Coastal Zone Technical Work Group
Peer Review Contribution

Incorporating Impact Assessment for Low Water Conditions on the Upper Great Lakes

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Summary

A basic issue, which came up during the course Coastal Process evaluations for the International Upper Great Lakes Study (IUGLS), was how to deal with low water economic impacts, especially those related to property values of riparian shoreline owners. Many different methods were suggested and examined in the course of the Study Board’s consideration of this problem. The most direct approach appeared to be the use of hedonic price analysis, a method which can be used to derive the relationship between property values and changes in lakefront amenities related to physical changes such as water levels, water quality or erosion. In this application, hedonic price analysis requires a large data set covering a representative sample of properties, and which includes property values and data on many variables other than water level which affect property values, in order that the specific impacts of fluctuating water levels be discerned from many other, perhaps more dominant factors.

It was determined by the IUGLS Technical Work Groups, Economic Advisory Group and the Study Board that while the hedonic pricing method was most appropriate, there was not sufficient data to support this application for a full evaluation of the study area, nor could the necessary data be readily collected in the time allotted and budget allocation. This leaves the IUGLS without a credible empirical method for determining the economic impact of low water impacts. However, the relatively good information on the direct physical effects of water level changes can still provide useful information as to the likely relative direction and approximate magnitude of the economic impacts. Furthermore, the Board has narrowed the focus of this evaluation by defining the problem as one of determining the relative difference in impacts – both direct physical (e.g. cost of shore protection ownership) and derived economic impacts - between the desired alternative plan and the current operating regulation plan. Since most of the formulated candidate plans have been found to have very small physical changes in lake levels – measured in centimeters - and the only plans that would be selected would be those that showed net improvements (benefits) across all sectors, the need for employing a formal economic methodology for valuing low water impacts was not viewed as pressing.

The analytical approach to high water impacts-- consisting mostly of economic damages to infrastructure from flooding and shore erosion losses--is relatively well understood, with broad applications in many flood management studies. A variety of conventional benefit-cost mechanisms have been employed by the IUGLS to measure direct damage to houses and infrastructure from high water, storms and erosion. However, loss of property value is not normally considered as part of such an assessment, because of the practical challenges in distinguishing water level impacts from other factors that may influence property values. It is understood that property values fluctuate as a function of regional economic activity and location factors (taxes, schools, quality of life, services, etc.) that have little to do with resource management impacts. Hence, the standard
approach taken to eliminate the confounding effects of regional economic fluctuations and variations is to measure those selected economic attributes (performance indicators) that are directly affected by a proposed resource management action – e.g., a new regulation plan. The direct impacts of an alternative proposed regulation plan are compared to a selected ‘basis of comparison’ plan – generally the existing plan. The relative differences between two comparable plans are used to measure those specific physical impacts that can be translated into economic measures (e.g., incremental flooding and storm damage, erosion due to high lake levels, damage to shore protection etc.). Thus, the overall absolute measures of the magnitude of long-term fluctuations in the economy together with natural lake fluctuations are not needed in such an analysis, as they are unaffected by the specific components of an alternative plan and its desired outcomes.

The IUGLS took a similar conventional economic assessment approach in analyzing the relative economic impacts of alternative lake level regulation plans for high water impacts. This approach was presented and independently peer-reviewed (Appendix B). However, because low water impacts do not generally cause direct economic damages (or at least they are difficult to quantify), as do high water, a somewhat different philosophy needed to be employed. Low water events generally affect lakeshore homeowners in a qualitative way, modifying the nature of the lakeshore experience rather than causing damage to infrastructure. Hence, it is more difficult to quantify those qualitative effects, and to disaggregate them from overall property values which represent a complex bundle of attributes that homeowner’s value. Hedonic pricing, rather than contingent valuation, was selected as the preferred approach, even as it was understood that this method may not be practically feasible – mainly because of a requirement for a large amount of very detailed and site-specific data, covering many different years and different circumstances and locations. The Independent Peer Review Group noted that hedonic pricing would be difficult to apply, but agreed that it had the most promise for this particular application, of all the methods considered. This was verified by a review of the literature and evaluation of 10 commonly used methods (Appendix A). Following this review, the IUGLS decided to further pursue the application of hedonic pricing and undertook an evaluation of the proposed method and its limitations.

Overall, several different studies were undertaken to resolve the methodological issues and to determine whether hedonic price analysis was appropriate for the study. The net conclusion of the various studies was that:

- Hedonic pricing is an appropriate method, but collecting data sufficient to yield statistically significant results would be daunting;
- Low water impacts are not consistently adverse – in other words some properties benefit from wider beaches, while others experience a reduction in amenities;
- It is clear from review of research papers reporting application of hedonic techniques, that lakefront or oceanfront properties have a high premium in
property values over those that do not have either access or a view of the water. However, separating the specific economic effects of high and low water levels from the overall lakefront premium is very difficult, especially during times of a regional economic downturn which is the dominant factor in reduced property values in the period which overlapped a period of low water.

Just as important however, is the recognition that Great Lakes regulation cannot adequately control the periodic large swings in lake levels that have caused episodes of 1 meter or more during a 5-year period. Regulation can only ameliorate the rate of rising and lowering of lake levels and compress the extreme upper and lower ranges, somewhat. The overall impact on property values – ‘with’ or ‘without’ regulation (the ‘natural regime’) would be approximately the same. Unlike a typical storage reservoir, whose water levels fluctuate widely during the season because of a relatively small volume compared to high outflows for hydropower production and water supply, the Great Lakes volumes are so large, relative to inflows, that regulation has only a marginal impact on lake levels. The long-term swings in lake levels over a decade or more can no more be regulated than the regional economy.

The 1909 Treaty implies that a regulation plan cannot make conditions any worse than the ‘natural’ (without regulation) flow and lake level regime. None of the candidate plans that have been formulated do so, and a few actually reduce the impacts of extreme lake level variability. Hence the practical value of any economic impact framework is to assist in selecting the ‘best’ (in terms of economic, ecological and physical performance) plan from among those that are acknowledged to improve the physical conditions for all the interest groups, when compared to the current operating Plan 77A.
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1.0 Introduction

The International Upper Great Lakes Study (IUGLS) is reviewing the current water level regulation strategy for outflows of Lake Superior based on impacts to key economic and ecosystem functions. Water level impacts to riparian property owners are a particular area of focus within the IUGLS. The Coastal Zone Technical Work Group (TWG) has been working to develop performance indicators that can be used to evaluate the impact of an alternative water level management strategy relative to the existing plan. Reports of past riparian damages in the Great Lakes are often focused on high water periods (e.g. flooding) and the performance indicators reflect such conditions. However, below average water levels have been experienced on the upper Great Lakes for about a decade (1999-2010). This has created considerable concern by some shoreline homeowners who have experienced negative physical impacts as a result (access to boat ramps; mudflats and shallow marinas), as well as perceived reductions in property values. The low water regime of the early 2000’s was also a contributing factor to the initiation of this IUGLS.

Given the recent importance of low water issues to a number of interests, and in particular shoreline property interests, the Study Board has made a considerable effort to adequately consider the potential impacts of persistent low water levels in the Lake Superior Regulation component of the IUGLS. This includes the development of a performance indicator that adequately captures identified low water concerns, which has been a challenging analytical task. Water levels fluctuate periodically on the Great Lakes, as do the economic fortunes of the region. Sometimes, it is impossible, in an analytical sense, to separate the effects of water level fluctuations from the overall impact of the economic downturns on real estate prices.

The Coastal Zone TWG was assigned the responsibility of assessing possible methods and advising the Study Board on a path forward for the incorporation of low water impacts to riparian property owners within the overall water level regulation strategy evaluation process. Given the importance of this issue to the public, the purpose of this peer review is to assess the approach taken by the Coastal TWG including the appropriateness of its review of a number of different methodologies and the validity of its findings, conclusions and guidance to the Study Board. To support the peer review evaluation, this report:
- defines the low water issue and rationale for assessment,
- highlights the overall Coastal Zone TWG strategy for developing a low water performance indicator,
- reviews key results from the performance indicator development process in the context of Coastal Zone TWG decisions, and
- discusses conclusions and next steps based on the existing results.
Full contractor sub-product reports are provided as appendices to allow for additional details and background on the Coastal Zone TWG decisions and recommendations to the Study Board.

2.0 Low Water Background, Rationale for Assessment, and Expected Magnitude of Water Level Regulation

Below average water level conditions were observed on the upper Great Lakes in the years leading up to the start of the IUGLS, particularly on Lake Superior and Lake Michigan-Huron. The low water levels were, and continue to be, a source of concern for many riparian property owners in the upper Great Lakes. In many cases, riparian property owners have indicated a negative impact on their use and enjoyment of the shoreline. As an example, Figure 1 shows a residential boat slip stranded due to low water conditions on Lake St. Clair in 1999. Newspaper articles from 2007 document some of the concerns of property owners in the IUGLS area, including reduced access to properties along Georgian Bay, reduced shoreline amenities in the form of unusable boat access, and increased potential along gently sloping shorelines for the growth and decomposition of vegetation in the newly exposed bottom lands.

Commonly used methods for quantifying coastal impacts often focus on high water impacts (e.g., flooding or erosion). These methods have been used to assess the benefits associated with low water conditions (e.g., larger beach area along eroding shorelines). In recent lake level studies by the IJC including the Levels Reference Study\textsuperscript{1} and the Lake

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure1.png}
\caption{Residential Boat Slip Stranded from Lake St. Clair During Low Water (1999) (from Baird, 2010 – Appendix D)}
\end{figure}

Ontario-St. Lawrence River Regulation Study\(^2\), the **physical effects** of low water impacts were incorporated within the erosion and shore protection performance indicators, but no attempt was made to quantify the perceived loss of consumer and property owner benefits of shoreline use and enjoyment as identified in recent riparian complaints. As such, the Coastal Zone TWG did not have a standard methodology and performance indicator that could be applied for incorporating the user benefits and losses associated with reported low water events.

The Coastal Zone TWG has attempted to identify and apply an appropriate method for quantifying low water impacts in the upper Great Lakes. The primary focus was to identify a method and performance indicator that would allow for the differentiation of water level management options in the form of altered Lake Superior outflow regulation. **The method needed to be appropriate, practical, and cost effective given the resource limitations of the IUGLS.** This summary report briefly highlights the collective activities of the Coastal Zone TWG regarding the efficacy of assessing low water impacts with specific reference to contractor deliverables and strategy decisions as outcomes of this effort.

One of the primary constraints on the choice of an appropriate low water performance indicator was the expected difference between alternative Lake Superior regulation strategies and the baseline (existing) plan. Lake Superior outflows are regulated on a monthly basis and the plan comparison is based on 109 year simulations of monthly water levels for all upper Great Lakes including Lake Superior, Lakes Michigan-Huron, Lake St. Clair, and Lake Erie.

The Plan Formulation and Evaluation Group (PFEG) of the IUGLS provided a suite of plausible regulation strategies during the early stages of the low water review to help frame the methodological choices. While the plans do not represent the final ones being evaluated by the Study Board, they do represent the expected range of water level scenarios. The largest differences between plans are expected on Lake Superior itself, with plan differences being reduced in downstream lakes. Figures 2 and 3 demonstrate the potential differences between regulation plan options. Figure 2 shows hydrographs for the baseline plan (77A), the unregulated scenario (PreProject), and three alternatives that represent plausible options that may be considered by the Study Board. Figure 3 shows the same plans but uses a frequency distribution based on 10 cm bins. Table 1 is based on the difference between an alternative regulation plan and the baseline condition (77A). For each month of the simulation (1308 in total), the difference between the water level of the alternative plan and the baseline plan was calculated. The standard deviation of the difference was then determined based on the full 1308 month record. On Lake Superior, the standard deviation ranges from 0.05 to 0.08 m. The

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differences in standard deviation are even smaller on the downstream lake (e.g. 0.01 to 0.02 m on Lake Erie).

Figure 2: Lake Level Hydrographs for Example Water Level Regulation Plans
Figure 3: Frequency Distributions (10 cm bins) for Example Water Level Regulation Plans
### Table 1: Standard Deviation Values (m) for the Monthly Difference Between an Alternative Regulation Plan and the Base Scenario for the 109 Year Simulation

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3.0  Methods and Overall Phased Strategy

It is important to remember there are two fundamental aspects to measuring economic impacts of fluctuating water levels that will be used by the IUGLS: i) an absolute measure of benefits and costs during particular high water level and low water level events and (ii) a relative comparison of benefits and costs related to the current regulation plan and whether the alternative plan makes conditions better or worse than the existing regulation plan.

The economic impact analysis within the IUGLS generally deals with the direct effects of naturally occurring lake level conditions (high or low lake levels in combination with storms and surges) on shoreline properties, navigation or hydropower production etc. (e.g. cost of ownership of shore protection). Such an approach is consistent with commonly applied economic impact analysis approaches (e.g. see U.S. Water Resources Council Principles and Guidelines; 1983) where proxy measures of direct impacts are used when it is impractical to determine net changes in consumer surplus and/or economic rent in the market for the suite of affected goods and services. However, direct low water property damages are hard to define and many of the concerns identified by property owners regarding low water are difficult to quantify (e.g. quantification of reduced shoreline access due to increased vegetation growth along a stretch of shoreline). As a result, the Coastal Zone TWG has moved to property values as a way to bundle 'intangible' impacts (as the Principles and Guidelines (1983) refers to them) during low water conditions. The approach is consistent with the overall Principles and Guidelines (1983) framework, although the Hedonic Pricing Model results may need to be considered within the Other Social Effects (OSE) account and not directly added to the overall assessment of National Economic Development (NED).

Given the uncertainty in the application of a particular methodology, the Coastal Zone TWG chose to establish a phased strategy for defining the potential low water issues and associated assessment techniques and applying them in the context of the IUGLS. This would allow for a progression of tasks, with discrete decision points for the IUGLS Board to address the feasibility of proceeding forward. Figure 4 highlights the overall strategy framework for the low water component of the Coastal Zone TWG effort. The initial activities included a scoping of the issue and detailed literature review of identified low water impacts and associated assessment techniques (see Section 4.1).
Using those reports as background, the Coastal Zone TWG proposed the use of a “hedonic pricing model” as a specific methodology within the socio-economic sector peer review\(^3\) (see Section 4.2). Feedback from the peer reviewers, the Study’s economic advisors and the Study Board, along with information from the low water theme report (Section 4.3) was used to modify the proposed approach. In particular, an effort was made to validate documented low water concerns using information from a real estate professional survey and a “benefit transfer” approach prior to considering the application of an empirical modeling methodology (see Section 4.4 and 4.5). Also, a model framework was established to test its application and detail the data requirements of the proposed approach (Section 4.6). The testing was used to consider the value of applying such a model at specific sites.

Figure 4: Flow Chart of Low Water Strategy and Decision Points
4.0 Results and Findings

4.1 Preliminary Methodology Scoping

A consultant was hired to undertake a general review of existing documentation regarding the assessment of low water impacts on riparian property owners including associated methodologies. Seven potential impact categories along with 10 evaluation methods were identified for consideration by the Coastal Zone TWG, along with several other preferred techniques for further review. The following section discusses major impact categories identified by the contractor as relevant and are listed in order of economic significance.

1. Property Values. Would lower water levels affect owner investment in the property?
   a. Lower property value
   b. Changed Land Uses
   c. Limit Property Development
   d. Limit Incoming Producing Property
   e. Change Neighborhoods/New Owners diversify

2. Aesthetics/Setting/Visual. Would lower water levels affect the resource that made the property attractive?
   a. Shoreline changes (natural character, algal or invasive plant growth, increased dunes, drainage ditches, accretion patterns, pollutants, trash, turbidity)
   b. Viewpoints (shore, longer walkways, lake, waterway traffic, exposed islands)
   c. Water quality (color, odor, nutrients)
   d. Air quality (odors increased seagulls, shoreline dust, breezes)
   e. Public vs. Private usage, privacy issue, annoyance

3. Waterfront Facilities and Public/Private Access. Would lower water levels affect the operation and maintenance of waterfront facilities and investments?
   a. Access to deep water (extending private/public walkways and outfalls/intakes, relocating docks, boat ramps, mooring cells, terminals, labor, materials, permits)
   b. Dredging patterns (around private docks, access channels, marina harbors, berthing areas, substrate changes, new disposal areas)
   c. Boat maintenance and repair (from increased silt or algae growth)
   d. Storm, wave, and erosion buffers (reduced erosion control measures)
   e. Exposure of submerged features to elements and erosion (municipal outfalls, etc.)

4. Recreation and Navigational Safety. Would lower water levels affect water-related activities, embayment areas, and navigation channels?
   a. Boating, swimming, camping, wading, sunbathing, beach sports, walking
   b. Marinas, state parks, nature preserves
   c. Sport fishing, hunting, bird watching (from loss of fisheries, wildlife, etc.)
d. Navigational passage ways (lighter loading of barge transports, alternative routing cost, access to shallow water fishing and pleasure boating, exposed obstacles, i.e. rocks, islands, outfalls)
e. Visitor behavior, dollars spent to local economy

5. **Job Market/Economic Development/Services.** Would lower water levels affect economic activity and the services that property owners are accustomed (government, public, commercial)?
   a. Shift in Business Activity and Tourism (Commercial fishing, barge transport, marinas, boat sales and rentals, hotels, RV parks, restaurants, recreation services)
   b. Population decrease/ Job loss/ Lost economic development from national perception of local economy
   c. Services (schools, police) provided through tax (State Income, Property, and Business)
   d. Amenities and services from larger population, business activities, or tourism (grocery stores, restaurants, marinas, support services, golf courses)

6. **Water Resource Management.** Would lower water affect existing and potential water resource management programs?
   a. Water supplies (intakes/ sources, fire protection, sewerage, effluent discharges, agricultural, irrigation, shore wells, ground water tables, demands and reserves)
   b. Hydroelectric power capacity (reservoir releases)
   c. Storm drainage management; flood capacity
   d. Alternative Method Cost (increased rates, regulatory costs/environmental impacts)

7. **Environmental.**
   a. Currents, circulation or drainage patterns
   b. Substrate changes
   c. Habitat for fish and aquatic organisms (food sources, shellfish beds, diversity)
   d. Wildlife forces and nesting areas, Islands exposed - habitats for seagulls
   e. Functions of wetlands (isolation), floodplains, sediment transfer
   f. Development of invasive (exotics) species
   g. Re-Vegetation, Tree Growth (Reduced Greenhouse Effects)
   h. Water quality (temperature, color, odor, nutrients)
   i. Protection or rebuilding of dunes and beach grass vegetation, marsh meadows

Using the impact categories identified above, a list of potential methods was prepared by the contractor for estimating economic and environmental valuations associated with potential low water **adverse and beneficial** effects to riparian property owners. In some instances, the contractor noted the techniques can be combined for a broader analysis or where reliance on a single method is undesirable. These methods include (1)

(1) **Comparative Analysis** is an item by item comparison of two or more comparable alternatives, products, sets of data, systems, etc. An example would consider the difference in real market property valuations among two homogeneous shoreline groups stemming from changed conditions (high, normal, low water levels). Another example using an appraisal type assessment would involve the analysis of waterfront vs. non-waterfront property values assessed during different times of changed conditions. A third approach might involve valuing residential property based on income productivity, quantifying the difference income levels under different time of changed conditions in terms of rent, occupancy, operating expenses, etc.

(2) The **Benefit Transfer Method** is a version of the Comparative Analysis where estimates of value are derived by transferring existing benefit estimates from studies already completed (can be outside of the region for lack of regional data) then adapted or simulated for comparison to the study area. For example, the value of sport fishing that would result from the restoration (or depletion of) fisheries in the Great Lakes could be estimated using studies of similar fisheries in the northern California.

(3) **Contingent Valuation Methods** use surveys to help respondents estimate personal willingness to pay for (or to preserve) an environmental attribute like a beautiful lake view or accessible recreational amenities. Typically the survey directly asks how much money people would be willing to pay (or willing to accept) to maintain the existence of (or be compensated for the loss of) the existence of the amenity, based on a hypothetical scenario.

(4) Contingent Choice Method (aka referenda, contingent ranking, or conjoint analysis) estimates environmental attributes, through survey, based upon asking people to make tradeoffs (or ranking in order of preference) among sets of environmental attributes or characteristics. While this method does not directly ask for willingness to pay, it is inferred from tradeoffs that include a monetary attribute, for example, choosing between lake elevations for hydropower (rates, $) vs. the amenities that higher elevations allow.

(5) The **Travel Cost Method** is most effective in valuing recreational areas and assumes that the value of a site is reflected in how much people are willing to pay to travel to visit the site. Surveys are used to calculate a dollar value of a recreational experience that places a value on avoiding changes in environmental quality. An example would consider how much visitors are willing to pay for access to a resource, considering travel time, fuel, lodging, and expenses.
(6) The **Unit Day Value and Random Utility Methods** are conceptually similar to travel cost. The unit day value method relies on expert or informed opinion and judgment to estimate the average willingness to pay of recreational users. By applying a carefully thought-out and adjusted unit day value to estimated use, an approximation is obtained that may be used as an estimate of project recreation benefits. The Random Utility Method uses the probability that an individual will visit one site out of several sites based upon varying site characteristics.

(7) **Hedonic Pricing** estimates values of specific attributes of a good or feature that directly affects market prices of some other good (most commonly applied to variations in housing prices). For example, if all characteristics of houses and neighborhoods throughout an area were identical, except for the view of the lake, then houses with better views of the lake would cost more. This higher price reflects the value of lake views to people who purchase houses in the area. Hedonic price modeling is determined both by internal characteristics of the good being sold and external factors affecting it.

(8) **Hedonic Travel Cost Analysis** surveys an individual’s preference to visit one recreational site over another (when each provides approximately comparable, though not identical services), then determines a value through a Hedonic Pricing Model for the special service not offered. The economic value of the service is determined from the extra travel expenses which people are willing to absorb in order to find the special service.

