bait harvesting main issue for a heavy regulated bait industry; need to ensure that all bait dealers have been trained on a consistent level and are following regulations
- Peer pressure could play a significant role in addressing unlicensed trade
- Outreach teaching bait users not to dump bait needs to be extended on a broader, more intensive scale
- Private live bait aquaculture needs be differentiated from wild caught bait industry
- Role of citizen/public reporting on illegal activities in live bait (unlicensed harvesters)
- Consistency in regulations; some species are permitted in one state and banned in others (e.g. goldfish)
  - Consider Great Lakes Regional Collaboration assessment of regulation; white list approach
- Fishers that catch their own bait may contribute to the spread of AIS
- Recognize industry efforts to address aquatic invasive species risk
- Cultured bait could be an option, except effective aquaculture methods to meeting demands do not exist for bait fish; it may be too intensive; and capital investment is a challenge

### Aquarium, Horticulture and Water Garden

- Identify the species that are traded and quantify amounts and economic values
- Identify alternative species to replace harmful AIS that are presently traded
- Internet sales are a problem; unlicensed dealers have direct access to the global market through the internet, facilitating an increased volume of sales (reflects current culture of changing purchasing/consumption habits)
  - Challenge is dealing with these illegal activities and enforcing regulations
- Need to document risk of the species in trade (success stories)
- Use Indiana Plant Assessment Group as a model (DNR working in partnership with industry to reach agreement on a risk assessment process)
- Minnesota model: DNR is working with landscape industry to identify alternatives to invasive plants
- Focus on consumer education based on a better understanding of what drives consumer behavior
- Horticulture and nursery certification programs needed on a broader scale

### Live food trade

- Lack of data and information
- Not a lot of outreach activities within the Great Lakes; one program has been developed in Massachusetts
- Look into substitute species
- Consumer education is important
- Need of economic studies (e.g. evaluate cost-benefit of a potential carp market)

### Wednesday, June 11, 2008

#### **Overview of Relevant Information Technologies: Trends and Challenges**

Roger Gauthier (Great Lakes Commission)

Gauthier gave an overview of information technology tools and applications. He started by suggesting that existing information technologies are underutilized and if they could be more fully exploited, it may reduce the perceived need for new and innovative technologies. Gauthier explained the differences between non-spatial and spatial data and their potential applications. He discussed the basics of geographic information system (GIS) technology and associated current trends, which included increasing data availability and standardization and creating “mashups”, or an application that combines data from multiple sources into a common display. An important initiative in this area is RAMONA, which was created to track and make available GIS products produced by state and local governments toward the building of a national spatial data infrastructure. Gauthier also spoke briefly about the related topics of data mining, search engines and web crawling which are tools supporting the process of sorting through huge data sets using topical clues. A significant challenge noted was to maintain existing databases. Finally, he gave some examples of information technology at work.

Gauthier then invited meeting participant Bing Liu (University of Illinois at Chicago) to speak further about data mining, specifically the role of web crawling. Liu discussed the differences in data that could be mined, including structured, semi-structured and unstructured textual data. He explained that data mining is dependent upon finding patterns within the data set being analyzed. An example provided of data mining application was analysis of ship data (e.g., schedule of ships at ports based on time and location) to determine disease distribution through ship traffic. Data mining efforts are generally part of a larger process that includes collecting/mining, integrating and synthesizing data to present a complete picture of the information that is organized, useable, and accessible. Liu mentioned that this data mining process could potentially be applied in querying aquarium species based on common characteristics of this set. Liu spoke about the advantages and disadvantages of user-based (or opinion) content, noting the following issues that should be considered:

- Providing a balanced summary of information
- Translating unstructured information into a “user-friendly” format
- Creating a context into which data must be formatted

He also suggested that it was valuable to have contributors, or people to submit information to you.

## Discussion

### *Accuracy of information*

It was acknowledged that there will always be inaccuracies in the information and data collected. Therefore, it is important to have “metadata” to help identify to what degree away the information is from the “truth”, and to be able to qualify data with some sort of confidence levels. A point was made that a well-educated public can be a valuable resource, and the opposite can be dangerous (e.g. disseminating inaccurate or incomplete information). It is necessary to look at the credibility of data sources if it is used to inform policy decisions, in an effort to avoid a “garbage in, gospel out” situation.

### *Advancements in technology*

Concern was raised over the value of purpose of some technology advancements (i.e. just because you can do it, does it mean you should do it?). Technology should be “fit for purpose”, that is it should be good for its application.

## **IT Applications for Invasive Species Management**

- **Nonindigenous Species Database Network (NISbase) & Global Invasive Species Information Network (GISIN)**

Shawn Dalton (U.S. Geological Survey)

Dalton focused his presentation on nonindigenous (non-native) species databases under operation by the U.S. Geological Survey (USGS). First, he discussed the Nonindigenous Aquatic Species (NAS) Database, which draws on information obtained from state and federal agencies, private individual, universities, museums, studies and scientific literature. He described NAS database capabilities and provided a list of all the information that could be obtained when the database is queried. Dalton explained that NAS database includes all non-indigenous species in the U.S., regardless of their “invasiveness” potential. He also provided information on NAS Alert System, which alerts subscribers to discoveries of nonindigenous aquatic species new to an area (e.g. state, county, drainage/watershed).

