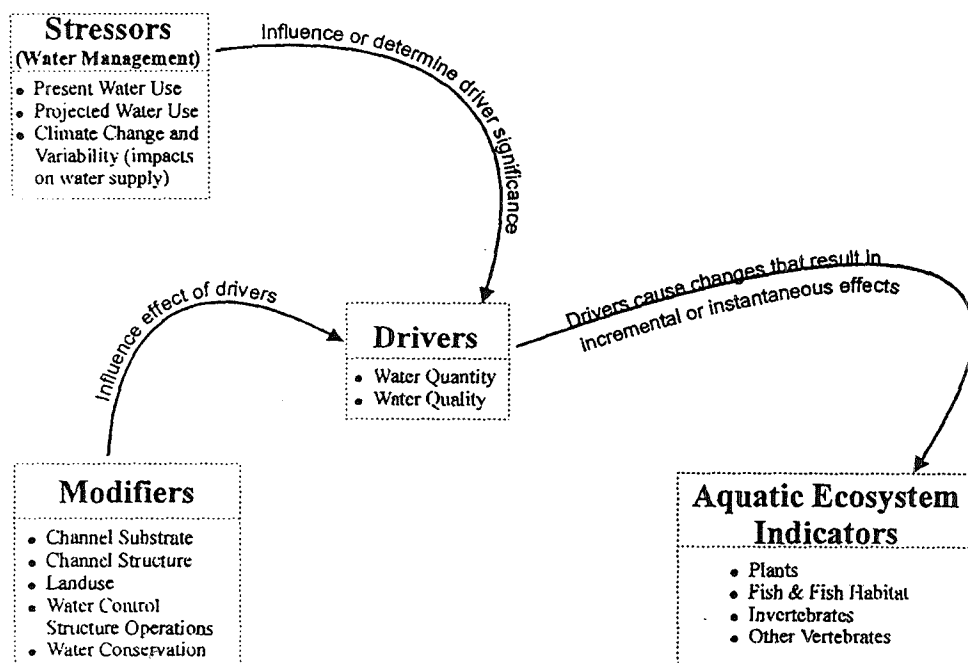


Ecological Consideration for Water Takings (Proposed Framework)

The following is a 7 step framework for asking questions relating to a water taking. This framework is based on results of an Ecological Indicators Workshop held in April, 2001 in support of the Canada/Ontario Water Use and Supply Project. The framework addresses the various indicators identified at that workshop. The workshop laid out 4 study parameters for indicators 1) Stressors, 2) Drivers, 3) Aquatic Ecosystem Indicators and 4) Modifiers.

Relationship between Study Parameters



Some modifications have been made to the original workshop indicators based primarily on comments received during the review process. Most notably, it was stressed that it makes more sense to focus on habitats of fish and other vertebrates rather than the species themselves. The primary reason for this is that it is easier to relate changes in water resources to the habitat than to a species population which may be under the influence of numerous stressors. Sedimentology which is listed below was not specifically dealt with at the indicators workshop, but has been added since it was inferred in a number of discussions.

The framework begins with asking questions directly related to the water taking itself and then follows through the various parameters. One important step at the beginning of the process is to identify any existing regional/watershed water management objectives. This will help to focus the questions required in the decision making process. A description of each of the indicators identified is provided as is an example scenario. For more details on the results of the Ecological Indicators Workshop, please refer to the workshop summary.

Definition of Indicators used in the Proposed Ecological Considerations for Water Takings Framework

NOTE: Each of the numbered headings below correspond with a numbered section in the attached diagram entitled Ecological Considerations for Water Takings.

1. Water Taking:

This is the stressor on the system. In this case a water taking has been identified. This could also be other stressors such as drought or climate change. The questions asked in this first box relate to the basic information needed to understand the details of the stressor, in this case water taking.

2. Affected Water Body

This identifies the water body or bodies affected by the stressor. This will influence the next series of questions. The framework should be followed for each affected water body. For example, if a water taking is going to affect both a groundwater source and stream, then you would follow steps 3-7 for each of these affected water bodies.

3. Water Quantity:

Water Level/Flow:

Water levels and flows assist in determining the degree to which shorelines and nearshore features will be exposed to hydraulic/hydrologic and/or weathering processes. Depending on shoreline and nearshore geomorphology, alterations of levels and flows have the potential to transform the sedimentary cycle, mobilize contaminated sediments, and change the structure of nearshore/shoreline habitats (e.g., wetlands). By closely monitoring or predicting water levels and flows in comparison to water takings, we will be better able to determine features (e.g., habitats) potentially sensitive to these changes.