(9) The **Ecological Evaluation Method** estimates the values of ecosystem functions based upon either the costs people have historically incurred to avoid damages caused by lost ecosystem services, the cost of replacing ecosystem services, or the costs of providing substitute services. For example, the cost of credits at a wetland bank might provide a dollar value for wetlands lost.

(10) The **Productivity or Market Price Methods** estimates economic values for environmental attributes or services that contribute to the production (or marketing) of commercially marketed goods. For example, if water quality affects the productivity of irrigated agricultural crops, the economic benefits of improved water quality can be measured by the increased revenues from greater agricultural productivity or valued by the market price of the crop harvest forgone due to pollution.
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Table 2: Evaluation Matrix Prepared by CDM to Support Coastal Zone TWG Effort to Focus on Specific Methodologies (note: P = rank of preferred methods in order to address impact, X = methods that also have potential to effectively address impact)

Of the ten methods identified, the Coastal TWG asked the contractor to focus on 1) Hedonic Price Method, 2) Travel Cost Method, 3) Contingent Value Method, and 4) Comparative Analysis as part of its detailed methodology review. These are the standard types of economic analysis that have been widely used for other resource-based benefit and damage calculations.

The contractor followed with a detailed scoping exercise to define potential methodologies for specifically evaluating the impact of low water levels on residential property owners (Appendix A). For this effort, a full literature review was undertaken, potential factors influencing property value response to low water were identified, and detailed descriptions (including pros and cons) of specified low water impact methodologies were provided. The information contained within the CDM reports provided a basis for the decision by the Coastal Zone TWG to focus on the Hedonic Price Method as the proposed low water impact modeling method submitted in the socio-economic sector peer review. This method was also discussed by the IUGLS Board and it was agreed that all the methods were deficient in one respect or another for this
particular problem, but the hedonic methods had the most promise, coupled with a ‘benefit transfer’ approach.

4.2 Contribution to the Socio-Economic Sector Peer Review

As identified in the 2009 socio-economic sector evaluations peer review document, the Coastal Zone TWG considers low water impacts to riparian property owners as being a collection of various factors including loss of services through exposure of unsightly mudflats, difficulty in accessing property via water, docks left high and dry, to name a few. Using information provided through the 2008 CDM contract (section 4.1), with approval of the IUGLS Study Board and the IUGLS Economic Advisors, the Coastal Zone TWG focused on a hedonic pricing method as a way of differentiating regulation plan impacts during low water conditions by capturing this range of potential impacts in a collective manner within the context of changes to property values. The hedonic pricing method was considered to the ‘best’ among a set of imperfect methods to provide a measurable and common metric that captures all potential low water impacts (both positive and negative) affecting a property. The underlying assumption is that property value variation over time for a given shoreline section is in part a reflection of changing water levels. As mentioned in the review of potential methodologies (Appendix A),

“The basic premise [of a Hedonic Price Model] is that the price of a marketed good is related to its attributes, or the services it provides. Virtually any commodity purchased by consumers is really a bundle of attributes. A house has attributes of location, lot size, scenery, number of rooms, floor space, etc. Although a single price is paid for the house, this price reflects the cumulative value of the various characteristics. Hedonic valuation uses statistical methods to deduce how much of the overall price is due to each attribute.”

The peer reviewers of the socio-economic sector evaluations document identified concerns with the proposal to use a hedonic pricing method to assess low water impacts (see page 4 of Appendix B). Two specific issues were identified. The first relates to the application of the hedonic pricing method for extreme water levels outside historic range. Since the hedonic pricing method is based on observed changes in property values under observed water level conditions, it can be difficult to verify model response for more extreme conditions. The second issue is the recognition and acknowledged deficiencies related to lack of a complete data set. The alternative suggested by the peer reviewers was to undertake data collection within the IUGLS in the hope of undertaking further analysis in the future, beyond the Study timelines. However, given the public concern expressed regarding low water impacts, the Coastal Zone TWG considered it important to work towards a quantitative assessment within the time frame of the study. Otherwise, the Study Board would not be able to incorporate potential low water impacts in its decision.
After careful consideration of the peer review comments and further discussions with the Study’s economic advisors and technical experts, the Study Board responded to the peer review comments (see page 4 of Appendix C), reiterating the option of pursuing a hedonic pricing model, but only if further information could be obtained through other methods including benefit transfer. Part of the revised proposal back to the peer reviewers included validation of the primary assumption of the Hedonic Price Model in the context within which it was proposed to be applied. Specifically, the revised approach identified that the input of real estate professionals on the potential linkages between water levels and property values would be required as well. The Study Board also noted that if an empirical method was required in the form of the Hedonic Pricing Model, it would only be done at specific sites and only after further evaluation was given of its utility under the circumstances of data paucity and other methodological barriers, in keeping with the Coastal Zone TWG’s phased approach.

4.3 Low Water Theme Report

The Coastal Zone TWG also initiated a contract with CDM and Baird and Associates to prepare detailed theme reports on the four selected coastal performance indicator categories of flooding, erosion, shore protection, and low water. The theme reports were intended to summarize the state-of-knowledge regarding how water level fluctuations impact the specific shoreline processes in the Great Lakes, as they affect property owners. As part of the theme reports, the contractors were asked to include:

- Initial guidance on how different water levels (and combination of water levels) impact the specified process based on past Great Lakes study findings as identified by the contractor using available documentation. A discussion on sensitivity and order of magnitude was to be included to further define expected level of impacts.
- Information on shore classification (past classification strategies, existing classification information, summary tables of shoreline classification by lake (as available in Levels Reference Study documents or that had been updated more recently)).
- Overview of past large-lake impact analysis studies (Levels Reference Study, Lake Michigan Potential Damages Study, Lake Erie Erosion Study, Lake Ontario – St. Lawrence River Regulation Study) including key findings and methodologies utilized.
- Documented examples and information on past damages (location and extent of damage) including potential water level thresholds if applicable.

The full low water theme report is provided in Appendix D. The report emphasizes the potential spatial variability in assessing low water impacts. The report also notes that there are few examples of low water assessments being undertaken on the Great Lakes, which is consistent with the preliminary findings of the Coastal Zone TWG within the preliminary scoping activities. Many of the examples identified in the CDM literature
review were for small lakes and reservoirs and the theme report authors suggested the results of these studies may only be applicable to shallow and protected areas of the Great Lakes shoreline, such as embayments. In contrast, open coast areas susceptible to wave attack and erosion were considered to be less sensitive to low water conditions. The report also suggested that some riparian property owners on open coast areas are likely to perceive a benefit from low water conditions and recommends considering the range of potential impacts, both negative and positive, in any economic modeling activities. It was also recommended that because of the uncertainties and wide differences in economic responses along the varied Great Lakes shorelines, that further studies be undertaken on the potential impacts. This further supported the efforts by the Coastal Zone TWG to pursue and test a potential methodology which was broadly applicable to the varied conditions encountered, and within the timeframe of the IUGLS.

The key results from the theme report were consistent with expectations of the Coastal Zone TWG. The information was used to provide context and focus for additional low water impact analyses. In particular, the need to consider spatial variability in the impacts or benefits of low water conditions and the observation that not all locations will be negatively impacted by low water conditions were critical findings – i.e., there were extensive shoreline areas within the Great Lakes system for which low water levels were considered positive, especially to property owners along eroding coastlines.

4.4 Real Estate Professional Survey

In keeping with the Coastal Zone TWG’s phased approach and based on follow-up to the Board’s response to the socio-economic sector peer review and on guidance from the Study’s economic advisors, the Coastal Zone TWG initiated another consultant to gather information from real estate professionals within select study areas of the upper Great Lakes. The goal was to identify water levels that real estate professionals would define as producing significant shifts in sensitivity affecting property values. Additionally, information was to be gathered to determine the attributes of property ownership that are affected by low water levels and how sensitive they would be to fluctuating water levels. The work was undertaken as a way of gaining a better understanding of how water level conditions impact shoreline property use and valuation.

The summary report for the real estate professional survey is provided in Appendix E. Surveys were undertaken in six study areas including Duluth, Minnesota; Holland, Michigan; Saginaw Bay, Michigan; Windsor, Ontario; Georgian Bay (Honey Harbour), Ontario; and, Goulais Bay, Ontario. The study sites were selected to include a range of physiographic and exposure conditions in response to the findings of the theme report as discussed in Section 4.3.

Overall, the participation rate from real estate professionals was quite low. However, the information obtained was consistent with the key findings outlined in the previous literature review and low water theme report. The general perception from the real
estate professionals was that overall, water level fluctuations were generally reflected in the market price of the residential property. Some of the areas (e.g. Duluth) were not considered sensitive to low water conditions whereas other areas, such as Windsor, did indicate a relative reduction in price levels during recent low water conditions, largely due to changes in amenities such as loss of access for recreation. Despite these results, many of the real estate professionals indicated that overall economic factors were far more important in influencing property value conditions and they were unable to speculate on how prolonged low water conditions outside of the historic levels would affect property conditions.

The real estate professional survey results aligned closely with the low water theme report findings. In particular, the survey information indicated that not all shoreline areas will respond negatively to low water conditions and some areas would realize benefits. The information provided by the survey also illustrated the potential difficulties in using property values to assess low water impacts, as the values are strongly influenced by general economic conditions outside of just water level fluctuations. **The surveyed real estate agents indicated that water level fluctuations within the historical range were generally priced into the real estate market for a number of the specific study sites and they were unable to separate out the specific impact of low water levels on property values.**

### 4.5 Benefit Transfer

Again, based on the Coastal Zone TWG’s phased approach and response to the socio-economic sector peer review, a ‘benefit transfer’ analysis was undertaken using available comparable studies and considering their application to the upper Great Lakes study area. A set of relevant studies was identified based on pre-defined evaluation criteria, their key findings extracted in the context of the information gained through the real estate professional survey, and a stage-impact function was developed based on the collective results. The report is provided in Appendix F.

Essentially a ‘benefit transfer’ approach assumes that there are analogous situations and systems for which data and results could be transferred to other comparable areas. There are lake and riverfront property situations that can be more easily controlled for other external economic factors. Hence, the results of these studies could be ‘transferred’ to other comparable areas. In interpreting the results, the contractor noted that there was considerable uncertainty in the developed stage-damage function and there were very few studies to rely on, particularly for the Great Lakes shoreline. As a result, the function should only be used as a rough approximation of potential responses.

The Coastal Zone TWG, with the help of the IUGLS economic advisors, reviewed the benefit transfer results and **agreed that the findings were highly uncertain.** Given the few applicable studies, the benefit transfer results were not considered appropriate for
IUGLS use in comparing regulation plans. The findings of the real estate survey (Section 4.4) that suggested some water level fluctuation was already priced into the real estate market in many of the survey areas also suggest that property values may not be a sensitive metric for comparing regulation plans. Despite these conclusions, the economic advisors did note that the response of the various studies, while uncertain, consistently showed a negative response in property values in shallow and protected areas under lower water level conditions which was consistent with the anticipated response based on the public complaints. The economic advisors also noted that even a small decrease in property values over the broad geographic area of the study may be important. What the economic advisors did not consider, however, was the physical reality that regulation cannot ameliorate those long-term water level impacts, and that the proper basis for evaluating plans is a relative comparison of the differences in lake level regulation plans – not the absolute values of property fluctuations. The relative basis of comparison would largely eliminate the large imprint of cyclical economic conditions, as well as long-term lake level fluctuations.

4.6 Methodology Development for Hedonic Pricing Model

Despite the uncertain and often inconsistent outcomes of both the real estate professional survey and the benefit transfer evaluation, the Coastal Zone TWG at the urging of the Study Board continued to pursue, in more detail, the potential application of an empirical method for assessing low water impacts. Part of the reason for the continued pursuit of an empirical method is to support the emerging Study components including adaptive management, water level restoration, and multi-lake regulation in the context of future lake level management and climate change. CDM Consulting detailed the requirements for applying the hedonic price method in the proposed methodology that is shown in Appendix G. CDM also did a brief test using what was referred to as a “simplified hedonic price method” approach where they used ‘asking prices’ and other variables along with water levels to determine a relationship. They also compared price fluctuations for shoreline properties vs. inland (shore view) properties. Initial tests did not show significant results, but did illustrate a number of promising possibilities for future studies if a larger dataset were to be obtained. If anything, the limited sample showed a negative correlation of property values with lake levels – i.e., property values went up as lake levels went down. The initial test utilized a short time series which may not have been long enough to capture expected results. As well, the simplified methodology did not capture the range of variables that would be included within a hedonic pricing model. As a result, the initial tests cannot provide evidence that a more detailed hedonic pricing model would not identify significant relationships.
5.0 Decisions and Next Steps

Given the information obtained to date, there is reasonable evidence to suggest that some areas of the upper Great Lakes shoreline are sensitive to low water conditions. Conversely, there are many more areas, along a much longer coastline, where high water impacts are viewed with more trepidation, and lower lake levels are preferred as a way of reducing storm damages. Hence, the relative sensitivity is expected to vary spatially and there is considerable uncertainty in the application of the potential methodological approaches in the context of the Great Lakes, particularly given the small differences in regulation plan options demonstrated so far by the initial set of candidate plans developed by Plan Formulation and Evaluation Group of the IUGLS. In fact, the relative differences in lake level changes resulting from alternative regulation plans is the actual basis for evaluation and decisions. It recognizes that periodic lake level fluctuations, from high to low extremes are relatively insensitive to regulation. So, comparing the relative differences in direct economic damages and benefits of alternative regulation plans is the practiced and realistic approach to economic impact assessment. Despite these challenges, the IUGLS Study Board has indicated its support for continued refinement of an empirical method for identifying low water impacts. Part of the Study Board interest is to respond to recent IJC direction to consider potential changes beyond Lake Superior regulation. Such changes include:

- Priority setting to support adaptive management to minimize risks to extreme water levels (e.g., what are the vulnerabilities to very low water levels and how can they be reduced?),
- Consideration of the impacts and benefits of water level restoration for past channel conveyance in the St. Clair River (e.g., can the value of reducing the frequency and severity of low water conditions through restoring water levels be quantified and can that benefit be compared to any potential costs?), and
- Consideration of the value and feasibility of additional regulation structures in the Great Lakes system (e.g., can the value of reducing the frequency and severity of high and low water conditions through system-wide regulation of water levels be quantified and can that benefit be compared to any potential costs?).

The Study Board has acknowledged the difficulties and uncertainties in attempting a Hedonic Price Model approach (or similar) but has recommended that the Coastal Zone TWG undertake a test for a set of specific study sites. At a minimum, site tests would demonstrate the value in pursuing such an approach as part of an adaptive management strategy. Given the acknowledged variability in shoreline conditions and potential responses within the study area, the test site results are not expected to allow extrapolation to large sections of shoreline but instead will provide an indication of the value in applying the proposed methodology. Further identification of critical site characteristics would be required to determine if the test site results are representative of other shoreline areas. The work has not begun but is expected to be initiated in the near future. Three sites have been selected for the low water impact analysis. These
include Duluth, Minnesota; Macomb and Wayne counties on Lake St. Clair in Michigan; and southern Georgian Bay in the Collingwood/Wasaga area in Ontario. It is anticipated that feedback from the peer review process will be incorporated into the model testing. The test site activities will be based on the work undertaken by the Coastal Zone TWG, including the methodology documented in Appendix G. The critical factor is undertaking the data gathering process to determine if enough information is available to support an empirical modeling approach at the three site locations. Prior to applying the methodology, further work will be required to ensure that the results adequately support the Study Board decisions as identified previously. In particular, further consideration will be given to:

1. The time series and cross-sectional structure of the data. Realty data sets represent both types of data—cross-sectional data from different homes at different locations in the same time period are comingled with sales prices from different years. To maximize the information potential of the data, the analysis needs to account for both the cross-sectional and time-series structure of the data and stochastic errors in the data. Panel data methods are one approach to such comingled data.

2. The impact of the 10-20 year periodic fluctuations in the general economy and the property market. The hedonic proposal should describe a procedure to deal with the property value impacts of periodic fluctuations in the general economy. Approaches may include normalizing the property value data on some index of regional prices or some type of difference-in-difference method using lakeshore and non-lakeshore property values.

3. The impact of lake-level cycles. The proposal should state whether and how time series cycles may be combined with cross-sectional variation to improve the precision of the hedonic estimates. The proposal should also recognize that the lake-level cycles may be correlated with periodic fluctuations in the general economy.

4. The location of the study sites. The selection of study sites should ensure a range of shoreline physiographic conditions is included.

5. The applicability of property values as an indicator of water level impacts. The application of a hedonic price model assumes that some component of a property’s value is influenced by water levels. However, the possibility exists that selling prices do not represent all potential risks at a property. If a purchaser bases their purchase on recent water level conditions without being aware of the full range of potential conditions experienced at the site in the past, they may not properly value the location. This would make it difficult to use property values as an indicator of changing water level conditions.

While this peer review is to focus on the approach taken by the Coastal Zone TWG to attempt to select an appropriate method for assessing low water impact and the validity of its findings, results from the test site studies can be made available to the peer reviewers as a follow-up if required/requested.
6.0 Summary and Conclusions

The Coastal Technical TWG was assigned the responsibility of assessing possible methods and advising the Study Board on a path forward for the incorporation of low water impacts to riparian property owners within the overall water level regulation strategy evaluation process. Low water impacts to riparian property owners have not generally been integrated into past Great Lakes water level regulation evaluations. As such, considerable effort was placed on identifying a technique that was appropriate within the constraints of the study. This report summarizes the activities of the Coastal Zone TWG related to the development of a low water performance indicator.

The Coastal Zone TWG found that there is evidence of sensitivity to low water conditions along certain sections of the Great Lakes shoreline. However, sensitivity to low water conditions is spatially variable within the study area. In some cases, riparians may also experience benefits due to low water conditions. A benefit transfer approach for quantifying impacts was considered but the results did not support incorporation into the overall regulation plan evaluation within the IUGLS as there were few studies available for consideration and the complex characteristics of the Great Lakes shoreline made it difficult to broadly apply existing information. Given the ongoing low water concerns identified by some riparians, the Coastal Zone TWG decided to move forward with testing a hedonic price model approach for select study sites. There are acknowledged limitations to the preferred approach and the results will not support a full lake impact evaluation of low water concerns within the IUGLS. However, the test site results will provide quantitative evidence regarding whether the proposed methodology would support a broader low water evaluation in the future.
Appendix A:
Literature Review: Scoping Exercise to Define Potential Methodologies

Pages 23 to 71
Scoping Exercise to Define Potential Methodologies for Evaluating the Impact of Low Water Levels on Residential Property Owners along the Shoreline of the Upper Great Lakes

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Section 1
Introduction

This scoping exercise is being conducted by the U.S. Army Corps of Engineers for the Coastal Zone Technical Working Group of the IJC’s International Upper Great Lakes Study. The Coastal Zone Technical Working Group is responsible for assessing the sensitivity of the coastal private and public riparian interest to fluctuating water levels as influenced by Lake Superior regulation at Sault Ste. Marie. The objective of this exercise is to define potential impacts of low water levels on waterfront property owners and associated methodologies for evaluating those impacts. For this purpose, this document is composed of three sections:

Literature Review - Task 2
Identification of Factors Influencing Property Value Response - Task 3
Detailed Descriptions of Possible Low Water Impact Methodologies - Task 4

Section 2
Literature Review - Task 2

Task 2 provides an assessment of the existing literature, studies, and methodological approaches that have been used in the past to estimate the economic value of low water impacts on waterfront riparian property values. This exercise has identified approximately fifty studies as being potentially useful to the International Upper Great Lakes Study; however only a few are founded in the Great Lakes areas. These resources address a host of issues that have resulted from low water scenarios; including affects on property values, aesthetics/views, proximity, water access/recreation, and overall quality of life.

The review revealed four important pieces of information:

- the kinds of impacts from low water levels that tend to be addressed in studies;
- the different types of methodological or economic valuation approaches that are available and have been used in studies;
- the types and sources of data that were either relied upon in other studies or that could be relied upon in the International Upper Great Lakes Study;
- an abstract of the literature resource with threshold levels of property value impact due to magnitude of low levels or persistence (time) of low levels is provided if available.
Reference Sources:

The references listed below are grouped into two sections. The first section lists alphabetically those studies where the lake levels were found to affect property values. The second section lists other studies where the lake levels were found to affect amenities, such as recreation, which may contribute to lakeside property values and may be useful information for the Upper Great Lakes study.

1. Benson, Earl D. et al., 1998. Pricing Residential Amenities: The Value of a View, Journal of Real Estate Finance and Economics. This hedonic pricing study shows the impact of proximity to water on housing values and provides estimates of the value of the view amenity in single family residential real estate markets. A focus on Bellingham, WA, a city with a variety of views, including ocean, lake, and mountain, allows for differentiation of the view amenity by both type and quality. Results estimated for several recent years suggest that depending on the particular view, willingness to pay for this amenity is quite high. The highest quality ocean views are found to increase the market price of an otherwise comparable home by almost 60%; the lowest quality ocean views are found to add about 8%. For ocean views of all quality levels, the value of a view is found to vary inversely with distance from the water. Study results showed that a lake front home gets 126 percent premium vs. house with no frontage or view (mean sales price $99,578), while a lake view adds 18% relative to no view. (HM, views and water-front amenities influenced by proximity to lake, affect on property values).

2. Benson, Earl D. and Julia L. Hanson, Arthur L. Schwartz, Jr., 2000. Water Views and Residential Property Values, The Appraisal Journal. This study is an examination of the impact of a water view exposure on the value of single-family homes. The authors developed a database of 6,949 home sales of 4,931 different residences over the 1984 to 1993 time period in Bellingham, WA. Each home's view exposure of the water was determined by personal inspection and each view was graded by its quality of exposure. Depending on the quality, a water view increased a home's value by 8% to 59% in the Bellingham market in 1993. Lake frontage increased a home's value by 126% compared to a no view, no frontage home. (HM, views and proximity to lake, affect on property values).