Next, Dalton talked about NISbase (International Nonindigenous Species Database Network) that combines data from multiple other databases, including the NAS database. He mentioned that security issues with NISbase limit complete data base sharing. A query function on NISbase can be used to select an information source. He also described the Global Invasive Species Information Network (GISIN) which is working to integrate international databases. At this point, work is focused on standardization of data (e.g. use of scientific name instead of common, time, geographic coordinates) and resolving outstanding issues toward making GISIN operational.

Dalton raised the issue that data input can be biased resulting from connoted terminology (e.g., alien, exotic, invasive). He emphasized that data must be integrated based on **protocol definitions**. Examples given include species origin, presence, persistence, distribution, abundance, trends, rate of spread, harmful (yes, no, potentially, unknown) regulatory listing (prohibited, restricted, non-considered, unknown). Another issue raised was the need to keep data updated. It was also mentioned that mapping data is an extremely big hurdle. To maintain data quality, mapping needs to be based on longitude and latitude settings.

- **Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS)**

Rochelle Sturtevant (National Oceanic and Atmospheric Administration; Great Lakes Sea Grant Network)

Sturtevant gave an overview of Great Lakes nonindigenous aquatic species related databases. She described an effort by the Nonindigenous Aquatic Species Database Working Group (NIASDWG) to inventory and identify needs for ten existing databases. She explained the content of each databases and the information they provide. A couple of the databases have lost funding and have not been updated in over a year. Sturtevant talked in more detail about the Great Lakes Aquatic Nonindigenous Species Information System (GLANSIS), a searchable database that also serves information to the USGS NAS database. GLANSIS includes information 185 nonindigenous species in the Great Lakes. Species are included based on the criterion that they are not native to the Great Lakes basin, but exist in the basin (i.e. in a Great Lake or in a wetland/water body directly connected to a lake). She added that a set of criteria was used for determining when a species should be considered as “established.” Criteria and species included will be reviewed in the near-term by an expert review panel. She emphasized that considerable effort had been put in to making sure users read important qualifying information about the data in the database. For instance, clarifying that the term nonindigenous does not imply “invasiveness.” Another issue raised was how to deal with the absence of data related to an infestation (i.e., the species is no longer found, so there is no data). Since it is difficult to prove a negative, there is a need for strong data to show that a population has failed or become extirpated, eradicated. It was noted that the system needs to be set up to report on the absence of a species (new absence? failed population?). Another challenge to be addressed is that databases are “hungry”, meaning they are in constant need of more, new, and up to date information.

## Discussion

### *Can a native species be “invasive”?*

Yes, but it is generally referred to as “nuisance” given the non-native connotations of using the term “invasive”. For example, the plant didymo is native to North America, but is being treated as “invasive” because of a strain difference between native and “invasive” didymo. Also, poison ivy is a native “nuisance” species.

### *Other related efforts*

The Commission for Environmental Cooperation (CEC) and NatureServe Canada are driving an initiative to establish an interoperable species database between the U.S., Canada and Mexico. The focus will start on aquatic species in trade and the Great Lakes region. Presently, Ontario is working with Nature Serve Canada to upload information to use as a demonstration for this project. Governments have yet to meet to determine standards and protocols.

## **Wrap-up Discussion**

Tim Eder (Great Lakes Commission) led a wrap-up discussion to talk about further ideas related to future directions and needs to advance management of the organisms in trade vector. Main points from this discussion follow.

- Expanding awareness and use of existing databases so that this tool is exploited to a great extent
  - How can the NatureServe database be better utilized by policy makers regarding AIS species
- Need for common source of regulations; develop a RAMONA-like effort for state-by-state regulations (updated, including emergency regulations)
- Need for inventories to facilitate sharing of best management practice information and lessons learned between pathways/efforts; information can be used to harmonize efforts in the region
- Information is needed to show what is being sold that is a problem and who is selling them
- Aquaculture and bait industries are highly regulated within the region (state licensed)
- Regulated businesses are “low hanging fruit”; need to identify unlicensed sales and target efforts there
- Inventory regulatory and other efforts in the region
- Use efforts by some industries to reach out to other industries
- Fully implement AIS education/awareness efforts across the region
- Develop an AIS education inventory/library
- Get more information by involving other state agencies (e.g. state departments of agriculture)

## **Next Steps**

- Staff will move forward in building a proposal for a larger project
- Pathway summaries will be completed in consultation with team members
- Project ideas will be based on what is being learned from OIT pathway summaries and outcomes from this workshop
- List of project ideas will be tested with project Advisory Committee
  - As ideas are developed, we will be working with representatives of the trade, Sea Grant, academics, experts from associations.