Baseflow:

Baseflow is defined as the groundwater contribution to streamflow (Singh, 1992). During the winter, surface runoff decreases due to the colder temperatures and as a result, streamflow may be wholly supplied by groundwater. The drilling and depletion of aquifers is becoming increasingly common in the Great Lakes Basin as a result of changing land uses and increased development. The replenishment of groundwater aquifers has yet to be fully understood. The groundwater-flow and discharge relationship is spatially and temporally variable and its impact on the health of aquatic ecosystems is significant. By analysis and monitoring of baseflow/groundwater, negative ecological impacts might be discernible and preventable through groundwater monitoring.

water, which directly impacts the amount of photosynthesis that can take place, resulting in negative impacts on fish and other biological communities through the reduction of plant productivity, siltation of spawning beds and fouling of gills. Water temperature will also increase more rapidly and to higher levels in turbid waters.

Deposition:

The carrying capacity of water will determine the size and weight of suspended particles, or load. When the water can no longer suspend a certain size or weight of particle (due to a deceleration in the speed of the moving water), the particles are deposited. This deposition of sediment is largely responsible for the fluvial, beachfront, nearshore and offshore sedimentary features we see within the Great Lakes Basin. Re-working and re-distribution of beach material is significant on the Great Lakes. Important fluvial features include cutbanks, pointbars, floodplains, channel bars, and deltas.

Contaminated Sediments:

Sediments also aid in the transport and settling of pollutants and contaminated sediments. Sediments particles can absorb and carry agricultural and industrial chemical compounds. If these toxins are released into aquatic habitats, they can damage food sources or cause abnormalities or death in the fish or other aquatic organisms.

5. Water Quality:

Water Temperature:

Water temperature is largely responsible for the types of biota found in an aquatic environment, and is typically controlled by the amount of water entering the groundwater system (influent streams) or the amount of colder groundwater entering the stream (effluent stream). The detection of change in water temperature regimes is extremely important in those aquatic environments which include water temperature-sensitive species. Although site robustness will vary, the sites that have water temperature-sensitive species should be frequently monitored.

Water temperature is also important in lakes where thermal stratification occurs. If a shift in water temperature occurs, so too will the process of thermocline formation, and subsequently could affect ecosystem health in the lake.

Water temperature data are available extensively in the south, but have limited distribution in the northern portion of Ontario.

Dissolved Oxygen:

Some aquatic ecosystems are extremely sensitive to the level of dissolved oxygen (DO) in the water. Although fluctuations of DO occur on all time scales, monitoring programs of

pesticides to water bodies and/or from inadequately treated effluent from sewage treatment plants. Nutrients are important for identifying cause and effect at specific study sites. The response of nutrients is indicated by dissolved oxygen and algae growth. Nutrients are typically measured at provincial water quality sites.

Water Conductivity:

The use of measuring conductivity in streams and lakes has emerged as an effective means of qualifying water chemistry. Conductivity measures the amount of ions present in the water, and can provide insight into the water contributed by groundwater to a lake or stream. It can also provide an indication of the amount of pollution, if the pollution is associated with an increase in the concentration of dissolved ions. Conductivity measurements can be made quickly, but do not offer comparative quantifiable data. The data can also be highly variable between and within sites. Due to data variability, it will be difficult to rely on this indicator to determine trends. Data are available spatially across the basin, but are limited temporally.

While considering the criteria for indicator selection, the previous four water quality parameters were suggested to have the highest feasibility and greatest impact as indicators in determining areas of ecosystem sensitivity. These water quality parameters are being suggested for the ecological information they may provide, despite the identified drawbacks when compared to the criteria for indicator selection.

6A. Aquatic Habitats:

Specific habitats are required by biota during their various life stages. When contained or within proximity to aquatic environments, these habitats can be impacted by alterations to water supplies.

Fish Habitat Requirements:

Fish habitats are made up of the areas within a waterbody that fish need to carry out their life processes. Habitat includes spawning, nursery/rearing, food production, and over-wintering areas. For the majority of fish, these areas are found in the littoral zone or nearshore areas of a waterbody.

Spawning Habitats:

- Areas of the waterbody fish require to find mates, nest, and reproduce.

Nursery/Rearing Habitat:

- Areas of a waterbody fish require for their young to hatch, feed, and grow into adults.

mammals, birds, reptiles, amphibians, fish, molluscs, lepidopterans (butterflies and moths), vascular plants, mosses and lichens.

6B. Habitat Characteristics:

Location of Habitat:

Where the habitat is located will determine whether it may be influenced by the water taking.

Quality of Habitat:

Various components of aquatic habitat need to be evaluated with respect to their response to the effects of changing water quality, quantity and sedimentology. They include:

- *Food:*

The abundance of food available within a particular habitat is critical to the quality of an aquatic habitat. Changes to food sources as a result of water quantity, quality or sedimentology could impact the quality of the aquatic habitat.
- *Water Chemistry:*

Water chemistry is an important factor in determining habitat quality. A fish species may prefer a certain habitat based on its water chemistry which could be affected by changes in water quantity, quality and sedimentology.
Example: Will there be a shift from basic (fen) to acidic (swamp) system?
- *Vegetation Cover:*

This provides food and/or shelter and is an important component of all fish and other aquatic vertebrate habitats. A change in vegetative cover as a result of water quantity, water quality or sedimentology could impact the quality of those habitats.
Example: Will lower water levels induce a shift from emergent to submergent vegetation cover, and will this affect waterfowl nesting sites?
- *Environmental Preferences*

These are the environmental conditions most desirable to a species. This may include water temperature, bottom structure and type, water clarity etc.