3. Bond, Michael T., Vicky L. Seiler, and Michael J. Seiler, 2002. Residential Real Estate Prices: A Room with a View, Journal of Real Estate Research. This study examines the effect that a view of Lake Erie has on the value of a home. Homes analyzed either did or did not have a view. The results indicate that square footage and lot size also significantly affect a home’s value. More importantly, having a very desirable view of Lake Erie adds $256,545 (an 89% premium) to the value of the home. (HM, views and proximity, affect on property values).
4. Bourassa, Steven C., Martin Hoesli, and Jian Sun, 2004. *What's in a View? Environment and Planning*. Through hedonic regressive equations, this paper provides an empirical analysis of the impact of a coastal view on residential property values using a very rich database of nearly 5,000 property sales in Auckland, New Zealand. Several dimensions of a view are analyzed (type of view, scope of view, and distance to coast). It finds that wide views of water add an average of 59% to the value of a waterfront property, but that this effect diminishes quite rapidly as the distance from the coast increases. Results lead to the conclusion that aesthetic externalities are multi-dimensional and can have a substantial impact on residential property values. (HM, views and proximity impact, affect on property values).

5. Colby, Dr. Bonnie and Steven Wishart, 2002. *Riparian Areas Generate Property Value Premiums for Landowners, Agricultural and Resource Economic*. This hedonic study illustrates that property owners receive a premium when selling homes and land near riparian areas, including along lakes through the western US. The study analyzed thousands of residential home sales and identified a property value premium of three to six percent, for homes locate within one-half mile of riparian areas, after accounting for the effects of lot size, home size, and other factors. In one example, in Tucson Arizona, the premium added up to $130 million for the 25,560 homeowners located within 1.5 miles of the riparian corridor, and most of the premium was located in the first half mile.

6. Colwell, Peter F. and Carolina A. Dehring, 2005. *The Pricing of Lake Lots, Journal of Real Estate Finance and Economics*. This article reveals aspects of lakefront property pricing especially with respect to lot frontage and distance from the lake. A data set with eighty observations of vacant Lake Michigan residential properties sales is used. The unique geography of northwest Michigan provides an opportunity to tackle empirical issues associated with zoning when correlated with lot attributes, such as topography. (HM, views and proximity, affect on property values).

7. Earnhart, Dietrich, 2001. *Combining Revealed and Stated Preference Methods to Value Environmental Amenities at Residential Locations, Land Economics*. This paper combines an established hedonic analysis and contingent valuation analysis, in order to estimate more accurately the aesthetic benefits generated by the presence and quality of environmental amenities associated with the housing market of Fairfield, CT, which is experiencing an improvement in the quality of its coastal beachfront due to active restoration efforts. (HM and CV, views and proximity, affect on property values).

8. Economic Impact of Lake Michigan Levels on Recreational Boating and Charter Fishing in Five Counties, 2001, Detroit District Corps of Engineers. In 2000, an analysis of the economic impacts of extreme high and low lake levels on recreational boating and charter fishing activities was undertaken along Lake Michigan. Most of the discussion deals with low water impacts, because boats require adequate water to function and during the recent period of low water,
boaters and boating industry persons appear unable to perceive high water as a potential problem. This study looked at the indirect effects of low water by estimating the economic loss of reduced boating opportunity and damage to boats and marina dredging. It did not look at the dredging of common harbor areas or damage to structures due to oxidation or other failure. This report focuses on loss to the boating industry and the financial impact to those businesses that are largely related to boating. This study involved three lines of investigation; (1) The direct losses of marina operators, boat dealers and charter fishing companies were investigated through a survey of those businesses in the pilot counties; (2) Marina operators were asked what their losses would be if Lake Michigan water levels were to continue to decline; and (3) Owners of registered boats were asked a series of questions about the use of their boat in the study counties, spending related to that use, and whether boating would be impacted if Lake Michigan water levels were to decline. The study found a substantial financial loss to recreational boating with a decline in Lake Michigan water level. This study found (1) a large economic loss to marinas in Michigan; (2) loss of trip-related spending in the community due to a loss of available marina slips; (3) a loss of spending due to a reduction in boating days; (4) small loss to charter fishing boats; (5) some increase in boat repair costs; and (6) reductions in the number of boat launch ramps that remain usable at extreme low water levels. (CV, recreational boating and fishing influenced by lake level, affect on property values).

9. Economic Values of Protected Areas Associated with Private Property Along Michigan’s Lake Superior Shoreline, 2001, Michigan Great Lakes Protection Fund. Using hedonic analysis, this study examines 162 non-shoreline properties within three miles of Michigan’s Lake Superior shoreline to determine if proximity to public access to the lake increased property value. The study also examines 53 shoreline parcels. Distance to public access to Lake Superior was a statistically significant variable in explaining land value per acre, as were variables for parcel size, county, stumpage value, view, road access, and distance to towns. For shoreline parcels - parcel size, lakefront length, beach type, county, and distance to a small town were statistically significant. Distance to public access to Lake Superior was not statistically significant for shoreline properties. The study concludes that public access to Lake Superior does increase the value of nearby non-shoreline property, but distance to public access probably does not increase the value of shoreline properties. Proximity to towns increased the value of the properties. County location was important in both data sets. All properties in Chippewa County were more valuable. For shoreline properties, those in Houghton and Keweenaw were more valuable while those in Ontonagon County were relatively less valuable. View, stumpage value and road access were statistically significant categories for non-shoreline property while beach type and lakefront length were important for shoreline properties. View was less important for Lake Superior shoreline properties since they have a de facto view of the Lake. (HM, views and access influenced by proximity to lake, affect on property values).
10. Feather, T. D., Pettit, E. M., Ventikos, P., 1992. Valuation of lake resources through hedonic pricing. IWR Report 92-R-8. U.S. Army Corps of Engineers, Institute for Water Resources, Fort Belvoir, VA. This report describes the application of the hedonic pricing technique (property values) to the evaluation of lake resources. Hedonic models are developed to test three hypotheses: (1) Land value of lakefront property is greater than non lake-front property. (2) The effect of lake characteristics (size, topography, bathymetry, and water quality) is realized in land values. (3) Water resource related impact on land value will diminish with distance from the water sources. Results confirmed all three hypotheses and illustrated the use of the hedonic technique for evaluating such environmental amenities as lake resources. (HM, topography, bathymetry, proximity, influenced by lake level, affect on property values).

11. Fuguitt, Diana, and Shanton J. Wilcox, 1999. Cost-Benefit Analysis for Public Sector Decision Makers. This book shows how to grasp the principles of cost-benefit analysis and several related economic valuation methods, in the case of a lake’s fluctuating levels. For example, property values near the lake can reflect such benefits as the pleasure of the view and easy access to engage in specific recreational activities (e.g. boating, swimming). However, these property values include only the valuation held by the residents adjacent to or near the water body. The valuation of any non-resident who might use the lake is excluded from the property value approach. When the objective is to estimate the total social benefits associated with the lake’s fluctuating levels, the values of nonresidents must be included. This study estimates recreational benefits, through contingent valuation interviews of swimmers, boaters and other visitors. (CV, views, access, recreation influenced by lake level, affect on property values).

12. Hanson, Terrill R., Luther Upton Hatch, Howard C. Clonts, Reservoir Water Level Impacts on Recreation, Property, and Nonuser Values, August 2002. Alabama-Coosa-Tallapoosa and Apalachicola-Flint-Chattahoochee River basins' water usage has evolved from power generation to multiple uses, while recreation and housing have become increasingly valuable components. This study focused on Alabama reservoirs, using contingent valuation questions in on-site, telephone, and mail surveys to estimate impacts on lakefront property values, recreational expenditures, and preservation values for scenarios of permanent changes to reservoir water quantity. As summer full-pool duration decreased, lakefront property value decreased, and as duration increased, property values increased, but at a lesser rate. Permanent one-foot reductions in summer full-pool water levels resulted in approximately 15 percent decrease in lakefront property values. Recreational expenditures decreased approximately 30 percent for each one-foot lowering of reservoir water levels. Current nonusers of the reservoirs showed strong preferences for protecting lake levels with willingness to pay values of $47 per household or approximately 29 million for the entire watershed basin area. (CV, recreational expenditures influenced by lake level, affect on property values).
13. Hanson, L.U. and T.R. Hatch, 2001. Change and Conflict in Land and Water Use: Resource Valuation in Conflict Resolution among Competing Users, Journal of Agricultural and Allied Economics. This paper focuses on the economic methods and values that were used in evaluating different water management scenarios and their affect on recreation and lakefront property values for six Alabama reservoirs. Drawing on a Contingent Valuation (CV) model, this study determines that a permanent one foot reduction in the summer full pool lake water level results in a 4 to 15 percent decrease in property value. Conversely, a permanent 8-foot increase in winter pool water levels resulted in a 19 percent increase in property values. (CV, recreation and views influenced by lake level affect on property values).

14. Hanson, Terrill R. Department of Agricultural Economics, Mississippi State University and L. Upton Hatch Department of Agricultural Economics, Auburn University, 1999. Impact of Reservoir Water Level Changes on Lakefront Property and Recreational Values (on Lake Martin in Georgia). This paper focuses on property and recreational valuation methodologies for reservoirs with annual draw downs using hedonic and contingent property valuation survey approaches. To determine the effect of changing water levels on property values, lakefront property values were estimated, followed by estimation of the perceived property value changes for each water management scenario. Lake Martin residents valued land at approximately 32% of the total average real estate value of $166,030. Lake Martin regression results for changes in time at summer full-pool indicate a 0.58% decrease in lakefront property value for each day decrease in summer full-pool time. For example, a 60-day reduction in summer pool water levels caused a 35% decline in property value while a 60-day increase only resulted in an increase in property value of 15%. The study found that a 5-foot drop in full-pool level would result in the loss of almost half (47% or $88,000) of the value of the lakefront property. Permanent one-foot reductions in summer full-pool water levels resulted in a 4 to 15 percent decrease in property values. The study also found that a one-foot reduction in water level would result in a decrease in annual visitation frequency per person of 4.486 days. In the valuation procedure, estimates of trip expenses, annual frequency of visitation and number of people visiting from each zone or market segment are used in estimating a use value per segment. The percentage reduction in visitation per one-foot drop in water level on Lake Martin was dramatic at 19%. Thus, for every one foot reduction in water level there was approximately $12.23 million decrease in recreational use expenditures. (HM and CV, recreation influenced by lake level, affect on property values).

15. Kashian, Dr. Russell, University of Wisconsin, Department of Economics, 2007. Lake Drawdown: A Debate on the Value of 2-Inches of Water. This study uses the hedonic price model to estimate the effect a change in water level has on the value of real estate on Lake Koshkonong in Wisconsin. Hedonic techniques are employed to show that a 2-inch reduction in the lake’s water level had a significant effect on shoreline property values. From January 1997 to December 2006, there were 252 single family home sales on two lakes (105 homes on Lake
Koshkonong and 147 homes on Beaver Dam Lake). Beaver Dam Lake was chosen, as a comparison, because of its many similarities to Lake Koshkonong. Both lakes are geographically situated such that they are influenced by demand for lake frontage by the Chicago, Madison and Milwaukee markets. Of particular interest was whether the repairs to the dam and the resulting decline in water levels, cause a decrease in the appreciation of Lake Koshkonong frontage relative to Beaver Dam Lake frontage. Prior to the dam repair, a foot of shoreline at Lake Koshkonong contributed $539 to the value of a home. During the same period, a foot of shoreline at Beaver Dam Lake contributed $235 to the value of a home on that lake. Following the completion of repairs to the Indianford Dam, a foot of shoreline at Lake Koshkonong contributed $962 to the value of a home and a foot of shoreline on Beaver Dam Lake contributed $448. In other words, the value of a foot of shoreline (in the post dam repair epoch) at Lake Koshkonong rose by 79%, while the value of a foot of shoreline on Beaver Dam Lake rose by 90%. The theory and empirical evidence support the hypothesis that changing lake water levels influence shoreline values on Lake Koshkonong. In this study, the repairs to the Indianford Dam, the corresponding decline in water levels at Lake Koshkonong, and the public’s knowledge of these issues caused a substantial change in demand that contributed to a significant decrease in shoreline property values. The impacts included: (a) Potential loss of functionality of piers and ability to use the piers for boating, swimming and other water activities for all or portions of the period between May and October; (b) Loss or diminishment of the ability to access the shoreline with watercraft; (c) Degradation of the appearance of the shoreline and exposure of “mud flats” under low water level conditions; (d) Reduction of the areas of navigability by larger motorized craft; (e) Exposure of rocks and other obstacles that can damage watercraft. (HM and Comparison, loss of access and navigability influenced by lake levels, affect on property values).

16. Khatari-Chhetri, J. B. and J. C. Hite, 1989. Impact of an Interbasin Water Transfer on the Market Values of Lakeshore Properties, Strom Thurmond Institute, Clemson University. This Hedonic Pricing Model (HM) study looks at the impact of lake pool draw downs on the sales price of vacant lots in South Carolina. The study estimated that for each vertical foot of drawdown the property value was reduced value by $8,454 per acre. (HM, future waterfront development influenced by lake level, affect on property values).

17. Lansford, Notie H., Jr.; Jones, Lonnie L, 1995. Recreational and Aesthetic Value of Water Using Hedonic Price Analysis. Journal of Agricultural and Allied Economics. This study used the hedonic method to isolate recreational and aesthetic components of residential property values around two Texas reservoir lakes, Lakes Austin and Travis. As the State owned the water, recreational users had no legal rights to any quantity of water. Residential sales, date of sale, and water level deviation from average lake level at the time of sale were key variables in their model. Other amenity variables were included, such as house location relative to lakefront, urban areas, schools, housing characteristics, sales price, and aesthetic views. Sites located on bluffs and having difficult access to water were valued at
90 percent of the lot having easier access to water. Marginal house sale prices for lake level deviations from historical levels were estimated to be $717 and $650 per foot above long-term lake levels for the two study lakes. The sale of an average home was worth $9,492 more when lake was full, relative to a sale when lake was down six feet; maintenance of higher water levels added value to homes surrounding the lake and increased the recreational and aesthetic values of the residential lots. The study found that beyond the water front, the marginal price falls rapidly with increasing distance and that waterfront property had a 72 percent premium over non waterfront property. Lake view from property had 9.6 percent premium and water level at time of sale was worth about $914 per foot of elevation. Twenty-two percent of housing price was found to be attributable to the recreational and aesthetic component. (Comparison, HM, recreation and aesthetics influenced by lake level, affect on property value).

18. Loomis, John, and Adam Smith, Paul Huszar, Colorado State University, 2005. Estimating the economic benefits of maintaining residential lake levels at an irrigation reservoir: A contingent valuation study, Water Resources Research. The CV method was used to estimate homeowners' willingness to pay for water leasing to maintain stable lake levels at an irrigation reservoir in a residential neighborhood. A binary model was used to analyze households' voter referendum responses for maintaining the lake level. The median willingness to pay (WTP) was found to be $368 per year for lakefront residents and $59 per year for off-lake residents. The median WTP for lakefront residents was significantly different from off-lake residents at the 90% confidence level. Using the median WTP for lakefront and non-lakefront residents, we found that the increase in homeowner association fees would generate approximately $43,000, enough money to lease sufficient water to reach the target higher lake level in a normal water year. (CV, lake level influences on waterfront and non-lakefront property values).

19. Loomis, John, M. Feldman. 2003. Estimating the Benefits of Maintaining Adequate Lake Levels to Homeowners Using the Hedonic Property Method, Water Resources Research. These authors indicate that reduction in lake levels negatively affects housing prices. This finding has important implications for cost benefit analyses of lakes managed for irrigation and hydroelectricity production. The hedonic property method was used to estimate residents' economic benefits from maintaining high and stable lake levels at Lake Almanor, CA. Nearly a thousand property transactions over a 14-year period from 1987 to 2001 were analyzed. The linear hedonic property regression explained more than 60% of the variation in house prices. Property prices were negatively and significantly related to the number of linear feet of exposed lake shoreline. Each additional one foot of exposed shoreline reduces the property price by $108–$119. A view of the lake added nearly $31,000 to house prices, while lakefront properties sold for $209,000 more than non-lake front properties. (HM, views and shoreline (accretion) influenced by lake level, affect on property values).
20. Michael, J.A., D.A. Sides and T.E. Sullivan, 2003. *The Economic Cost of Sea Level Rise to Three Chesapeake Bay Communities*, The Maryland Coastal Zone Management Program. This study uses a hedonic model to find that for each 100 meters of distance from shore, the property value of shorefront properties decreased by about 3 to 4% along the Chesapeake Bay in Shady Side and Piney Point in Maryland and 18% on the Hooper Islands. In the case of unimproved real estate, properties witnessed a decrease in value of between 2% and 4%. (HM, views and access influenced by proximity to lake, affect on property values).

21. Muller, Nicholas Z., Middlebury College of Economics, 2007, *Using Hedonic Property Models to Value Public Water Bodies*. This study establishes that public water bodies (lakes) provide external benefits that are reflected in the value of nearby residential real estate. The study employees several economic valuation approaches to quantify nonmarket services. With a hedonic model, this paper tests whether water levels affects resource valuation (price of homes) using an actively managed reservoir in Indiana and a passively managed lake in Connecticut. The hedonic analysis found a difference in the waterfront premium of properties on Candlewood Lake, which has a stable water level, and Lake Monroe which experiences substantial seasonal lake level changes. Evidence uncovered in this study suggests that while it requires more effort to determine which properties are in waterfront locations and which properties have a view, distance-only models are not as accurate. (HM, views influenced by lake level, affect on property values).

22. Murray, M.N., et al, 2003. *Economic Effects of TVA Lake Management Policy in East Tennessee*, Center for Business and Economic Research, University of Tennessee. In this study, researchers look at the economic value and impact of longer down downs on East Tennessee Lakes and the willingness to pay for a proposed policy change. This maximum WTP would be the amount that makes the individual indifferent between the old policy and old electricity rates and a new policy with higher electricity rates. Reliance is placed on both survey response data and on a statistical analysis of the relationship between home values and lake levels for sample of households on the lakes. Contingent valuation approaches are used to estimate economic value of water level changes on property values. The report also uses a hedonic price model to estimate economic value for homeowners based upon revealed preferences (actual home buying patterns). Lowering the lake pool resulted in a decrease in the value of lake properties of 1% to 5%. In addition, the benefits of delaying the winter drawdown until September 1st range from $35 to $4,950 for a parcel on Douglas Lake. The more valuable the property associated with the lot, the larger effect was found. (CV, recreation influenced by lake level, affect on property values).

23. Parsons, George R. and Yangtu Wu, 1991. *The Opportunity Cost of Coastal and Use Controls: An Empirical Analysis*, Land Economics. This study uses hedonic price analysis of housing data from a county on the Chesapeake Bay to show the impact of coastal land use regulation to increase public areas for wider beaches
through the limiting of development on land adjacent to water. The study found the mean sales price of a waterfront structure to be $181,341, and that the value declines by $4,175 per mile from water. The study found that water frontage had 73 percent premium relative to no water frontage, and a view of water had an 8.1 percent premium. The study finds three principle effects: gain in aesthetics and clean water, loss of residential proximity to the coast, and loss of amenities at inland locations. (HM, views, loss of amenities, rental income, exposed shoreline (accretion) influenced by proximity to lake, affect on property values).


25. Provencher, Bill, 2005. Evaluating the Effects of Classification on Wisconsin Lakefront Property Values. This study demonstrates the important economic and ecological links between property valuation and shoreline zoning regulations. This hedonic study evaluates the negative effects of restricted shoreline development versus the positive amenity effect, through the use of a hedonic price equation and market sales data for 1172 lakefront properties sold before and after the classification (on restricted shoreline development) took effect. Based on these data, the overall effect of the lake classification on property value was positive, though the effect could be negative on some smaller lakes with stricter regulations. (HM, restricted shoreline development, access, and proximity, affect impact on property values).

26. Pompe, Jeffrey J. and James R. Rinehart, 1993. Beach quality and the enhancement of recreational property values. This study measures the effect of beach quality on developed and undeveloped coastal property values. As the demand for outdoor recreation has grown in recent years, more and more people have chosen seashore areas for permanent residences and vacationing. Coastal property values have risen substantially and this trend is expected to continue. Beach quality is an important determinant of coastal property values, but one that has received very little examination, partly because its influence is difficult to measure. This study uses the hedonic pricing technique to examine the contribution of beach quality, as measured by beach width, to property values in two South Carolina coastal towns. Using two separate models, it estimates the values of wider beaches to vacant lots and single family homes, both with and without water frontage. For ocean-front property, increasing the beach width from 79 to 80 feet, increases the value of developed and undeveloped lots by $558 and $754, respectively, and increases the value of lots located a half a mile from the beach by $254 and $165, respectively. The willingness to pay for wider beaches is an indication of the size
of the recreational values produced by wider beaches. (HM, comparison, proximity and wide beaches influenced by lake level, affect on property values).

27. Seiler, Michael J.; Bond, Michael T.; Seiler, Vicky L., 2001. The Impact of World Class Great Lakes Water Views on Residential Property Values. This hedonic study examines the impact of Lake Erie water views on property values. Half of the samples of homes in this study had a clear water view while the other half, adjacent properties, did not. Lake Erie is fresh water and freezes over in the winter. It provides an ocean-like view because of its size and because it generates waves large enough to surf. The study results show that having a lake view increases home value by $115,000, or by approximately 56%. This study examines the relationship between the property values of 1,172 lakefront and adjacent residential properties and several factors that are expected to influence home values. The results show that having a lake view does cause significantly higher property values. (HM, views, proximity, and access influenced by proximity to lake, affect on property values).

28. Shapiro, Lisa K. and Heidi L. Kroll, 2001. A Study of the Economic Values of the Surface Waters of New Hampshire, Phase I Report. This hedonic study identifies swimming, fishing, and boating as top recreational uses of surface water, and therefore important contributors to the water's economic value as related to waterfront property values. The Maine Study found that of direct annual expenditures for recreational uses of Maine's lakes, swimming contributed around 25 percent, fishing 14 percent, and boating more than 59 percent. (HM, recreation expenditures influenced by lake levels, affect on property values).

29. Shultz, Steven, and Schmitz, Nick, 2008. View shed analyses to measure the impact of lake views on urban residential properties. Views of two man-made lakes from nearby single-family homes in Omaha, NE, were determined through multiple listing service and geographic information system frontage classifications. Hedonic modeling determined that lake views increase home values by between 7.5% and 8.3%, which is substantial considering that the lakes were designed primarily for flood control and storm water management rather than recreational use. The study further found that frontage itself is not as critical an amenity as view, in identifying the amenity values of man-made lakes and determining the fair market values to charge developers and private citizens for the right to build homes adjacent to publicly owned and managed lakes. A standard hedonic model was used to model the factors influencing single-family housing sale prices within a half mile of two man-made reservoirs during the 2000 to 2006 period. (HM, views and proximity to lake, affect on property values).

30. Smith, V. Kerry; Palmquist, Raymond B., 1993. Temporal Substitution and the Recreational Value of Coastal Amenities, Resources for the Future, Quality of the Environment Division Discussion Paper. This paper uses the three markets (peak, pre, and post season) for weekly rentals of vacation properties along The Outer Banks of North Carolina and the hedonic model to test whether coastal amenities
influence the timing of recreation trips to the beach. Proximity to the ocean was found to be a significant influencing factor between the seasons with ocean front properties having 1.9 to 4.7 percent smaller discounts for pre-season rentals relative to other properties. (HM, lakefront amenities impact rental income and rental property values).

31. Steinnes, Donald N., 1992. *Measuring the Economic Value of Water Quality: The Case of Lakeshore Land*, Annals of Regional Science. The valuation of water quality has proved difficult for economists using hedonic methods. This hedonic study, by employing a sample of lakes and considering only property values, is able to overcome many methodological and empirical problems inherent in previous studies. One objective measure of water quality is found to be significant for various alternative specifications of the hedonic model. The results suggest that economic value may be attached to a perceived, rather than actual, measure of water quality. (HM, water quality, impacts on property values).

32. Taylor, L. O., and V. K. Smith, 2000. *Environmental amenities as a source of market power*, Land Economics. The study demonstrates that site-specific environmental amenities, such as views and proximity to a shorefront of a coastal beach, can provide a source of product-differentiating market power. Using estimates from hedonic-price equations and residual-demand models, the analysis recovers firm-specific estimates of price markups of waterfront properties as measures of market power, and uses these markups to estimate the implied marginal value for access to along coastal beaches. The application involves rental price and occupancy data for several thousand beach properties along a portion of the North Carolina coastline during the 1987 to 1992 rental seasons. (HM, views, proximity and rental income influenced by lake level, affect on property values).

The following sources were also found during the literature review. They may contain property valuation information relating to changed water levels that may be relevant to the Upper Great Lakes study, as indicated by their title and/or general abstracts. They are listed here for information.

33. Allen, D. S., R. S. Jackson, and A. R. Perr. 1996. *Alabama-Coosa-Tallapoosa and Apalachicola-Chattahoochee-Flint Comprehensive Study: Recreation Demand Element*, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. This study is an evaluation of potential water management alternatives (varied lake levels) on water-based recreation at 25 reservoir and river reaches of the two watersheds. The Corps used a combination telephone survey to determine use and expenses and mail survey employing CV questions to determine recreational boat owners change in trips for two lowered water conditions. They estimated recreational boaters spent $1.27 billion in 1995. Recreational trips were significantly reduced at lowered water levels; total boat trips were decreased by 35 percent to 63 percent depending on location. At more severe water level reductions, trips were decreased by 65 percent to 82 percent. (CV, recreational expenditures influenced by lake level, affect on recreation).
34. Baird, W.F. & Associates, Ltd. Potential Impacts and Costs of High and Low Lake Level Scenarios on Lake Michigan Harbor Structures, 2000, prepared for the USACE Detroit District. This report assesses the potential impacts of different water level scenarios on the maintenance costs at the harbor facilities on Lake Michigan and the influence of lake level scenarios on long shore transport at the harbors. The information presented in the report was intended to assist the USACE in the completion of cost-benefit analysis of the current practice of regular maintenance and repair work and the alternative of structure restoration or replacement for its Lake Michigan harbor structures. (CV, commercial navigation influenced by lake level, on property value of commercial harbor facilities).

35. Bishop R., C. Brown, M. Walsh and K. Boyle, 1989. Grand Canyon and Glen Canyon Dam Operations: An Economic Evaluation, Glen Canyon Environmental Study, U.S. Bureau of Reclamation. Perhaps one of the most prominent uses of Contingent Value Method was sponsored by the U.S. Bureau of Reclamation in its evaluation of the economic effects of re-regulating the flow releases from Glen Canyon Dam. Due to the dam being upstream from Glen Canyon National Recreation Area and Grand Canyon National Park, peaking power operations at the dam were having a deleterious effect on downstream fishing and rafting. As always, the million dollar question was "just how much is this recreation worth" as compared to the market value of the peaking power. The first studies carried out used CV to quantify how the value of fishing and rafting would change with more even base flows as compared to peaking power. The economic effects were substantial, representing changes of $2 million annually and caused the focus to turn to finding a release pattern that could increase the economic value of all the multiple purposes. (CV, recreation expenditures influenced by lake level).

36. Blomquist, Glenn, 1988. Valuing Urban Lakeview Amenities Using Implicit and Contingent Markets, Urban Studies. Amenities influence individual location decisions and affect overall social well being. This comparative study focuses on implicit contingent market approaches of valuing lake amenities. Lakeshore residents in Chicago were surveyed to collect data to estimate implied housing hedonic values and contingent values for two lake view-related amenities. For willingness to pay, contingent values are found to be within a factor of two of implicit values. The difference is consistent with sorting which occurs in the housing market. The results provide further evidence of progress in valuing amenities. (HM and CV, views and proximity affected by lake level changes).


valuation are described, special emphasis is placed on the problems and limitations of implementing these methods to value changes in the quality and quantity of water-related amenities. Major empirical efforts to value national and regional water quality improvements, water-based recreation, and ecosystem preservation are discussed. (General information on economic methods for valuing lake level influences).

39. Cordell and Bergstrom, 1993, Comparison of Recreation Use Values among Alternative Reservoir Water Level Management Scenarios. Contingent Valuation and willingness-to-pay questions were used to value alternative water level scenarios on recreational use values for four North Carolina reservoirs. The value recreational users placed on higher water levels held longer into the summer and fall seasons- i.e., an additional one, two, or three months was compared to the value of current reservoir management. It was found that maintaining higher water levels for longer periods during the summer and fall resulted in considerable gains in estimated recreational benefits. Aggregate values for changes in recreation were $3.7 million, $7.6 million and $13.6 million for one, two, or three additional months of average full-pool water levels, respectively. (CV, recreational expenditures influenced by lake level, affect on recreation).

40. Eiswerth, M. E., J. Englin, E. Fadali, and W. D. Shaw, 2000. The Value of Water Levels in Water-Based Recreation: A Pooled Revealed Preference/Contingent Behavior Model, Water Resources Research. This paper presents estimated recreation values for preventing a decline in water levels at, and even the total loss of, a large western lake that is drying up. The study uses a travel cost model; in combination with revealed preference data. They employ contingent behavior responses to hypothetical questions on alternative water levels and number of trips. This particular pooled approach has not previously been applied to examine the values of alternative water quantities in water-based recreation. (CV and TC, recreational expenditures influenced by lake level, affect on recreation).

41. Feather, Tim, et al, 2008. Property Value Impacts from Coastal Erosion on Chesapeake Bay, Maryland for the Baltimore District Corps of Engineers. As a part of the Maryland Coastal Management Study, the Corps utilized a hedonic pricing model to address how property values on the Chesapeake Bay were impacted by shoreline erosion rates. The results of this study and other research efforts was intended to provide policymakers with information relevant to measuring an accounting of social effects associated with civil works projects in the Bay. A rigorous analysis of data from the 16-county study area through OLS regression surfaces a statistical model of sales price with all the explanatory variables shown to be statistically significant. Holding all other variables constant, the model showed a 17% decrease in property value attributable to the high/medium erosion status of these properties’ shorelines. (HM, lakefront erosion impact on property values).

43. Huszar, E., W. D. Shaw, J. Englin, and N. Netusil, 1999. Recreational Damages from Reservoir Storage Level Changes, Water Resources Research. Several extreme events affecting recreation have occurred in the Humboldt River Basin of northern Nevada. This paper develops and estimates a joint model of fish catch and recreation demand, both of which depend on water levels, to assess the losses and gains from water level changes tied to events in the basin. In 1992, agricultural users completely drained the Reservoir killing millions of fish. Additionally, since 1990, gold mines located in the basin have discharged into the basin causing a decrease in fishing and related fishing expenditures in the area. (TC, recreational fishing expenditures influenced by lake level and affect on recreation).


45. Keillor, Philip and Elizabeth White (Editors), 2003. Living on the Coast: Protecting Investments in Shore Property on the Great Lakes. Detroit District U.S. Army Corps of Engineers and University of Wisconsin Sea Grant Institute. Living on the Coast describes how natural processes affect the coast, including changes in lake levels, storm surges, wave climate, transport of sediment, ice on the shore, and shoreline erosion. It covers the economics of protecting coastal investment, including shoreline property features and value, and government regulations to protect a coastal investment. (General information on lake level influences on coastal properties).

46. Lake Michigan Potential Damages Study Overview, Marie Strum, United States Army Corps of Engineers, Detroit District. The USACE Detroit District and key cooperators are conducting the Lake Michigan Potential Damages Study to assess economic impacts due to potential extreme changes in Lake Michigan water levels over the next 50 years. The objective is to create a modeling procedure and engineering/management tool for predicting future shoreline retreat and calculating economic damages due to erosion, lake level changes, and related social/cultural impacts. (General information on lake level influence).

47. Leggett, C. G., and N. E. Bockstael, 2000. Evidence of the effects of water quality on residential land prices, Journal of Environmental Economics and Management. This study uses hedonic techniques to show that water quality has a significant effect on property values along the Chesapeake Bay. Many environmental hedonic studies have almost entirely ignored the potential for omitted variables bias-the possibility that pollution sources are likely to be unpleasant neighbors. (HM, water quality impact on property values).
48. Lofgren, B.M., Quinn, F.H., Clites, A.H., Assel, R.A. Eberhardt, A.J., Luukkanen, C.L., 2002. Evaluation of Potential Impacts on Great Lakes Water Resources Based on Climate Scenarios of Two General Circulation Models. *Journal of Great Lakes Research*. The results of GCM predictions of the effects of climate change were used to derive potential impacts on the water resources of the Great Lakes basin. These impacts showed influence on the levels of the Great Lakes and through survey, the decreases in the satisfaction of the interests on commercial navigation, recreational boating, riparian property owners, and hydropower due to lake level decreases. (CV, recreation and navigation influenced by lake level changes).

49. Lyke, Audrey J., 1993. Discrete Choice Models to Value Changes in Environmental Quality: A Great Lakes Case Study. Unpublished doctoral dissertation, Department of Agricultural and Applied Economics, University of Wisconsin, at Madison. This dissertation research concerns two economic methods of natural resource valuation; the travel cost method and the contingent valuation method. In particular, the model links travel costs and fishing success rates to angler decisions of where to fish. In 1990, several hundred Wisconsin anglers, selected from fishing license sales records, were asked to complete questionnaires about their sport fishing in Wisconsin. The models are used to estimate how these values would be different if there were selected changes in lake levels and fishing quality. (CV and TC, recreational fishing expenditures influenced by lake level).

50. Mahan, B. L., S. Polasky, and R. M. Adams, 2000. Valuing urban wetlands: A property price approach, *Land Economics*. This study estimates the value of wetland amenities along a lake in the Portland, OR, using the hedonic property price model. Residential housing and wetland data are used to relate the sales price of a property to structural characteristics, neighborhood attributes, and amenities of wetlands and other environmental characteristics. Results indicate that wetlands influence the value of residential property differently than other lakefront amenities. Increasing the size of the nearest wetland to a residence by one acre increased the residence’s value by $24. Similarly, reducing the distance to nearest wetland by 1,000 feet increased the value by $436. (HM, lakeside wetlands impact on property values).

51. McGinnis, H., F.W. Bell, C. Storey and P. Rose, 1995. The economic value of Weiss Lake, report prepared by A.L. Burruss Institute of Public Service, Kennesaw State College, and Department of Economics, Florida State University. This study interviewed lake users and non-users to query among other things, their perceptions of the lake, their willingness-to-pay for water quality improvements, reasons why non-users do not visit the lake and the values that non-users place on the option to use the lake and simply knowing that Lake Weiss exists. (CV, recreation lake level, water quality).

52. Michael, H. J., K. J. Boyle, and R. Bouchard, 2000. Does the measurement of environmental quality affect implicit prices estimated from hedonic models. This case study derives implicit prices for nine measures of water clarity using hedonic
property value models of lakefront properties in Maine. Hedonic property value models are often used to derive point estimates for identifying the relationship between environmental quality and property prices. The measurement of the environmental quality variable is often selected based on convenience, but variables reflecting different perceptions about environmental quality may result in implicit prices that vary substantially. Results show that water clarity variables based on different perceptions may result in differences in implicit prices large enough to potentially affect policy decisions. (HM, water quality impacts on property values).

53. Parsons, G. R., Powell, M., 2001. Measuring the cost of beach retreat, Coastal Management. This study estimates the cost over the next 50 years of allowing Delaware's ocean beaches to erode away. Since most of the costs are expected to be land and capital loss, especially in housing, attention is focused on measuring that value. They use a hedonic price regression to estimate the value of land and structures in the region using a data set on recent housing sales. Then, using historical rates of erosion along the coast and an inventory of all housing and commercial structures in the threatened coastal area, they predict the value of the land and capital loss assuming that beaches migrate inland at these historic rates. If erosion rates remain at historic levels, the study estimates the cost of retreat over the next 50 years in year 2000 terms is about $291 million. They compare these estimates to the current costs of nourishing beaches and conclude that nourishment make economic sense, at least over this time period. (HM, lakefront erosion impact on coastal properties).

54. Pendleton, L., 1999. Reconsidering the Hedonic vs. Random Utility Method debate in the valuation of recreational environmental amenities, Resource and Energy Economics. This study reveals the two preference methods for valuing the environmental amenities of recreational resources along a lake setting: the hedonic travel cost method and the random utility method. While both methods are now widely applied, both models are shown to possess strengths and weaknesses that are important determinants of their effectiveness as valuation tools. (General information on methods for valuing lake level influence).

55. Pendleton, L., and R. Mendelsohn, 2000. Estimating recreation preferences using hedonic travel cost and random utility models, Environmental & Resource Economics. Over the last decade, several authors have questioned the validity of the hedonic travel cost model, arguing instead that the random utility model is a superior method for valuing recreational site attributes. This paper demonstrates that the two methods emanate from a similar utility theoretic framework; yet in practice these methods differ in the assumptions made in their application. Constraining the underlying utility functions to be consistent, both models are applied to the valuation of recreational site attributes of lakes in the Southeastern United States. The way in which each method estimates preferences for site attributes is shown to depend critically on the method and the underlying utility function. (HM and TC, recreation influenced by lake level).
56. Planning & Zoning Center, Inc., 1999. Lake Michigan Potential Damages Study: Prediction of Responses to Hazards related to Lake Level Changes. The purpose of this report was to estimate future costs for structural protection due to changing water levels on Lake Michigan through the identification of survey and responses of shoreline property owners and local officials regarding potential damages. One response to the survey was of interest: Question, page 31: What action would you take if several years of low water. Answer: It would be a good time to sell as property values are higher with low water levels than with high. (General information on low-level influence to property values).

57. Platt, J., 2000, Impact of Fluctuating Reservoir Elevation on Recreation Use and Value. Technical Memorandum EC-2000-02, U.S. Bureau of Reclamation, Technical Service Center, Economics Group, Denver CO. This paper presents a series of approaches for estimating the effect on recreation uses and value of fluctuating reservoir water levels. The approaches are separated into visitation and valuation based approaches. The valuation based approaches tend to be more data intensive, often requiring information from surveys of recreators and/or the general public (e.g., contingent valuation, individual travel cost methods). With the possible exception of the contingent valuation approach, where survey results could be used directly, all of the valuation based approaches involve some form of modeling and therefore statistical regression analysis. The individual travel cost model has numerous data and statistically oriented advantages, but also appears to be the most complicated of all the reviewed approaches. (CV and TC, recreational expenditures influenced by lake level, affect on recreation).

58. Platt, J., 2001. Reservoir Recreation Use Estimation Modeling With Water Level Fluctuation. Technical Memorandum EC-2001-02. U.S. Bureau of Reclamation, Denver, CO. The objective of this document was to present the results of a range of statistical use estimating models (hedonic, travel-cost, contingent value) developed to measure the change in recreation use associated with fluctuating water levels at two Kansas reservoirs. One of the driving forces was the need to address water level impacts on land based activities (e.g., camping, picnicking, wildlife observation). Water based activities (e.g., swimming, boating, boat fishing) can often be addressed using alternative methods including information on the availability of water access facilities such as boat ramps. Based on the visitation data provided for Kirwin and Webster reservoirs, there was a significant relationship between land based activities and reservoir water levels. (HM, CV, TC, Comparison, access influenced by lake level, affect on recreation).

59. Quinn, Frank H., Scientist at the Great Lakes Environmental Research Laboratory, 2004. The Potential Impacts of Climate Change on Great Lakes Transportation. This study demonstrates the potential impacts of climate change in the Great Lakes on commercial and private transportation due to low lake level conditions and mitigation factors required, such as an increased need to dredge the harbors and deepen the channels to maintain adequate depths. (General analysis on transportation influenced by low lake levels).
60. Revealing the Economic Value of Protecting the Great Lakes, 2001, prepared by the Northeast-Midwest Institute and the National Oceanic & Atmospheric Administration. This is a guidebook to familiarize resource managers and decision-makers for the Great Lakes with the techniques currently available for economic analysis and environmental benefits. This is an excellent source regarding pros and cons of the different types of environmental and economic valuation methods available. (General information on economic methods for valuing lake level influences).


63. Smith, V. Kerry; Kaoru, Yoshiaki, The Hedonic Travel Cost Model: A View from the Trenches, Land Economics, 1987. Concern over the theoretical framework underlying the hedonic travel cost model's implicit prices and the definitions of the quantities of site characteristics consumed by recreationists and those choosing to move to these locations, waterfront in particular, for the recreation purpose, motivated this analysis. This evaluation of the hedonic model considers the implication of the definitions of price and quantity measures for both the demands for the characteristics of recreation sites and for the benefit measures based on them. (General information on methods for valuing lake level influence).

64. Warbach, John, Planning & Zoning Center, Ed Mahoney, Michigan State University, Chuck Pistis, Michigan Sea Grant Extension, 2001. Lake Michigan Potential Damages Study: Economic Impact of Fluctuating Water Levels on Recreational Boating and Charter Fishing. Recreational boating accounts for hundreds of millions of dollars in yearly spending in the states surrounding Lake Michigan. This study finds that fluctuations in lake level can restrict boating activity and affect boater spending. Low water can limit the number of usable slips in marinas, reduce the size of boats that marinas can serve, require dredging to provide access, force modification of docks and seawalls, force charter fishing boats to change locations and increase the number of incidents of bottom damage to boats. It can also limit the use of boat launch ramps. This study looked at spending related to boating in Lake Michigan shoreline counties, how boating activity changed due to recent low water levels and how future changes in water level could affect boat access to Lake Michigan and boater spending. The study
was conducted through surveys of boaters, marina operators, charter boat captains and marine dealers. The study included observation of marina and launch site facilities. (CV and TC, recreation and navigation influenced by lake level and affect on spending).

65. Ward, F., B. Roach, and J. Henderson, 1996. The economic value of water in recreation: Evidence from the California drought. Water Resources Research. A significant barrier to the efficient management of reservoir systems is a lack of reliable information on how recreational values change with changing reservoir levels. Through travel cost methods, this paper presents evidence on the values of water levels for recreation at reservoirs in Sacramento, CA. Data on visitors were collected by origin and destination before and during the early part of the 1985-1991 California drought. Because lake levels varied widely during the sample period, water’s effect on visits was isolated from price and other effects. An estimated regional travel cost model containing water level as a visit predictor provided information to compute marginal values of water in recreation. For the range of the lake levels seen, annual recreational values per acre-foot of water vary from $6 at Pine Flat Reservoir to more than $600 at Success Lake. These findings are limited to use values of visitors who travel to the reservoirs and did not reflect passive use values to people who value the reservoirs but never visit them. (TC, recreational expenditures influenced by lake level).

66. Wilson, M. A., and S. R. Carpenter, 1999. Economic valuation of freshwater ecosystem services in the United States: 1971-1997, Ecological Applications. Economic value has been assigned to nonmarket goods and services provided by surface freshwater systems in the US in studies that have used variations of three approaches for a quantitative assessment of economic value: travel cost methods, hedonic pricing methods, and contingent valuation methods. To determine the economic value of nonmarket ecosystem goods and services, each method focuses on a different aspect of social benefit associated with lakes. (General information on economic methods for valuing lake level influences).