Access to Habitat:

Depending on the physical and topographic conditions of a system, access to the various types of habitat required throughout the life cycles of fish and other vertebrates could be compromised as a result of changes to water quantity and sedimentology. Migration habitats could be particularly sensitive. (i.e. access from a lake to a wetland)

down a contour are often made up of pools and riffles with a high degree of localized substrate separation. Using historic information (e.g., data from sites evaluated under the Ontario Stream Assessment Protocols (OSAP)) we may be able to track changes in channel substrate composition and derive inferences about the effects water supply has on altering different channels as a result of their substrate composition. Pebble counts and granulometry were identified as methods for measuring or tracking changes in substrate.

Tracking changes in channel substrate and structure can help to uncover the types of external influences that are having impacts on individual channels. Further, this information can also provide us with insight regarding the potential response of these channels to varying water supplies. Based on the insight gained about the individual channels, we may be able to better comment on the possible behavior of other watercourses within the Great Lakes system.

Water Conservation:

Similar to the modifying effects resulting from the operation of water control structures, water conservation can significantly affect our impact on flow regimes within a watershed. Through the use of conservation techniques in homes, industries, and in agricultural practices, large reductions in water consumption can be achieved. These reductions result in diminished demands on water supplies, and, in turn, modify the impacts to the ecosystem components affected by changes to water quantity and quality.

Cumulative Water Takings

How much water is currently being taken from any surface or groundwater source will affect the sensitivity of that watershed to further water takings or other stressors such as drought or climate change. It is important to know, therefore, what the current water takings are from a system as this can alter the impacts of any further water taking via cumulative impacts.

References:

- Barko, John W., J.D. Madsen, and T.D. Wright, 1999. *Ecological Effects of Water Level Reductions in the Great Lakes Basin: Report on a Technical Workshop*. US Army Corps of Engineers.
- Briggs, D.J., 1993. *Fundamentals of Physical Geography - 2nd Canadian Edition*. Copp Clark Pitman Ltd, Toronto, Ontario, 692 p.
- Kawartha Fisheries Association, 2001. *Fish Habitat Requirements*. Available at URL: <http://www.scugog-net.com/kfa/fishhab.html>

Ecological Considerations for Water Takings (Proposed Framework)

EXAMPLE:

Scenario: A water taking is being proposed for a municipal water intake operation near Cambridge, Ontario. Based on the Proposed Framework, this is an example of how the procedure would be followed.

1. Water Taking	
Where?	From an drilled aquifer 20 km west of Cambridge.
How much?	Approximately 20,000 m ³ per day (0.5 % of flow)
Where's the return area?	20 km downstream of the well site, into the Grand River at a water treatment facility
How much is returned?	90% of groundwater taking
What's the quality of returned water?	Treated municipal water
What are the regional water management objectives?	To achieve: <ul style="list-style-type: none"> • Maintain or enhance baseflow; • Prevent and reduce unnatural erosive or peak flows; • Prevent and remediate contamination of surface and subsurface waters by pollutants and thermal impacts generated by land use activities; and • Maintain or enhance current rates of groundwater recharge and maintain current groundwater flow patterns. <i>(example from Toronto Region Conservation Authority)</i>

2. Affected Water Body
This water taking will affect the Grand River, groundwater aquifer, and tributary streams fed by groundwater aquifer.

3. Water Quantity	
Does the water taking affect:	
Water level?	<ul style="list-style-type: none"> • No
Water flow and flow variability?	<ul style="list-style-type: none"> • Yes - reduction of baseflow to the Grand River • Yes - reduction of flow on tributary streams that receive groundwater flow (amount undetermined)

6. What will the Water Quantity, Sedimentology & Water Quality affect?	
Aquatic Habitats of:	
Fish	
• spawning?	Yes - 2 spawning sites identified
• nursery/rearing?	Yes - 3 young-of-year sites identified
• adult feeding?	Yes - 1 site identified
• migration?	Yes - 1 site identified
Other Vertebrates:	
Birds?	No
Amphibians?	No
Reptiles?	No
Mammals?	No
Endangered Species	No
Habitat Characteristics	
Where is the habitat?	<ul style="list-style-type: none"> Affected fish habitat sites have been identified
Quality of the habitat?	<ul style="list-style-type: none"> Cold water habitats in tributaries have been identified as being vulnerable food sources: change in water temperature and nutrients may alter food sources water chemistry: water temperature and nutrients will change the water chemistry vegetation assemblages: may change due to water temperature and nutrient shifts environmental preferences: change in water temperature will affect habitat preference.
Access to the habitat?	<ul style="list-style-type: none"> access to spawning, young of year and juvenile habitats may be affected
Resilience to the habitat?	<ul style="list-style-type: none"> plant diversity may be affected landscape characteristics? Sedimentary features in river may be changed: upstream movement of cut banks and bars