67. Zay, Daniel L., DLZ Michigan, Inc; John Warbach, Planning & Zoning Center; John Hoehn, Michigan State University. Methods for Calculating Damages Due to Extreme Water Levels on Lake Michigan. DLZ Michigan is assisting the Corps of Engineers on a lake potential damages study in five prototype counties in Wisconsin along the Lake Michigan shoreline. Calculations of potential economic damages from both high and low water scenarios and from bluff erosion are being projected over a 50-year period. Low water damage calculation methods include assessing the potential impact of low water on dredging volumes, the frequency and potential impacts on shore protection structures, and the potential economic consequences associated with water levels and the impacts it has on commercial and residential property values. (General analysis on lake level and erosion influence on property values).
Section 3
Identification of Factors Influencing Property Value Response - Task 3

Based on the literature review undertaken, Task 3 identifies three major low water impact categories that have been quantified in the past and shown in studies to have an influence on the value of riparian properties.

Specifically, this exercise provides the following:

- A listing of amenities/attributes associated with properties located adjacent to a lake
- Identification of a range of factors that have potential to influence property valuations relative to variations in water levels
- References of studies where impacts of similar features have been quantified in the past
- Prioritization of the items as critical, non-critical, or unclear for future assessment activities

Introduction

From the literature review, the quality of life for individuals who own property adjacent to lakes has been shown to be affected by lower lake levels in three ways. When a natural lake is at average levels, property owners enjoy a bundle of recreational amenities generated by the presence of the lake. Many property owners build private docks from which they access the lake with boats and personal watercraft, while others access the lake directly from the shoreline (e.g. from roads leading to boat ramps). In addition, lakefront property owners as well as individuals with property within sight of the lake enjoy an array of water views. Finally, the proximity of existing properties to the lake can be affected if the width of the beach is increased (accretion), which in some opinion is better than the alternative, losing beach width (erosion).

When water levels are lower, access to water may be impeded and views of the lake may be dramatically changed. In extreme cases, properties that were within one hundred feet of the lake may now have hundreds of yards of beach (or mud) when the lake is lower. Some property owners may find it costly to access the water from their docks, while others may find it completely impossible when levels fall. Those who access the water directly from the shoreline may be forced to hike across several feet of mud before reaching the water. Lower water levels tend to decrease the quality of lake views by exposing additional shoreline that usually lacks aesthetic appeal. The specific nature of the view from a particular parcel of property depends on the topography of lakefront land and the contours of the lake bottom. Parcels of
land adjacent to areas of the lake that are fairly deep may still have a view of the lake, but that view may be tarnished by a ring of mud around the waters’ edge. Parcels of land adjacent to shallow areas of the lake may see more drastic changes in their view as the area that was once lake turns into a mud flat that may extend several hundred feet. In fact, it is not particularly uncommon for the lake to be out of view from some parcels when lake levels are lower.

With this in mind, a parcel of lakefront property can be thought of as a bundle of the amenities that the lake provides. The following are the three most common impacts to riparian properties resulting from changed, low water conditions as found in the literature review. In addition, a range of factors are identified that have potential to influence the degree of impact on riparian property values, along with references of studies where impacts of similar features have been quantified in past.

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<td>Topography - of Lakefront Land</td>
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<td>Bathymetry - Contours of the Lake Bottom</td>
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<td>Direct Access (Dock) vs. Road Access (Public Ramp)</td>
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<td>Beach type (e.g., bedrock, mud, erosion, etc.)</td>
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<td>Backshore Beach Width/Distance to Lake</td>
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<td>Recreational Opportunities</td>
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<td>Properties Zoned for Dock vs. Not</td>
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<td>Length of Lake Frontage</td>
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<td>Rental Residential/Full Time Residential/Commercial</td>
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<td>Developed vs. Undeveloped (Vacant) Property</td>
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<td>Views/ Aesthetics</td>
<td>Lakefront or One/Two Tiers Back (Non-shoreline)</td>
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<td>Unobstructed Water View vs. Partial</td>
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<td>Topography of Lakefront Land</td>
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<td>Near shore Width of Beach/ Distance to Lake</td>
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<td>Proximity</td>
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Previous Studies. The general conclusions that emerge from the literature review include positive premiums for properties with lake-frontage (proximity), access, and views. While the studies differed in the specific water level management scenarios they evaluated; they all came to the same general conclusion, lower water levels lead to lower property values, as depicted in the following studies found during the literature review.

Access

A Lansford and Jones, Lit Review Resource #17, study found that beyond the water front, property values fall rapidly with increasing distance from the lake and that properties with lakefront access had a 72 percent premium over non lakefront property. They found the sale of an average home was worth $9,492 more when the lake was at average levels, relative to a sale when lake was lower because of increased access and recreational values. A Benson et al, #1, study found that a lake front home has a 126 percent premium versus a house with no lake front access. M.N. Murray, #22, revealed that an overwhelming majority of lakefront property owners (91 percent) with direct lake access believed the value of their property would increase (average of $38,000, or 5 percent) if water levels remained at full pool longer. Kashian, #15, showed that lowered lake levels caused a decrease in property values because of a diminishment in the ability to access the shoreline with watercraft, and lost ability to use piers for boating, swimming and other water activities.

View

The Benson et al, #1, study also showed that a lake view added 18 percent of the property value relative to a property with no view. A Parsons and Wu, #23, study found that properties with a view of the lake received an 8 percent premium compared with similar homes with no view. M.N. Murray, #22, concluded that the specific nature of the lake view from a particular parcel of property depends on the topography of lakefront land and the contours of the lake bottom. Seiler and Bond, #27, conducted a study on Lake Erie and found that because of its ocean-like qualities, a clear lake view increased home value by $115,000, or by 56%. In a later study, (Seiler and Bond, #3), found that very desirable unobstructed view of Lake Erie added $256,544 (or 89% premium) to the value of the home. Kashian, #15, showed a relationship between decreased property values and a degraded appearance of the shoreline and exposure of “mud flats” under low water level conditions.
Proximity

Parsons and Wu, #23, also measured the distance from a home to the water (proximity) and found the sales price went down as distance increased. The Loomis and Feldman study, #19, found that a view of the lake added nearly $31,000 to house prices, while lakefront properties sold for $209,000 more than non-lake front properties. Pompe and Rinehart, #26, found that for ocean-front property, increasing the beach width by one foot increased the value of properties by an average of $656, while the value of properties located a half a mile from the beach increased property values by an average of $210. Loomis, Smith, Huszar, #18, found a homeowner’s willingness to pay to maintain lake water levels (through homeowner dues) differed significantly upon proximity to the lake at $368 per year for lakefront residents versus $59 per year for off-lake residents.

General (on several impact categories)

A 2001 study (Michigan Great Lakes Protection Fund, #9) found that views and road access were statistically significant categories for non-shoreline property, while beach type and lakefront length were important for shoreline properties. A study by Hanson and Hatch, #14, found that a permanent one-foot reduction in the water level resulted in a 4 to 15 percent decrease in property values, while an eight-foot increase in the water level resulted in a 19 percent increase in values. Khatari-Chhetri and Hite, #16, estimated that for each vertical foot of lake level decrease the property value was reduced value by $8,454 per acre.
Section 4
Detailed Descriptions of Possible Low Water Impact Methodologies - Task 4

This section describes methods that are used to estimate monetary valuations associated with amenities, attributes, and/or services, such as views, access, recreation, and proximity, among others. Information adapted for this section was based upon a variety of sources, including a website funded by the US Department of Agricultural, Natural Resources Conservation Service and the National Oceanographic and Atmospheric Administration.

Using information from Tasks 1-3, this exercise identifies four methodological approaches which could potentially be used to estimate the identified impacts to riparian properties in the Upper Great Lakes Study area (including recreational and primary residences), as follows:

1) **Hedonic Pricing Method.** Estimates economic values for amenities, attributes, and/or services that directly affect the market prices of some other good. The Hedonic Pricing Method is most commonly applied to variations in real market property valuations that reflect the value of the amenities and/or attributes.

2) **Travel Cost Method.** Estimates economic values associated with amenities, attributes, and/or services of sites that are used for recreation. The Travel Cost Method assumes that the value of the site is reflected in how much people are willing to pay to travel to visit the site.

3) **Contingent Valuation Method.** Estimates economic values for virtually any amenity, attribute, and/or service, and most widely used for estimating non-use, or passive use values. The Contingent Valuation Method asks people to directly state their willingness to pay (or be compensated) for specific amenities, attributes, and/or services, based on a hypothetical scenario.

4) **Comparative Analysis.** Estimates economic values associated with amenities, attributes, and/or services by finding the differences in valuation among two similar groups stemming from changed conditions. The Comparative Analysis is most commonly applied to variations in real market property valuations that reflect the value of the amenities and/or attributes of the properties under two different actual or hypothetic scenarios as they are assessed during times of the changed conditions.
Hedonic Pricing Method

Overview

The hedonic pricing method is used to estimate economic benefit and cost values for characteristics that directly affect market prices. It is commonly applied to variations in housing prices that reflect the value of local amenities, attributes, and/or services.

The basic premise is that the price of a marketed good is related to its attributes, or the services it provides. Virtually any commodity purchased by consumers is really a bundle of attributes. A house has attributes of location, lot size, scenery, number of rooms, floor space, etc. Although a single price is paid for the house, this price reflects the cumulative value of the various characteristics. Hedonic valuation uses statistical methods to deduce how much of the overall price is due to each attribute.

Application of the Hedonic Pricing Method:

Step 1: The first step is to collect data on residential property sales in the region for a range of time periods (e.g., times of high, low, and average water levels). The required data include:

- selling prices and locations of residential properties
- property characteristics that affect selling prices, such as lot size, number and size of rooms, number of bathrooms, type and quality of construction
- neighborhood characteristics that affect selling prices, such as property taxes, crime rates, quality of schools, distance to nature preserves, and socio-economic conditions such as income level and occupational profiles
- accessibility characteristics that affect prices, such as distances to work and shopping centers, and availability of public transportation
- characteristics that affect prices (views, proximity, access, recreational facilities - docks)

In this case, the characteristic of concern is the recreation, views of the lake, aesthetics (e.g. weed growth, smell), distance to walk to the beach, available boat mooring at the house, etc. The researcher might collect data on the characteristics that would affect the recreation or views on the lake within a given radius of each property, and might also note whether a property is directly adjacent to the beach. Often, this type of data may be obtained from computer-based GIS (geographical information systems) maps. Data on housing prices and characteristics are available from municipal offices, multiple listing services, and other sources.

Step 2: Once the data are collected and compiled, the next step is to statistically estimate a function that relates property values to the property characteristics, including the distance to the lake. The data are analyzed using regression analysis, which relates the price of the property to its characteristics and the characteristic(s) of interest. Thus, the effects of different characteristics on price can be estimated.
regression results indicate how much property values will change for a small change in an isolated characteristic, holding constant the characteristics found to contribute to property valuations. The resulting function measures the portion of the property price that is attributable to each characteristic. Thus, the researcher can estimate the value of the views by looking at how the value of the average home changes when the degree of view changes.


**The Situation**
This study uses the hedonic method to isolate recreational and aesthetic components of residential property values around two lakes on the Lower Colorado River in Texas.

**The Challenge**
As the State owned the water and the property under the lake, recreational users had no legal rights to any quantity of water or the use of it. However, in order for the State to fully consider the public’s interest on several proposed water management alternatives, the State needed to assess the value placed on the recreational and aesthetic values of the lake as reflected through property values. The values revealed by the hedonic price function reflect the willingness of consumers to pay for the attribute.

**The Analysis**
The study found that the following variables were relevant and had significant effects on property values in Texas: residential sales, date of sale, and water level deviation from average lake level at the time of sale. Other amenity variables were also included, such as house location relative to lakefront, urban areas, schools, housing characteristics, sales price, and aesthetic views. Sites located on bluffs and having difficult access to the lake were valued at 90 percent of lots that had easier access to lake.

**The Results**
The marginal price of lake level deviation was found to be $717 per foot at Lake Austin and $650 per foot at Lake Travis, measuring the actual changes in reservoir water level in relation to date of property sale. The sale of an average home was worth $9,492 more when lake was full, relative to a sale when lake was down six feet; maintenance of higher water levels added value to homes surrounding the lake and increased the recreational and aesthetic values of the residential lots.
The study found that beyond the water front, the marginal price fell rapidly with increasing distance and that waterfront property had a 72 percent premium over non-waterfront property. Lake view from property had 9.6 percent premium and water level at time of sale was worth about $914 per foot of elevation. Twenty-two percent of housing price was found to be attributable to the recreational and aesthetic component.

**Why Use the Hedonic Pricing Method?** The hedonic pricing method was selected in this case because the water level changes were consistent and frequent and:

- Housing prices in the area appeared to be related to the lake frontage and recreational and aesthetic components that the lake offered.

- Data on real estate transactions and lakefront parcels were readily available, thus making this the least expensive and least complicated approach.

**Alternative Approaches:**
Since the lake was used mainly for recreation, the travel cost method might be used. Alternatively, survey-based methods, like contingent valuation, might be used. However, these methods would generally be more difficult and expensive to apply.

**How Do We Use the Results?** The results can be used to evaluate agency investments in water management proposals. The hedonic value function can be used to determine the benefits and costs of the amenities, attributes, and/or services associated with the property values, which can then be compared to the cost of the water management proposal.

**Summary of the Hedonic Pricing Method:**
The hedonic pricing method is used to estimate the value of amenities that affect prices of marketed goods. Most applications use residential housing prices to estimate the value of amenities. The method is based on the assumption that people place more value on the amenities of the property (view), rather than the structure size. Thus, prices will reflect the value of a set of characteristics that people consider important when purchasing the good. It is relatively straightforward and uncontroversial to apply, because it is based on actual market prices and fairly easily measured data. If data are readily available, it can be relatively inexpensive. If data must be gathered and compiled, the cost of an application can increase substantially.

**Advantages of the Hedonic Pricing Method:**
Hedonic valuation is useful because the transactions typically analyzed represent a large share of most consumers’ welfare. A house purchase is the single largest transaction that most consumers ever make, and the largest portion of one’s time is typically spent at home. Thus the value attached to the residential environment should represent a large share of the overall value attached to the quality of the associated amenities, attributes, and/or services.
A leading strength of the hedonic valuation method is its use of actual market transactions, which reflect real commitments of the consumer based on actual choices.

Property markets are relatively efficient in responding to information, which are good indications of value.

Property records are typically very reliable.

Data on property sales and characteristics are readily available through many sources, and can be related to other data sources to obtain descriptive variables for the analysis.

The method is versatile, and can be adapted to consider several possible interactions between market goods and the component amenities, attributes, and/or services that make that good.

**Issues and Limitations:**

- The scope of benefits that can be measured is limited to things that are related to housing prices. A hedonic analysis of property values may underestimate the full value of an amenity because it measures only the values of services captured by property values.

- Data availability often limits what can be included in a hedonic study and, more generally, the types of amenities and attributes that can be analyzed.

- The method will only capture people’s willingness to pay for perceived differences in attributes, and their direct consequences. Thus, if people aren’t aware of the linkages between the environmental attribute and benefits to them or their property, the value will not be reflected in home prices.

- The method assumes that people have the opportunity to select the combination of features they prefer, given their income. However, the housing market may be affected by outside influences, like taxes, interest rates, or other factors.

- The method is relatively complex to implement and interpret, requiring a high degree of statistical expertise.

- Large amounts of data must be gathered and manipulated. Price, attribute, and socioeconomic data are needed for a large number of individual transactions, and such detailed data are routinely available for only a few goods and services. Housing and labor market transactions are notable cases where a good deal of data are available, but even in these markets the data may not truly represent the full population.

- All appropriate data that reflects the attributes and therefore the properties composite value are needed to conduct this type of analysis. Through the use of
regression analysis and econometric modeling, the contributing internal property attributes (square feet, bedrooms, etc.) and external economic attributes (proximity to commercial, schools, etc.) can be controlled (coefficients held constant) to isolate and reflect the effects of the water levels (independent variable) on the property valuations (dependent variable).

- The time and expense to carry out an application depends on the availability and accessibility of data.

**Travel Cost Method**

**Overview:**
The travel cost method is used to estimate economic use values associated with amenities, attributes, and/or services of sites that are used for recreation. It assumes that the value of the site is reflected in how much people are willing to pay to travel to visit the site. The method can be used to estimate the economic benefits or costs resulting from:

- changes in access costs for a recreational site
- elimination of an existing recreational site
- addition of a new recreational site
- changes in amenities, attributes, or services at a recreational site

Note: The literature review found no examples of using the travel cost method alone to segregate the value of recreational spending on property values. However, the literature review found a hedonic travel cost analysis used in support of a Hedonic analysis. The study used recreation (fishing) as the primary reason the residents owned lake front property. The analysis found that with decreases in fishing expenditures because of lake level decrease; property values decreased, Pendleton and Mendelsohn, Resource #55.

The basic premise of the travel cost method is that the time and travel cost expenses that people incur to visit a site represent the “price” of access to the site. Thus, peoples’ willingness to pay to visit the site can be estimated based on the number of trips that they make at different travel costs. This is analogous to estimating peoples’ willingness to pay for a marketed good based on the quantity demanded at different prices. The travel cost method is relatively uncontroversial, because it is modeled on standard economic techniques for measuring value, and it uses information on actual behavior rather than verbal responses to hypothetical scenarios.

**Application of the Travel Cost Method:**
On average, people who live farther from a site will visit it less often, because it costs more in terms of actual travel costs and time to reach the site. The number of visits from origin zones at different distances from the site, and travel cost from each zone,
are used to derive an aggregate demand curve for visits to the site, and thus for the recreational or scenic services of the site. This demand curve shows how many visits people would make at various travel cost prices, and is used to estimate the willingness to pay for people who visit the site (whether they are charged an admission fee or not).

Other factors may also affect the number of visits to a site. People with higher incomes will usually make more trips. If there are more alternative sites, or substitutes, a person will make fewer trips. Factors like personal interest in the type of site, or level of recreational experience will affect the number of visits. A more thorough application will take these and other factors into account in the statistical model.

**Data Needs:**

Typically data are collected through surveys of individual travelers—on-site, telephone or mail surveys may be used. The survey data usually include the characteristics of individuals, the number and locations of their trips, and information for deriving travel costs. On-site surveys can provide heavy sampling of users, but these surveys over sample frequent users and need to be augmented with general population data to learn what proportion of the population uses the resource. In addition, especially for simpler applications, much information may be available from state and county resource agencies, or from federal surveys, such as the National Survey of Fishing, Hunting and Wildlife Associated Recreation, published every five years by the U.S. Fish and Wildlife Service.

To apply the travel cost method, information must be collected about:

- number of visits from each origin zone (usually defined by zipcode)
- demographic information about people from each zone
- round-trip mileage from each zone
- travel costs per mile
- the value of time spent traveling, or the opportunity cost of travel time

More complicated, and thorough, applications may also collect information about:

- characteristics of the individuals
- exact distance that each individual traveled to the site
- exact travel expenses
- the length of the trip
Scoping Exercise
Shoreline Upper Great Lakes

- the amount of time spent at the site
- other locations visited during the same trip, and amount of time spent at each
- substitute sites that might be visited instead of this site, and the travel distance to each
- other reasons for the trip (is the trip only to visit the site, or for several purposes; broader economic reasons, e.g. gas prices, recessions)
- quality of the recreational experience at the site, and at similar sites (e.g., fishing success)
- perceptions of environmental quality at the site
- characteristics of the site and other, substitute, sites

The most controversial aspects of the travel cost method include accounting for the opportunity cost of travel time, how to handle multi-purpose and multi-destination trips, and the fact that travel time might not be a cost to some people, but might be part of the recreational experience.


The Situation

This study uses the travel cost method to estimate the effect on recreation uses and value of fluctuating reservoir water levels. The approaches are separated into two categories: 1) impacts to recreation visitation and 2) impacts to recreation value. The purpose of the study was to provide a basis to apply to a variety of other river basins in which a public agency controls the management of multiple water uses.

The Analysis

With little reliable information to rely upon, a significant barrier to efficiently and economically manage federal reservoir systems was how recreational values change from changing reservoir levels. Through travel cost methods, this paper presented evidence on the values of water levels for recreation at a Corps of Engineer reservoir in Sacramento, CA. Data on visitors were collected by origin and destination before and during the early part of the 1985-1991 California drought. Because lake levels varied widely during the sample period, water level effects on visitation were isolated from price and other effects. An estimated regional travel cost model containing water level as a visit predictor provided information to compute marginal values of water in recreation.
The Results
For the range of the lake levels evaluated, annual recreational values per user per acre-foot of water varied from $6 at Pine Flat Reservoir to more than $600 at Success Lake. These findings were limited to use values of visitors who travel to the reservoirs and did not reflect passive use values to people who value the reservoirs but never visit them.

Why Use the Travel Cost Method?
The travel cost method was selected in this case for two main reasons:

- The site is primarily valuable to people as a recreational site. There are no endangered species or other highly unique qualities that would make non-use values for the site significant. Nonuse values are values that do not depend on personal use of environmental amenities (e.g., recreational fishing).

- The expenditures for projects to protect the site are relatively low; thus, using a relatively inexpensive method like travel cost makes the most sense.

Alternative Approaches:
Contingent valuation methods could also be used in this case. While they might produce more precise estimates of values for specific characteristics of the site, and also could capture non-use values, they would be considerably more complicated and expensive to apply.

Options for Applying the Travel Cost Method:
There are several variations of the travel cost method. These include: (1) A simple zonal travel cost approach, using mostly secondary data, with some simple data collected from visitors, (2) An individual travel cost approach, using a more detailed survey of visitors, and (3) A random utility approach using survey and other data, and more complicated statistical techniques.

Zonal Travel Cost Approach:
The zonal travel cost method is the simplest and least expensive approach. It will estimate a value for recreational services of the site as a whole. It is applied by collecting information on the number of visits to the site from different distances. Because the travel and time costs will increase with distance, this information allows the researcher to calculate the number of visits “purchased” at different “prices.” This information is used to estimate the economic benefits for the recreational services of the site.

Individual Travel Cost Approach:
The individual travel cost approach uses survey data from individual visitors in the statistical analysis, rather than data from each zone. This method thus requires more data collection and slightly more complicated analysis, but will give more precise
results. For a hypothetical example of a recreational fishing site, rather than simply collecting information on number of visitors and their zipcodes, the researcher would conduct a survey of visitors.

Using the survey data, the researcher can estimate, using regression analysis, the relationship between number of visits and travel costs and other relevant variables. This time, the researcher would use individual data, rather than data for each zone. The regression equation gives the demand function for the “average” visitor to the site, and the area below this demand curve gives the average consumer surplus. This is multiplied by the total relevant population (the population in the region where visitors come from) to estimate the total consumer surplus for the site. Because additional data about visitors, substitute sites, and quality of the site has been collected, the value estimates can be “fine tuned” by adding these other factors to the statistical model.

**Random Utility Approach:**

The random utility approach is the most complicated and expensive of the travel cost approaches. It is also the “state of the art” approach, because it allows for much more flexibility in calculating benefits. It is the best approach to use to estimate benefits for specific characteristics, or quality changes, of sites, rather than for the site as a whole. It is also the most appropriate approach when there are many substitute sites. It assumes that individuals will pick the site that they prefer, out of all possible fishing sites. Individuals make tradeoffs between site quality and the price of travel to the site. Hence, this model requires information on all possible sites that a visitor might select, their quality characteristics, and the travel costs to each site.

**Advantages of the Travel Cost Method:**

- The travel cost method is relatively uncontroversial because it mimics conventional empirical techniques used elsewhere by economists to estimate economic values based on market prices.

- The method is based on actual behavior—what people actually do—rather than—what people say they would do in a hypothetical situation, “willingness to pay.” Individuals must spend money and time, and their economic values are deduced from their behavior.

- The method can be applied without enormous expense.

- Data can be collected onsite and on-site surveys provide opportunities for large sample sizes, as visitors tend to be interested in participating.

- The results are relatively easy to interpret and explain.

**Issues and Limitations of the Travel Cost Method:**

- The greatest disadvantage of the travel-cost method is that it cannot be employed unless some observable behavior can be used to reveal values.
The range of variation in the data should be sufficient to cover the range of policies to be examined.

The travel cost method assumes that people perceive and respond to changes in travel costs the same way they would respond to changes in admission price.

The simplest models assume that individuals take a trip for a single purpose – to visit a specific recreational site. Thus, if a trip has more than one purpose, the value of the site may be overestimated. It can be difficult to apportion the travel costs among the various purposes.

Defining and measuring the opportunity cost of time, or the value of time spent traveling, can be problematic. Because the time spent traveling could have been used in other ways, it has an "opportunity cost." This should be added to the travel cost, or the value of the site will be underestimated. However, there is no strong consensus on the appropriate measure—the person’s wage rate, or some fraction of the wage rate—and the value chosen can have a large effect on benefit estimates. In addition, if people enjoy the travel itself, then travel time becomes a benefit, not a cost, and the value of the site will be overestimated.

The availability of substitute sites will affect values. For example, if two people travel the same distance, they are assumed to have the same value. However, if one person has several substitutes available but travels to this site because it is preferred, this person’s value is actually higher. Some of the more complicated models account for the availability of substitutes.

Those who value certain sites may choose to live nearby. If this is the case, they will have low travel costs, but high values for the site that are not captured by the method.

Interviewing visitors on site can introduce sampling biases to the analysis.

Standard travel cost approaches provides information about current conditions, but not about gains or losses from anticipated changes in resource conditions.

In order to estimate the demand function, there needs to be enough difference between distances traveled to affect travel costs and for differences in travel costs to affect the number of trips made. Thus, it is not well suited for sites near major population centers where many visitations may be from "origin zones" that are quite close to one another.

The travel cost method is limited in its scope of application because it requires user participation. It cannot be used to assign values to on-site environmental features and functions that users of the site do not find valuable. It cannot be used to value off-site values supported by the site. Most importantly, it cannot be used to measure nonuse values. Thus, sites that have unique qualities that are valued by non-users will be undervalued. The method cannot be used where travel is not directly involved (e.g. owner occupied shoreline) and does not capture consumer's surplus.
Contingent Valuation Method

Overview

The contingent valuation method is used to estimate economic values for virtually any amenity, attribute, and/or service. It can be used to estimate both use and non-use values, and it is the most widely used method for estimating non-use values. Non-use values are values that do not depend on personal use of amenities (e.g., spending for recreation). It can find value on anything from the enjoyment of a scenic vista or a wilderness experience, to appreciating the option to fish or bird watch in the future, or the right to bequest those options to your grandchildren. It also includes the value people place on simply knowing that giant pandas or whales exist.

It is also the most controversial of the non-market valuation methods. It asks people to directly state their willingness to pay for specific amenities, attributes, and/or services, based on a hypothetical scenario.

It is clear that people are willing to pay for non-use, or passive use, environmental benefits. However, these benefits are likely to be implicitly treated as zero unless their dollar value is somehow estimated. So, how much are they worth? Since people do not reveal their willingness to pay for them through their purchases or by their behavior, the only option for estimating a value is by asking them questions.

People are asked for the amount of compensation they would be willing to accept to give up a specific attribute. It is called “contingent” valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the attribute or service. The contingent valuation method is also referred to as a “stated preference” method, because it asks people to directly state their values. The fact that CV is based on what people say they would do, as opposed to what people are observed to do, and is the source of its greatest strengths and its greatest weaknesses. It is one of the only ways to assign dollar values to non-use values of the environment—values that do not involve market purchases and may not involve direct participation. These values are sometimes referred to as “passive use” values.

Application of the Contingent Valuation Method:

Step 1: The first step is to define the valuation problem. This would include determining exactly what services are being valued, and who the relevant population is. In the case of the Great Lakes, the resource to be valued is a specific site and the services it provides is primarily recreation. Because it is a federally owned public lake, the relevant population would be all citizens of the U.S.

Step 2: The second step is to make preliminary decisions about the survey itself, including whether it will be conducted by mail, phone or in person, how large the sample size will be, who will be surveyed, and other related questions. The answers will depend on the importance of the valuation issue, the complexity of the question being asked, and the size of the budget.
In-person interviews are generally the most effective for complex questions, because it is often easier to explain the required background information to respondents in person, and people are more likely to complete a long survey when they are interviewed in person. In some cases, visual aids such as videos or color photographs may be presented to help respondents understand the conditions of the scenario that they are being asked to value. In-person interviews are generally the most expensive type of survey. However, mail surveys that follow procedures that aim to obtain high response rates can also be quite expensive. Mail and telephone surveys must be kept fairly short, or response rates are likely to drop dramatically. Telephone surveys may be less expensive, but it is often difficult to ask contingent valuation questions over the telephone, because of the amount of background information required.

**Step 3:** The next step is the actual survey design. This is the most important and difficult part of the process, and may take six months or more to complete. It is accomplished in several steps. The survey design process usually starts with initial interviews and/or focus groups with the types of people who will be receiving the final survey, in this case the general public. In the initial focus groups, the researchers would ask general questions, including questions about peoples’ understanding of the issues related to the site, whether they are familiar with the site and its fishing possibilities, whether and how they value this site and the habitat services it provides.

In later focus groups, the questions would get more detailed and specific, to help develop specific questions for the survey, as well as decide what kind of background information is needed and how to present it. For example, people might need information on the location and characteristics of the site, the uniqueness of species that have important habitat there, and whether there are any substitute sites that provide similar habitat. The researchers would also want to learn about peoples’ knowledge of hydropower and its impacts, and whether hydropower is a controversial use of the site. If people are opposed, they may answer the valuation questions with this in mind, rather than expressing their value for the services of the site. At this stage, different approaches to the valuation question and different payment mechanisms would be tested. Questions that can identify any “protest” bids or other answers that do not reveal peoples’ values for the services of interest would also be developed and tested at this stage.

After a number of focus groups have been conducted, and the researchers have reached a point where they have an idea of how to provide background information, describe the hypothetical scenario, and ask the valuation question, they will start pre-testing the survey. Because the survey will be conducted by mail, it should be pretested with as little interaction with the researchers as possible. People would be asked to assume that they’ve received the survey in the mail and to fill it out. Then the researchers would ask respondents about how they filled it out, and let them ask questions about anything they found confusing. Eventually, a mail pretest might be conducted. The researchers continue this process until they’ve developed a survey that people seem to understand and answer in a way that reveals their values for the services of the site.
Step 4: The next step is the actual survey implementation. The first task is to select the survey sample. Ideally, the sample should be a randomly selected sample of the relevant population, using standard statistical sampling methods. In the case of a mail survey, the researchers must obtain a mailing list of randomly sampled U.S. citizens. They would then use a standard repeat-mailing and reminder method, in order to get the greatest possible response rate for the survey. Telephone surveys are carried out in a similar way, with a certain number of calls to reach the selected respondents. In-person surveys may be conducted with random samples of respondents, or may use “convenience” samples – asking people in public places to fill out the survey.

Step 5: The final step is to compile, analyze and report the results. The data must be entered and analyzed using statistical techniques appropriate for the type of question. In the data analysis, the researchers also attempt to identify any responses that may not express the respondent’s value for the services of the site. In addition, they can deal with possible non-response bias in a number of ways. The most conservative way is to assume that those who did not respond have zero value.

Case Study Example of the Contingent Value Method – Values of Recreational Amenities of Lake Martin in Georgia. Hanson, Terrill R. Department of Agricultural Economics, Mississippi State University and L. Upton Hatch Department of Agricultural Economics, Auburn University, 1999. Impact of Reservoir Water Level Changes on Lakefront Property and Recreational Values (on Lake Martin in Georgia).

The Situation

This study uses the contingent valuation method to isolate recreational components of residential property values along a lake in Georgia. The valuation question of concern was how much recreation was worth to the owners, compared to the market value of the peak-load power supply.

The Analysis

The lake reservoir drawdown schedule was regulated by FERC (through the Alabama Power Company), so to determine the effect of changing water levels on property values, lakefront property values were found, followed by an estimation of the perceived property value changes for each water management scenario that FERC was proposing.

Step 1: Landowner Survey Data. Mail surveys were sent to Lake Martin lakefront landowners from October 1994 to May 1995 by a professional consulting company. Lakefront landowner mailing lists were obtained from homeowner associations, utility companies, and county plat maps. Randomly selected addresses from the master list were selected. After three weeks, a reminder card was sent and if there was no response an alternate was chosen and sent a survey. Of the 561 Lake Martin surveys mailed out 231 were returned and usable.
The mail survey instrument contained 38 questions that focused on characteristics of the property and the landowner, values associated with lakefront property, and effects of changing water conditions on property values. Contingent property valuation questions were asked to establish the relationship between changing water conditions and landowner property values. Respondents were asked to estimate values for their land, house and improvements. The impact of changes in length of time at summer full-pool, permanent changes to summer full-pool water level, and winter drawdown were the three areas of interest.

Step 2: Recreational User Survey Data. Two surveys were conducted that focused on recreational users. One survey was an onsite survey that directly interviewed users on the lake and the second survey was a telephone survey targeting households with telephones within the watershed basin of the study reservoir. The on-site user survey was developed, field tested, and implemented on Lake Martin reservoir from July 1994 to July 1995. Clerks were trained in conducting the survey and recording the data. Random stratified sampling procedures were used over time and lake area. There were 202 completed recreational user surveys for Lake Martin. Socio-demographic data were collected in the survey as well as primary activity information the respondent was engaged in on the day of the survey. Hours of activity were asked as well as how many days a year the person did this primary activity at the reservoir. The respondent’s trip expenses were asked by category of expense, i.e., gas for car/boat, food - beverages and ice, picnic supplies, lodging, rental equipment, and activity supplies.

From October to November 1995, a telephone survey of households in the Coosa and Tallapoosa Rivers watershed was conducted by the Auburn University Center for Governmental Services. Prior to the survey a pre-test was conducted to determine any unanticipated problems. The survey duration was kept and averaged six minutes per interview. This telephone survey complemented data collected through the on-site user survey. The sampling frame was population proportional for 25 Alabama and 12 Georgia counties within the Coosa and Tallapoosa River watersheds, representing a total of 959,114 households. A total of 2,050 individuals responded to the survey. The telephone survey included questions on socioeconomic, demographic, visitation, expenses, and usage of study reservoirs.

The Results

Lake Martin residents generally valued the recreational component of the lake at approximately 32% of the total average real estate value of $166,030. The study found that a five-foot drop in full-pool level would result in the loss of almost half (47% or $88,000) of the value of the lakefront property. Permanent one-foot reductions in summer full-pool water levels resulted in a 4 to 15 percent decrease in property values. Lake Martin regression results for changes in time at summer pool indicated a 0.58% decrease in lakefront property value for each day decrease in summer pool time. A 60-day reduction in summer pool levels caused a 35% decline in property value while a 60-day increase only resulted in a property value increase of 15%.
The study found that a one-foot reduction in water level would result in a decrease in annual visitation frequency per person of 4.486 days. In the valuation procedure, estimates of trip expenses, annual frequency of visitation and number of people visiting from each zone or market segment are used in estimating a use value per segment. The percentage reduction in visitation per one foot drop in water level on Lake Martin was dramatic at 19%. For every one foot reduction in water level there was approximately $12.23 million annual decrease in recreational use expenditures which in turn not only reflected on the value of the primary residences, but also on the value of the recreational residences that relied on summer rental income.

Why Use the Contingent Valuation Method?
The contingent valuation method was selected in this case because of the evaluation of both use and non-use values, and their potentially significant levels.

Alternative Approaches:
Since non-use values were significant, other methods such as the travel cost method, would have underestimated the benefits of the recreational value of the lake.

How Do We Use the Results?
From the analysis, the researchers can estimate the average value for an individual or household, and extrapolate this to the relevant population in order to calculate the total benefits from the site. For example, if they find that the mean willingness to pay is $.10 per capita, the total benefits to all citizens would be $26 million.

Advantages of the Contingent Valuation Method:
- CV is enormously flexible in that it can be used to estimate the economic value of virtually anything. However, it is best able to estimate values for goods and services that are easily identified and understood by users and that are consumed in discrete units (e.g., user days of recreation of rental properties), even if there is no observable behavior available to deduce values through other means.

- CV is the most widely accepted method for estimating total economic value, including all types of non-use, or “passive use,” values. CV can estimate use values, as well as existence values, option values, and bequest values.

- Though the technique requires competent survey analysts to achieve defensible estimates, the nature of CV studies and the results of CV studies are not difficult to analyze and describe. Dollar values can be presented in terms of a mean or median value per capita or per household, or as an aggregate value for the affected population.

- CV has been widely used, and a great deal of research is being conducted to improve the methodology, make results more valid and reliable.

- The CV Method measures consumer’s surplus associated with use value. The HPM and TCM do not capture consumer’s surplus
Issues and Limitations of the Contingent Valuation Method:

- Although the contingent valuation method has been widely used for the past two decades, there is considerable controversy over whether it adequately measures people's willingness to pay (WTP) for environmental quality.

- People have practice making choices with market goods, so their purchasing decisions in markets are likely to reflect their true WTP. CV assumes that people understand the good in question and will reveal their preferences in the contingent market just as they would in a real market. However, most people are unfamiliar with placing dollar values on environmental goods and services. Therefore, they may not have an adequate basis for stating their true value.

- The expressed answers to a WTP question in a CV format may be biased because the respondent is actually answering a different question than the surveyor had intended. Rather than expressing value for the good, the respondent might actually be expressing their feelings about the scenario or the valuation exercise itself. For example, respondents may express a positive WTP because they feel good about the act of giving for a social good (referred to as the “warm glow” effect), although they believe that the good itself is unimportant. Respondents may state a positive WTP in order to signal that they place importance on improved environmental quality in general. Alternatively, some respondents may value the good, but state that they are not willing to pay for it, because they are protesting some aspect of the scenario, such as increased taxes or the means of providing the good.

- Respondents may make associations among environmental goods that the researcher had not intended. For example, if asked for WTP for improved visibility (through reduced pollution), the respondent may actually answer based on the health risks that he or she associates with dirty air.

- Some researchers argue that there is a fundamental difference in the way that people make hypothetical decisions relative to the way they make actual decisions. For example, respondents may fail to take questions seriously because they will not actually be required to pay the stated amount. Responses may be unrealistically high if respondents believe they will not have to pay for the good or service and that their answer may influence the resulting supply of the good. Conversely, responses may be unrealistically low if respondents believe they will have to pay.

- The payment question can either be phrased as the conventional 'What are you WTP to receive this environmental asset?', or in the less usual form, 'What are you willing to accept (WTA) in compensation for giving up this environmental asset?' In theory, the results should be very close. However, when the two formats have been compared, WTA very significantly exceeds WTP. Critics have claimed that this result invalidates the CVM approach, showing responses to be expressions of what individuals would like to have happen rather than true valuations.
If people are first asked for their WTP for one part of an environmental asset (e.g. one lake in an entire system of lakes) and then asked to value the whole asset (e.g. the whole lake system), the amounts stated may be similar.

In some cases, people’s expressed WTP for something has been found to depend on where it is placed on a list of things being valued. This is referred to as the "ordering problem."

Respondents may give different WTP amounts, depending on the specific payment vehicle chosen. For example, some payment vehicles, such as taxes, may lead to protest responses from people who do not want increased taxes. Others, such as a contribution or donation, may lead people to answer in terms of how much they think their “fair share” contribution is, rather than expressing their actual value for the good.

Many early studies attempted to prompt respondents by suggesting a starting bid and then increasing or decreasing this bid based upon whether the respondent agreed or refused to pay a such sum. However, it has been shown that the choice of starting bid affects respondents’ final WTP response.

Strategic bias arises when the respondent provides a biased answer in order to influence a particular outcome. If a decision to preserve a stretch of river for fishing, for example, depends on whether or not the survey produces a sufficiently large value for fishing, the respondents who enjoy fishing may be tempted to provide an answer that ensures a high value, rather than a lower value that reflects their true valuation.

Information bias may arise whenever respondents are forced to value attributes with which they have little or no experience. In such cases, the amount and type of information presented to respondents may affect their answers.

Non-response bias is a concern when sampling respondents, since individuals who do not respond are likely to have, on average, different values than individuals who do respond.

Estimates of nonuse values are difficult to validate externally.

When conducted to the exacting standards of the profession, contingent valuation methods can be very expensive and time-consuming, because of the extensive pre-testing and survey work.

Many people, including jurists’ policy-makers, economists, and others, do not believe the results of CV.

CV Method could be expensive and time consuming.
Comparative Analysis Method (Comparative Statistical Analysis)
Overview
As should be clear by this point, there are several methods for investigating nonmarket values. Many economists believe that a combination of methods has potential advantages over a single method, in terms of the range of potential values that can be included, and flexibility.

A comparative analysis estimates economic values associated with amenities, attributes, and/or services by finding the differences in valuation among two similar groups stemming from changed conditions. It is commonly applied to variations in real market property valuations that reflect the value of the characteristics of the properties assessed under the conditions of two different scenarios (actual or hypothetic).

An example of a comparative analysis would consider the difference in real market property valuations among two homogeneous shoreline groups assessed under different lake pool conditions (e.g. winter pool vs. summer pool or waterfront vs. non-waterfront). The two sets of assessments would then be analyzed through hedonic model analysis, contingent valuation, travel cost, or other appropriate economic valuation method, and then the results compared.

Another example might involve valuing residential property based on income productivity, quantifying the different income levels under changed and normal conditions in terms of rent, occupancy, operating expenses, capitalization rate, etc.

Why Use the Comparative Analysis Method? Comparative analysis is often used in correlation with the other methods for a broader analysis or where reliance on a single method is undesirable.

Case Study Example of the Comparative Analysis Method – Impact of Fluctuating Reservoir Elevation on Access and Navigability Use, Lake Koshkonong in Wisconsin, 2007. Kashian, Dr. Russell, University of Wisconsin, Department of Economics, Lake Drawdown: A Debate on the Value of 2-Inches of Water

The Situation
This study compares two hedonic price models to estimate the effect a change in water level has on the value of real estate on Lake Koshkonong in Wisconsin. Hedonic techniques are employed to show that even a two-inch reduction in the lake’s water level had a significant effect on recreational amenities such as access and navigation along the shoreline.

The Analysis
From January 1997 to December 2006, there were 252 single family home sales on two lakes (105 homes on Lake Koshkonong and 147 homes on Beaver Dam Lake). Beaver
Dam Lake was chosen, as a comparison, because of its many similarities to Lake Koshkonong. Both lakes are geographically situated such that they are influenced by demand for Lake frontage by the Chicago, Madison and Milwaukee markets. Of particular interest was whether the repairs to the dam and the resulting decline in water levels, cause a decrease in the appreciation of Lake Koshkonong frontage relative to Beaver Dam Lake frontage. The impacts evaluated: (a) potential loss of functionality of piers and ability to use the piers for boating, swimming and other water activities for all or portions of the period between May and October; (b) loss or diminishment of the ability to access the shoreline with watercraft; (c) degradation of the appearance of the shoreline and exposure of “mud flats” under low water level conditions; (d) reduction of the areas of navigability by larger motorized craft; (e) exposure of rocks and other obstacles that can damage watercraft.

The Results

Prior to the dam repair, a foot of shoreline at Lake Koshkonong contributed $539 to the value of a home. During the same period, a foot of shoreline at Beaver Dam Lake contributed $235 to the value of a home on that lake. Following the completion of repairs to the Indianford Dam, a foot of shoreline at Lake Koshkonong contributed $962 to the value of a home and a foot of shoreline on Beaver Dam Lake contributed $448. In other words, the value of a foot of shoreline (after dam repair) rose by 79% at Lake Koshkonong, while the value of a foot of shoreline on Beaver Dam Lake rose by 90%. The theory and empirical evidence support the hypothesis that changing lake water levels influence shoreline values on Lake Koshkonong. In this study, the repairs to the Indianford Dam, the corresponding decline in water levels at Lake Koshkonong, and the public’s knowledge of these issues caused a substantial change in demand that contributed to a significant decrease in shoreline property values.

Strengths of Comparative Analysis

- The scope of benefits that can be measured is not limited to things that are related to housing prices, only.

- Results of a comparative analysis reassures the analyst that the results are valid

- Utilizing a variety of valuation methods allows for a broader analysis where reliance on a single method is undesirable

- Comparing alternative scenarios allows the analyst to make change variables in whatever magnitude is conveniently interpretable as a change of one standard deviation in any one of the component attributes.

- The results of a comparative analysis can confirm that regression-based measures are a useful analytical tool when measuring house price changes with respect to changed amenities.
Comparing the results of two scenarios of conditions or two non-market valuation techniques is likely more defendable (in court or to higher level agency review) than relying on the results of one analysis.

Comparative Analysis can synthesize many comparable estimates of the benefits to a given environmental change, using information from all of them to come up with an estimate of benefits that draws from a broader collection of underlying information.

Limitations of Comparative Analysis

- Since comparative analysis requires two sets of data for comparison, it may be more costly than a single analysis.
- The results depend heavily on model specification.
- Large amounts of data must be gathered and manipulated.
- The time and expense to carry out an application depends on the availability and accessibility of data.
Appendix B:
Resource Economics Peer Review Comments

Pages 73 to 80
Re: Peer Review of the Study Board Document, Socio-Economic Sector Evaluations of Lake Superior Regulation Plans for the International Upper Great Lakes Levels Study (IUGLS)

The Review Team convened by the Independent Review Group (IRG) has assessed the Socio-Economic Sector Evaluations of Lake Superior Regulation Plans for the International Upper Great Lakes Levels Study methodology proposal developed by the Lake Superior Study Group of the IUGLS. The Review Team has participated in a thorough discussion with the PEG, the IUGLS Study Managers, and the International Joint Commission’s (IJC) Engineering Advisors concerning the proposal.

The Study Managers has been asked to respond to the IJC’s Directive to “review the operation of structures controlling Lake Superior outflow in relation to impacts of such operations on water levels and flows, and consequently affected interests assess the need for changes in the Orders or regulation plan to meet the contemporary and emerging needs, interests, and preferences for managing the system in a sustainable manner, including climate change scenarios; and evaluate any options identified to improve the operating rules and criteria governing Lake Superior Outflow regulation”. In particular this Review Team was tasked with reviewing the methodology pertaining to socio-economic evaluation of the Lake Superior regulation plans.

For the most part, the Review Team finds the methods to be appropriate and sufficient to inform water resources decision makers with a few exceptions noted below. The Review Team has also developed suggestions to improve the evaluation strategy. Based on the review of the proposal and the technical discussion, following are Review Team comments on the proposed methodology. These comments should be considered along with the IRG’s previous report in May 2009 concerning Lake Superior regulation plans.

A. Study Objective and Focus

The study objectives can be summarized under the following statements:

(a) At the outset, the strategy document states that “The key goal of the International Upper Great Lakes Study is to formulate and evaluate options to improve the rules for regulating levels on Lake Superior.” (page iii).

(b) The document then expands the description of the goals by re-stating the IJC Directive to the Study Board (page xi) to: “examine physical processes and possible ongoing St. Clair River changes and its impacts on levels of Lakes Michigan and Huron; review the operation of structures controlling Lake Superior outflow in relation to impacts of such operations on water levels and flows, and consequently affected interests; assess the need for changes in the Orders or regulation plan to meet the contemporary and emerging needs, interests, and preferences for managing the system in a sustainable
manner, including climate change scenarios, and evaluate any options identified to improve the operating rules and criteria governing Lake Superior Outflow regulation”.

(c) The IJC Directive then concludes (page xii) that “In carrying out this mandate, the Study Board is encouraged to integrate as many relevant considerations and perspectives into its work as possible, including those that have not been incorporated to date in assessments of The Upper Great Lakes System regulation, to assure that all significant issues are adequately addressed.”

(d) Further, after revisiting the IJC Directive, the strategy document states that (page xii), “So, the fundamental purpose of the study is to develop and evaluate a set of alternative regulation plans that improves the current regulation plan 77-A”. And on page 1, “This strategy paper deals with only the rules for regulating Lake Superior releases.”

The strategy document then discusses some biophysical facts that begin to question the efficacy of studies with objectives (a) to (d). Starting on page 5 and continuing on to page 6, and particularly the figures on page 6, it is noted that “…regulation has a very modest, if not negligible effects on the extremes of the water levels spectrum.” (page 5). And on page 3, “any new regulation plan is expected to have a relatively small impact on water levels … making it difficult to quantitatively differentiate the impacts of the new plan from the existing one”.

The Review Team is concerned that, in framing rather sweeping objectives in response to the IJC Directive, the Study Team may be raising public expectations as to the degree to which the regulation of Lake Superior may be modified to meet the competing needs of water users and shoreline interests around Lake Superior and the downstream lakes of the upper Great Lakes. A realistic account of the possible changes in water level regulation is particularly important given the shared vision planning approach identified in the methodology. The ultimate resolution may well be based on “informed consent” under which is understood that adaptation, not absolute control, is a key element of the regulation strategy. Studies that specifically identify the relevance of Lake Superior regulation to levels regimes of downstream lakes, given the historical record, are important to considering public expectations. This will provide context for any proposed improvements to Lake Superior outflow regulation.

The IJC specifically directed the study to examine climate change issues. Feasible climate change scenarios could radically change the inflows to Lake Superior. Detailed site investigations and study of water uses are important to determine the range of lake levels, including those outside the historical range, which pose problems.

The final step would be to integrate the economic and ecosystem stresses as a function of lake level, with the climate change scenarios, and changed physical characteristics and outflow management to determine optimum plans in the interests of uses and the ecosystem.
The Study Group should ensure that the stated objectives of the study in response to the IJC’s Directive do not raise unwarranted expectations by the public.

B. Integration across use studies and the ecological studies, including study criteria

There appears to no systematic integration of methods and criteria among the studies. For example, does the methodology allow us to say that a “navigation dollar” is equivalent to a “hydropower dollar”? One integration gap appears to be the development of climate change scenarios, and the implications of climate change. Each of the study areas and disciplines needs to be involved in the development of the parameters for the climate change studies since the uses and disciplines are best placed to understand the potential stresses.

There does not appear to be a consensus on the study time period. The most common reference within the methodology document is to a 100-year planning horizon, but this should be stated clearly for each study component.

There is no reference to the sequencing of studies in terms of time lines. For example the use and ecological studies should do a preliminary overview of existing knowledge of stresses posed by lake level regimes. The study teams should also recommend a research strategy to address key gaps by an early date such that the all study teams and Study Group have an opportunity to appreciate the big picture, and can discuss priority data gaps that may be critical to the overall study.

The Study Group should ensure that there is a high degree of consistency and integration across the various study sectors of this proposal.

C. Climate Change Stress Testing

The Review team agrees that climate change poses a particular challenge to developing an adaptive management framework for Lake Superior regulation. Probabilities associate with any particular climate change scenario cannot be calculated. An alternative is to develop scientifically-justified runoff scenarios that can have destructive consequences considering climate change. That is, what are the water level ranges outside the historical record where the society, economy, and environment within the upper Great Lakes basin are stressed? What are the effects and can they be mitigated?

A study and response strategy could look like the following. It would not utilize probabilities as such, but would use a reactive strategy based upon knowledge about damages. The current study at this stage would accomplish steps (a) to (c), with (d) and (e) as responses to future, uncertain events.

(a) Determine Ecosystem and Economic System Stresses at the historic range and say +20% and -20% change above and below that range
(b) Develop scientifically-sound climate change scenarios that meet this criterion.

(c) Apply early warning indicators from part (a), identifying potential damages.

(d) Conduct research on management and remediation strategies as conditions evolve.

(e) Evaluate benefits and costs of management and remediation strategies relative to the benefits and costs of waiting for more information, and conducting further research.

While the Review Team considers that climate change stress testing is an important component of this study, the approach identified in the previous discussion should not be taken as prescriptive.

D. Irrigation Water Use

Irrigation water use is given the same priority as hydropower use in the *Boundary Waters Treaty* yet it receives no explicit discussion in the study proposal. It is the Review Team’s understanding that current withdrawals for irrigation in the upper Great Lakes are similar to those for municipal purposes. Yet irrigation use is largely consumptive while municipal use is largely non-consumptive. Even so, it is likely that current irrigation water use is not particularly relevant to the regulation of Lake Superior.

However, under a climate change scenario, with irrigation water use increasing, this situation may not continue, as irrigation may become both a large withdrawal use and consumer of water. Increased irrigation may also lead to nutrient and contaminant laden return flows that may have localized ecological effects.

The Study Group should be directed to review the current level of irrigation water use and place that use in the context of current water demands in the basin. If present water use or projected water use under climate change is significant, the socio-economic effects of irrigation water use should be explicitly considered in the Lake Superior regulation plan.

E. Hedonic Price Model.
The hedonic price index model proposed (page 48) will likely not work to estimate potential damages over the range of extreme events. The model can be used in episodic cases of one particular event, and then with time series data evaluate the damage with and without the event. The model also is very data and time intensive. As an alternative, we suggest a focus on the top five percent of communities having the highest sensitivity to low/high water impacts with the objective of starting to build a repository of actionable data.

F. Secondary Benefits and Regional Expenditures

The methodology proposal (page 80) does not provide specific guidance for the study groups to address secondary benefits and regional expenditure. This is a significant omission. Secondary (negative) impacts on regional economies may be severe if lake level regimes shut down shoreline activities. This is important to shoreline communities that are heavily dependent upon shoreline developments for a large share of community income. As lake level regimes foreclose these economic opportunities, other opportunities are not possible due to geographic isolation or workforce skill sets, and infrastructure that cannot easily be adapted to new economic uses. Second, aboriginal groups, and other low-income households may also be disproportionately affected by lake level regimes. It is recommended that an overview of potentially sensitive communities and disadvantaged groups that could be affected be undertaken. This could be accomplished with the use of census data, which could be overlaid on a site map of affected activities that the study groups could prepare. The Study Group should be directed to prepare or become aware of plans and scenarios that affect regional economies, disadvantaged groups, and low-income households.

G. Detailed Comments Based on Study Proposal

The following detailed comments on the study proposal are editorial in nature. They are provided for the information of the Study Team.

Page xi. What were the drive or energy, the public issues and the political circumstances that led to the IJC Directive to the Study Board? Has this political/social climate changed since the Directive was issued? Can this be made explicit such that the study is continuously aligned to meet the expectations and deal with the perceptions of the evolving political/social climate? There do not appear to be separate studies related to the institutional framework that would assist this process. What is the nature of study results that would be difficult to explain, or have the greatest acceptance for implementation?

Page 13. “The Upper Great Lakes region includes U.S. counties with unemployment rates of over 20 percent, and the future of the U.S. and Canadian auto industry appears tenuous.” Statements such as this refer to current conditions which may be short term and immediate trends which could be irrelevant in the context of the long-term implications of proposed regulation plan. We suggest developing a report section on economic context and policy to frame the analysis assumptions.
The third and fourth paragraphs appear to be at odds. The third paragraph states the economic conditions will stay at current levels for the 100-year planning horizon. The fourth paragraph states that the contextual narrative will provide the Board information on trends. So there will be a “business as usual” forecast in some way, but the third paragraph states no, for example the amount of water withdrawn for cooling will be at today’s levels. What is the answer?

We suggest that the study would get useful information for evaluation purposes with access to trends forecast, and another higher growth scenario. Comparisons among the three in plan formulation may show that economic growth forecasts may or may not affect decision-making. This is a useful result.

As such, we propose the evaluating the following economic scenarios.

(a) The current economy going forward for 100 years, with and without climate change (no economic trends)
(b) The current economy going forward for 100 years, utilizing current economic trends, with and without climate change.
(c) A high economic growth scenario going forward for 100 years, with and without climate change.

Scenario (c) could incorporate expert opinion on the upside to growth of the Midwest economy. One positive sign for growth is the growing importance of ocean shipping, containerization, rail and containerization trends. The Midwest, and Chicago in particular, are poised for major expansion within a world-wide system of growing trade, given its strategic hub location between rail and water transport, mid continent joining all three coasts. There are other upside potentials for the Midwest that need to be investigated, including the role of carbon credits and sequestration. This will be driven by international protocols and carbon trading. Given the biophysical and climatic advantages for the region, growth in agriculture could result. This is an example. Not much is known about this yet but it needs investigation. There may be other upside opportunities as well.

“The Board’s recommendation for a new regulation plan or order is unlikely to have much effect on hydropower production at the stations in the St. Marys River, and most likely no measurable effects at downstream hydropower stations on Lake Michigan, the Niagara River, and on or near the Welland Canal.”

If this is the case, why do the hydropower analysis at all? That said, there may be major implications from climate change scenarios that require new release works at the St. Mary’s River.

Electricity price forecasts. The price of electricity could increase in an economic growth scenario in which carbon credits, sequestration requirements become important. Also the profitability of hydroelectric power could increase since it would not likely require carbon credit offsets. As the quantity of water in the St Marys River is
insufficient to operate the installed hydro capacity continuously, one could also contemplate complementary operation of hydro and wind power in such a way as to provide higher valued hydropower for peaking.

Page 27. “The primary performance indicator for commercial navigation will be changes in the cost of shipping.” This is reasonable, but may not capture the total cost of losses to commercial transportation due to low water levels. If there is a shift to less economic and environmentally desirable modes, such as rail and especially trucking, the increased costs may occur outside commercial navigation. The environmental consequences of increased greenhouse gas emissions would also need to be noted. Also diversion to trucking causes additional wear and tear to roadways that could be overlooked. (This point is covered to some degree in the last paragraph of section 4.2.3 on page 28).

Page 29. How will the study team capture information on commodity changes using one year of data?

Page 29. “Quantification of M&I impacts is hampered because of the lack of definitive information on intake pipe location and vulnerability to low water levels, and the expense of obtaining comprehensive data.” Information on intake pipe and outfall pipe location and vulnerability is absolutely essential to undertake the study, to determine lake level impacts on these facilities. Study resources to undertake such surveys are essential. On pages 33 to 36, there appear to be comprehensive surveys of intakes and outfalls. So there is confusion between the meaning of the discussion between page 29, and pages 33 to 35. Exactly what is the problem with current data?

Page 30. “…the effect of M&I use is barely noticeable in comparison to the renewable flows in Great Lakes ….” “Most of the water that is withdrawn is returned to the basin.” It would be potentially useful to disaggregate the municipal and industrial uses. One can reasonably assume that most water withdrawn for municipal purposes will return to the basin. One can also assume, that with reasonable water conservation measures – Denver, for example – water demands for municipal purposes will not increase even with significant population increases. The same assumptions may not apply to industrial water use, but knowledge of existing industrial uses can be used to make an informed projection of future use.

Page 35. A more convincing argument should be made for considering only intakes and low levels, to the exclusion of outfalls and high levels.

Page 37. Water use demand is described, forecasting demand to the year 2040. Why wasn’t the forecast period 100 years, the same as most of the other studies in the program?

Page 39. The sample sites miss two very important boating sites: Michigan City, IN/New Buffalo, MI, and Traverse City, MI. The study should state the criteria used to select sites. Should the criteria be based on the local importance of tourism and recreation?
Page 41. Last sentence is mis-worded. However, the IRG feels that the estimated economic value of these economic sectors (tourism, recreational boating, cruise ship) should be presented in order to put the importance of these issues into context.

Page 43 – Page 47. Coastal Zone Processes- low and high water damages, and erosion damages to riparian property. It is not clear from the methodology document what the performance indicator for this use. “At this time, with the exception of low water impacts, the Coastal Zone TWG is not planning to use dollar values (for example average annual damage due to flooding) as part of the Stage 2 Pls. It is hard to imagine not having dollar estimates of damages a performance indicator. Without it, the Board would have perhaps information on the number of riparian properties affected. The severity of the damage needs to be known for levels regulation purposes, and floodplain management to prevent damages from getting worse.

Also, could the historical experience of 1978-87 and 1999-2006 be used to estimate actual economic impacts of high/low levels?

US Co-Chair, IRG  Canada Co-Chair, IRG

Chris Brewer, MA  R. Derek Bjonback, Ph.D., MBA
US Panelist  Canada Panelist
Appendix C:
Study Board Response to Resource Economics Peer Review Comments

Pages 82 to 89
November 6, 2009

Dr. Paul Pilon  
Engineering Advisor, Canadian Section, International Joint Commission  

Dr. Mark Colosimo  
Engineering Advisor, United States Section, International Joint Commission  

Dear Drs. Pilon and Colosimo,  

Subject: Response to IRG Review of “Socio-Economic Sector Evaluation of Lake Superior Regulation Plans for the International Upper Great Lakes Levels Study”  

References:  

This is the Board's response to the advice and comments provided by the Independent Review Group (IRG) with respect to the socio-economic sector evaluation strategy proposed for the Lake Superior phase of the studies. The IRG met with the IUGLS team at the Crowne Plaza Detroit Metro Airport Hotel, Romulus, Michigan, on July 21 and 22, 2009, to discuss this strategy and also the proposed ecological evaluation methodology. The Board has previously responded to parallel IRG reviews of plan formulation and evaluation strategies. It will respond separately to the parallel review of ecological evaluation strategies.  

The Terms of Reference for the IJC IPR state:  

- “The overarching charge shall be to evaluate the appropriateness and sufficiency of the work plans, studies, models and monitoring efforts used to inform decisions....”  

- “The review should focus on scientific aspects connected with the issues, not on the decision-making process within the purview of the Commission itself.”  

In response to these directives, the IRG review states that “for the most part, the Review Team finds the methods to be appropriate and sufficient to inform water resources decision makers with a few exceptions....” The Review Team also provided some recommendations and suggestions intended to improve the evaluation strategy. The purpose of this document is to review and respond to the IRG's exceptions, recommendations, and suggestions.
1. **Study objective and focus.**--The Review Team noted the contrast between the “rather sweeping objectives” of the IUGLS and the predictions of “very modest, if not negligible” effects of re-regulation of Lake Superior on water levels. The Team expressed its concern that the scope of the study may raise “public expectations as to the degree to which the regulation of Lake Superior may be modified to meet the competing needs of water users and shoreline interests around Lake Superior and the downstream lakes ....”

1. **Response.**--The Study Board is well aware of the need to promote realistic expectations on the part of the public and other stakeholders. The Review Board points to the case where the public may over-estimate the ability of regulation to maintain desired water levels. The Board plans to continue using public information, public meetings, and other forms of outreach to inform interested parties as to the actual impact of regulatory options. The board recognizes that this is a challenging task, since many observers will inevitably confuse normal, climate-driven lake level fluctuations with the less noticeable effects of regulation.

The Review Team also noted:

“The IJC specifically directed the study to examine climate change issues. Feasible climate change scenarios could radically change the inflows to Lake Superior. Detailed site investigations and study of water uses are important to determine the range of lake levels, including those outside the historical range, which pose problems.”

For this reason, the socio-economic strategy has been designed to address two very different sets of effects: (1) the effects of relatively small changes in water level resulting from possible re-regulation of Lake Superior and (2) the effects of potentially large changes in water level resulting from long-term events such as climate change. These large changes may be within the water levels experienced in recent history or they may be outside historical ranges. The “sweeping objectives” noted by the Review Team may prove to be unnecessary in the case of re-regulation, but the Study Board believes that the assessment of long-term effects requires examination of a broad range of issues.

2. **Integration across use studies and the ecological studies, including study criteria.**--The Review Team argued for “a high degree of consistency and integration across the various studies ....” In other places in the review document, the Team stated that it found “no systematic integration of methods and criteria among the studies,” “no reference to sequencing of studies,” and the absence of a “research strategy to address key gaps by an early date.” Specifically, the Review Team asked whether the “methodology allows us to say that a 'navigation dollar' is equivalent to a 'hydroelectric dollar.'” The Team also asked how the development of climate change scenarios would be integrated into the study.

2. **Response.**--The Study Board recognizes the desirability of the consistent use of commensurate measures, such as dollars, for all performance indicators. However, there are several reasons why universal commensurability cannot be achieved.
• Even where dollar measures are available, some may apply to the entire study area (e.g., hydropower impacts) while others pertain to specific sites (recreational boating studied for 17 discrete sample areas). While these measures can be compared to a limited degree, they cannot be summed or otherwise treated as commensurable.

• Some performance indicators are associated with market goods (e.g., hydropower or commercial navigation) and others are associated with non-market goods that can potentially be measured in dollar terms (e.g., shoreline changes or recreation). But there are still other performance indicators that cannot be expressed in dollar terms (such as ecosystem changes), or where the cost of the studies necessary to obtain a credible dollar measure may be excessive.

• The Study Board is currently identifying decision-making frameworks which may be appropriate given the variety of metrics in which the performance indicators will be expressed.

The Study Board is committed to seeking dollar-denominated measures for all socio-economic performance indicators, provided that development of such measures is feasible, cost-effective, and able to demonstrate the relative impacts of different water level regulation plans. But it must be recognized, as noted, that the dollar values thus obtained are not all comparable due to the use of discrete study sites for measurement of some effects.

Beyond the selection of consistent units of measurement, there is an ongoing effort to improve integration of methods and criteria among the various studies--and among the Technical Working Groups--and to identify and correct any gaps that may be found within the overall study framework. The Study Board has recently developed a new study organization for the purpose of achieving improved oversight and coordination. The Lake Superior Regulation Task Team will now consist of 12 Technical Working Groups (TWGs), covering the development of performance indicators plus integrative and advisory functions.

3. **Climate change stress testing.**--The Review Team noted that “climate change poses a particular challenge to developing an adaptive management framework.” The Team proposed, for the consideration of the Study Board, an approach to “climate change stress testing.” This approach begins by postulating ecosystem and economic stresses outside of the historic range, then developing climate change scenarios that would be expected to produce the postulated stresses. Early warning indicators appropriate to these events would be defined, as well as candidate management and adaptation measures. Benefits and costs of the management and adaptation measures would be used to develop optimal responses to the postulated events.

3. **Response.**--This is a timely comment by the Review Team, since it addresses a topic under active consideration by the Lake Superior Task Team. Two approaches have been identified:
• **Climate-down.**--Using GCMs and/or expert elicitation, define a number of extreme climate change scenarios. Determine the impacts of these events, should they occur, and develop and analyze appropriate management and adaptation measures. These data can then be used to develop an adaptive management plan incorporating optimal responses to various events.

• **Impacts-up.**--Identify a number of extreme climate-induced events, such as high or low water levels outside of the historic range. Determine the climate scenarios that could give rise to these events; develop and analyze management and adaptation measures suitable to these events. Using these results, develop an adaptive management plan incorporating optimal responses to the postulated events.

Note that the second approach is very similar to the Review Board's suggestion.

Of course, these outline approaches greatly understate the complexity of the planning process needed to develop an adaptive management plan. But work is proceeding on this topic. The Study Board will adopt the approach that seems best in the circumstances.

4. **Irrigation water use.**--The Review Team, while noting that present irrigation water use “is likely ... not particularly relevant to the regulation of Lake Superior” recommended that the Water Uses TWG “be directed to review the current level of irrigation water use and place that use in the context of current water demand in the basin.”

4. **Response.**--The water use study, now nearing completion, addresses current irrigation water use to the extent that it can be measured or estimated. It is important to note that many irrigators draw water from private wells and that this use is unmetered and unobserved. Very few irrigators withdraw water directly from the Lakes. This issue will be addressed in the Contextual Narrative as well.

The Review Team also noted that “irrigation may become both a large withdrawal use and consumer of water” under climate change.

The feasibility of projecting irrigation water use under various climate change scenarios has not yet been determined, but this is a topic that will be addressed later in the study.

5. **Hedonic price model.**--The Review Team noted that the hedonic price analysis model “will likely not work to estimate potential damages over the range of extreme events.”

5. **Response.**--Agreed. Hedonic price analysis is not under consideration for this purpose. It is, however, a possible approach to developing an economic measure of damage due to water levels made slightly higher or lower as a result of re-regulation of Lake Superior. It should be noted that the economic cost of high water events is relatively better understood than low water effects. The Coastal TWG will undertake a phased approach for addressing potential low water impacts. The first step will be a series of focus group sessions with real estate professionals designed to
provide further understanding of the sensitivities to low water conditions by riparian property owners. If sensitivities are identified, the possibility of a benefits transfer approach will be investigated. If it is decided that an empirical valuation study is needed, hedonic price analysis may be considered, along with other methods. Any empirical valuation would be tested at a specific site to confirm its applicability and further analysis would not be undertaken if it was deemed inappropriate.

6. **Secondary benefits and regional expenditures.**—The Review Team notes that “secondary (negative) impacts on regional economies may be severe if lake level regimes shut down shoreline activities.” The Team recommends “an overview of potentially sensitive communities and disadvantaged groups that could be affected ....”

6. **Response.**—The Study Board disagrees in part and concurs in part with this recommendation. With respect to secondary economic effects, which arise because of underused infrastructure, private investment, workforce skills, etc., there is no apparent need to address this in the study. The direct economic effects of alternative regulation plans will be adequately represented by studies already underway or planned by the Board. Furthermore, given the likely small direct effects expected to result from Lake Superior re-regulation, secondary economic effects will be even smaller, probably de minimus. In the case of the much larger direct effects expected from the climate change scenarios, it must be remembered that secondary economic effects are normally expected to be transient. The Board sees no need to explore such effects in a long-range projection.

On the other hand, the long-range direct effects of climate change may result in major structural changes in the basin economy. There is a definite need to identify those communities that are most vulnerable to the impacts of changes to hydrologic regimes associated with climate change and those groups which are most sensitive to the likely changes. The process of identifying these potentially sensitive entities is already programmed as part of the Adaptive Management TWG's Statement of Work. An economic analysis of the possible impacts on these entities, once identified, is planned, although the specific methods have not yet been identified. The Study Board strongly agrees with the Review Panel's recommendations on this subject.

7. **Other detailed comments.**—

“We suggest developing a report section on economic context and policy to frame the analysis assumptions.”

*Estimated economic value of tourism, recreational boating, and cruise ships should be presented for context.*

The Contextual Narrative for the Lake Superior study, now being drafted, will present current and projected demographic, economic, and other conditions. In particular, it will show the
contribution to the regional economy of the various lakes-dependent sectors, such as tourism and recreational boating.

Estimates will be presented of net losses experienced by marinas when water levels drop up to 3 feet or more or if they rise 3 feet or more. These estimates will be calculated using information from almost 20,000 slip depth measurements and using financial calculations developed by Dr. Ed. Mahoney for a study on Lake Michigan. The calculations/methodology are supported by the U.S. Army Corps of Engineers and various States in the Great Lakes basin.

*The Review Team expressed concern about possible inconsistencies in planning horizons and growth assumptions. Three different growth scenarios were proposed.*

Planning horizons and growth assumptions are chosen for each study as appropriate to the objectives and purpose of that study. However, uniformity across specific studies is important if those studies are to be used for the same purpose. The Adaptive Management TWG is presently considering various growth assumptions, not dissimilar from those proposed by the Study Team, but for a maximum 50-year planning period.

*Changes in the cost of shipping may not capture the total cost of losses to commercial transportation due to low water levels.*

Agreed. While the established methodologies being used by the technical working group focus on estimating impacts to transportation costs, as noted elsewhere, the very limited effect of changes in Lake Superior regulation on water levels doesn't warrant attempting to model additional external costs. The contextual narrative will identify various externalities (environmental, safety, infrastructure wear/tear impacts) that could result in additional costs outside the commercial navigation arena. The significance of these additional factors increases when focusing on climate change and adaptive management.

With respect to use of one year of shipping data and potential commodity changes, the transportation cost model has the capability and will be used to show the sensitivity of the results to significant changes in particular commodity areas (such as significant drops in iron ore movements associated with down turns in steel manufacturing, or increases/decreases in coal movements associated with changes in environmental/energy policies, etc.).

“A more convincing argument should be made for considering only intakes and low levels, to the exclusion of outfalls and high levels.”

Agreed. The Water Uses TWG plans to test the assumption that outfalls do not present a major problem under high water conditions by surveying a small number of wastewater treatment plant operators with known high elevation outfalls.

*The Review Team noted that the sample sites do not include two important boating sites: Michigan City, IN/Buffalo, MI and Traverse City, MI.*
The following describes the method used by the Recreation Boating and Tourism TWG to select the sample areas (Areas of Survey – AOS).

Eighteen locations were chosen by the TWG to represent significant regions of the upper Great Lakes’ recreational boating and tourism industries. These eighteen locations acted as the center-points for 80 km diameter circles, referred to as “areas of survey” (AOS). These eighteen circles were represented visually on Google Earth, to be used to identify marinas.

The eighteen AOS were selected according to several criteria: In terms of eco-regions, sites were chosen to provide an even representation of both the Great Lakes Forest Region and the Boreal Forest Region. Geologically, an even representation of both Precambrian Shield (granite) and Escarpment (primarily limestone bottoms) rock formations was desired. AOS selection was also designed to encompass a maximum concentration of ports/marinas, and aimed for equal representation in terms of regional susceptibility to fluctuating water levels. The Chicago area was not selected because that area has very deep waters. The TWG selected areas significantly impacted by historic fluctuations in water level. The TWG also wanted to ensure that at least two sites were selected on each major body of water. One site on the U.S. side was selected at the request of a Public Interest Advisory Group (PIAG) member and another was selected due to its concentration of tourism businesses related to boating and water recreational activities. The eighteenth site added is the area around Sandusky/Toledo.

Members of the Recreational Boating, Cruise Ship and Tourism Technical Working Group have extensive tourism and boating experience around the Great Lakes and sites were selected and agreed to by all committee members based on the above noted criteria.

With respect to the Review Team's specific query, the two named sites were not included as sample areas because in both cases significant numbers of boaters have access to deep water and are thus less affected by water level changes. Michigan City, IN, and New Buffalo, MI, are both commercial harbors and also characterized by near shore deep water. The largest fraction of boating facilities in Traverse City, MI, are in the deep water West Arm bay (the shallower East Arm bay is less used).

*The Review Team questioned the apparent intention of the Coastal TWG to consider measuring dollar impacts only for low water effects.*

As noted above, all TWGs will use dollar measures for socio-economic performance indicators wherever feasible and cost-effective. The Coastal Zone TWG has initially focused on low water effects because this is the area most likely to require new empirical research. The feasibility of stating low water impacts in dollar terms will be explored through the phased approach described above. The TWG will work with the Study Board to determine whether such valuations are necessary to support the re-regulation decision.
“Could the historical experience of 1978-87 and 1999-2006 be used to estimate actual economic impacts of high/low flows?”

The Task Team has looked closely at these events and will continue to do so, in order to learn whatever lessons may be found. However, based on reviews of these experiences, it is not feasible to rely on these historical periods for measuring economic impacts. This is because the necessary data were not reported at the time and, indeed, could not have been identified in the absence of considerable analysis.

Respectfully submitted,

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Co-Lead, United States IUGLS Director

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Appendix D:
Low Water Theme Report

Pages 91 to 114
Low Water Theme Report

February 18, 2010
11526.200
Low Water Theme Report

Prepared for
International Joint Commission
Coastal Zone Technical Working Group

Prepared by
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Project Number
11526.200

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1.0 INTRODUCTION

This report was prepared for the Coastal Zone Technical Working Group (CZTWG) for the International Joint Commission’s (IJC) five-year International Upper Great Lakes Study (IUGLS). The report, which describes low water impacts on shorelines, is one of four descriptive theme reports (the others being: Flooding, Erosion and Shore Protection) that were prepared for the IUGLS. The study area includes Lake Superior, Lake Michigan-Huron, Lake St. Clair and Lake Erie. The focus of the CZTWG analysis of regulation impacts is on the open lake and embayment shoreline, not the connecting channels.

1.1 Scope of Study

The Low Water Theme Report summarizes the current understanding of low water level impacts on the upper Great Lakes shorelines. The report includes: a description of how low water levels affect the shorelines of the Great Lakes and a review of previous studies and literature. Figure 1.1 provides a schematic diagram of how natural fluctuations in lake levels can impact beach width fronting a seawall and residential development.

![Figure 1.1 Water Level Impacts on Beach Width](image)

The Low Water Performance Indicator (PI) will evaluate the physical processes and impacts associated with low water along both private lands (riparian landowners) and public shorelines (provincial, state or national park lands). Typical mitigation or restoration activities (e.g. dredging for recreational boat access, vegetation clearing for improved aesthetics, etc.) completed in these areas as a result of low water could also be considered in the Low Water PI.

Damage or failure of shore protection structures located on public or private land will not be considered in the low water impact analysis, since they are included in the Shore Protection PI.
1.2 Low Water Level Impacts and Benefits

Water levels in the Great Lakes fluctuate on an annual basis as well as in response to longer cycles (decadal or climactic cycles). Annually, water levels rise in the spring when runoff to the lake is high due to melting snow and evaporation rates are low due to cool lake and warm air temperatures. Peak levels occur in the summer as more water flows into the lakes than out. During the fall and winter, when evaporation is high due to warm lake and cool air temperatures and new precipitation inputs are generally lower than the spring, the lake levels drop and reach annual lows.

Longer-term water level fluctuations can occur over several years to decades. During wet and cool years, lake levels rise, while during hot and dry years, lake levels decline. Figure 1.2 shows the monthly mean water levels between 1918-2008 for the three main lake systems. For the three lakes shown, Lake Superior has the smallest range of monthly mean water levels (range of 1.19 m) while Lake St. Clair has the largest range of monthly mean water levels (range of 2.08 m).

High lake levels occurred in the early 1950s, early 1970s, mid-1980s, and mid-1990's while low lake levels occurred in the late 1920s, mid-1930s, mid-1960s, and from the late 1990s until present. Along shorelines with shallow nearshore bathymetry (or gentle nearshore slopes), small water level fluctuations can change the shoreline extent and characteristics significantly. For example, previously submerged portions of the lake bottom become an extension of riparian “backyards” and often dramatically change the aesthetic conditions and access to the lake. Refer to Figure 1.3 for an example of low water conditions on Lake St. Clair. During average and high lake levels, the riparian owners are able to access the lake for swimming from their seawalls, launch personal watercraft and dock small boats during fair weather. During low water this access is lost and replaced with emergent vegetation and rotting algae mats.

Figure 1.4 highlights low water impacts on the granite shoreline of Macey’s Bay, near Honey Harbour on Georgian Bay. Boat docks are completely inoperable during low water and grey water intake lines are significantly compromised. Dredging costs can increase significantly for both private land owners and commercial marinas. Nearshore water quality can also be negatively affected by low water in sheltered areas or embayments with limited circulation or natural inflow from upland watersheds (Schiefer, 2003).
Figure 1.2 Upper Great Lake Monthly Mean Lake Levels (1918-2008) (USACE, 2009)
When low water levels occur along undeveloped shorelines (sheltered, embayed or open coast areas), positive changes to physical habitat can occur, including: beach and dune recovery, increased vegetation growth, and creation of new early successional terrestrial habitat in previously submerged areas, to mention a few.

For open coast beach areas along developed shorelines, periods of falling or low water levels are beneficial in many ways, including: increases in beach width as lake levels drop, cross-shore migration of sand from the lake to the beach, which further widens the beach and provides additional sediment for dune growth, more recreational space for beach users, and storage of sand in the beach and foredune, which provides a natural buffer against storm erosion during the next period of high lake levels.
In addition, periods of low water along open coastlines can lead to the loss of hydrostatic pressure for shore protection structures and increased toe erosion, both of which can lead to costly maintenance. In some cases, increased beach width is perceived negatively by riparian landowners and thus low water conditions have a negative impact on their enjoyment of their property. Collectively, the impacts and benefits of low water periods throughout the study area will be explored in the following sections of this report.
2.0 LOW WATER LEVEL SHORELINE IMPACTS

Section 2.0 of the report will describe low water impacts for two generalized categories of coastline (1) sheltered shorelines with shallow nearshore bathymetry, and (2) exposed shorelines with steep nearshore bathymetry.

2.1 Sheltered Shorelines with Shallow Nearshore Bathymetry

Water level fluctuations can drastically alter the shoreline position in areas that have shallow nearshore bathymetry or low sloping topography. During low water level periods, large expanses of shorelines that were previously submerged can become exposed. The nearshore landscape can be altered noticeably during prolonged periods of low levels, as have been present on the Great Lakes for the last ten years.

In undeveloped areas, these changes can be beneficial to the environment. Figure 2.1 illustrates the land progradation and formation of deltas that can occur around river mouths during periods of persistent low water levels. The mouth of the Ford River, which drains into the northern part of Green Bay from Delta County, MI is shown at three different times between 1998 and 2006. The top photo, shows the area in April 1998, after the high lake levels experienced in the mid-1990s. The middle photo shows the progradation of the delta in June 2003, after five years of low water levels as well as the widening of the beach to the east. The bottom photo shows the area in August 2006 after another three years of low water levels. The delta was colonized by vegetation and stabilized after the prolonged low water level period creating new terrestrial habitat areas.

In developed areas, the effects of prolonged low water levels are sometimes not desirable. Shallower water levels and increased vegetation growth, which can affect water accessibility (unusable boat ramps, muddy conditions, etc.) and aesthetics (change in view, stagnant water, smell, etc.) are generally nuisances to riparian landowners and other users of the lake (commercial/recreational boaters, fishermen, etc.). Figure 2.2 shows how the shoreline in Saginaw Bay changed in response to the low water levels between 1998 and 2005. The top two photos show the lakeward migration of the shoreline between April 1998 and June 2005 in Arenac County, MI. Also evident is the beach widening, vegetation growth and the channel dredging for recreational boat navigation in response to the shallower water levels. The bottom two photos show the lakeward migration of the shoreline in Bay County, MI between April 1999 and August 2005. Increase in the area covered by vegetation and dredging activities in response to the prolonged low water levels are also observed.
Figure 2.1 Landscape Changes Due to Extended Low Water Period at the Ford River, Delta County, MI, Northern Green Bay (1998-2006)
Figure 2.2 Low Water Impacts in Saginaw Bay Due to Extended Low Water Period. Top Figures: Arenac County, MI: April 1998 & June 2005. Bottom Figures: Bay County, MI: April 1999 & August 2005.
These negative impacts are observed in many of the embayed areas around the Upper Great Lakes which feature shallow nearshore bathymetry (Green Bay, Saginaw Bay, Georgian Bay, Lake St. Clair). Figure 2.3 shows the extensive dredging around northwest Collingwood, in Simcoe County, Ontario on Georgian Bay in June 2007. In some areas, where the bottom of the lakes are covered by bedrock, this type of adaptation requires channel blasting.

![Figure 2.3 Dredging in Response to Low Water Levels in Northwest Collingwood, Simcoe County, Ontario (June 2007)](image)

Figure 2.3 Dredging in Response to Low Water Levels in Northwest Collingwood, Simcoe County, Ontario (June 2007)

Figure 2.4 presents a ground level picture of a stranded residential boat slip on Lake St. Clair during the present low water regime, along with excessive weed growth and algae accumulation along residential seawalls in Figure 2.5.

![Figure 2.4 Residential Boat Slip Stranded from Lake St. Clair During Low Water (1999)](image)

Figure 2.4 Residential Boat Slip Stranded from Lake St. Clair During Low Water (1999)
2.2 Exposed Shorelines with Steep Nearshore Conditions

Open coast shorelines, which generally feature steeper nearshore bathymetry and more wave energy are not as sensitive to prolonged periods of low water levels. In these areas, the change in shoreline position due to falling or low lake levels is generally not as dramatic as areas with a gentle nearshore slope. Impacts on navigational channels are also less severe than in sheltered environments with gentle nearshore bathymetry.

Exposure of these shorelines to high wave energy also reduces the potential for fine sediment accumulation, such as silts and clays, in the shallow nearshore zone and along the beach. Further, the energetic nearshore environment also prohibits the growth of submerged and emergent aquatic vegetation. Therefore, the combination of these factors reduces the potential for the growth and deposition of aquatic vegetation during periods of low water levels.

Prolonged periods of low water levels can be beneficial to exposed shorelines and the environment. For example: 1) lower water levels widen the exposed portion of the beach, which provides natural erosion protection, 2) a wider dry beach increases sediment supply to the foredune and often results in dune recovery/rebuilding, 3) enhances recreational opportunities for beach users, and 4) completes the cycle of beach erosion and low water recovery that sustains the dynamic habitat found along sandy beaches and barrier beaches throughout the Great Lakes.

Figure 2.6a to d presents a sequence of photographs looking south along the barrier beach at Hillman Marsh, on Lake Erie. During high lake levels in 1998, the barrier beach was almost completely inundated and a breach developed. Refer to the conditions in Figure 2.6a during a mild storm on Lake Erie. Once the storm conditions subsided, the glacial till beneath the sandy barrier and root mats from the eroded vegetation were exposed and are documented in Figure 2.6b. By
2004, following six years of low to average water levels on Lake Erie, the sand beach had returned. Refer to Figure 2.6c. By 2006, it was even wider (Figure 2.6d). These photographs document the significant influence lake levels have on this barrier beach, which is migrating inland due to natural and anthropogenic factors. Further, it highlights the significant impacts water levels have on the visitor experience to this beach, the amount of usable beach area, and terrestrial habitat for native species.

Figure 2.6a  Hillman Marsh Barrier Beach During Storm Conditions and High Water (1998)

Figure 2.6b  Hillman Marsh Barrier Beach During High Water (Eroding Clay Substrate in Foreground)

Figure 2.6c  Sand Beach Returns to Hillman Marsh Barrier During Low Water (2004)
Figure 2.6d Beach Width Increases During Prolonged Low Water (2006)

Figure 2.7 documents embryo dune growth in 2004 on Lake Michigan, south of Michigan City, at the base of a very old eroding relic dune (>1,000 years old). The marram grass has stabilized the aeolian deposit and will continue to support dune building while water levels remain low to average. The growth of this embryo dune diversifies the beach habitat and provides a natural buffer against storm erosion.

Figure 2.7 Embryo Dune Growth South of Michigan City Harbor (August 10, 2004)

Figure 2.8 documents the beach and dune conditions south of Michigan City Harbor. The backshore is a combination of dunes and sandy bluffs, protected with an armour stone revetment. Without shore protection, this shoreline would erode during high lake level conditions, which is why the riparian land owners have constructed the revetment. During low water conditions, there is a beach lakeward of the revetment, which increases the recreational benefits of this shoreline and...
buffers the shore protection from direct wave attack. Although there are beach benefits to this shore during average to low lake level conditions, when high lake levels return the beach will likely erode and the waters edge will be defined by the shore protection.

![Figure 2.8 Revetment at the Base of Eroding Dune, South of Michigan City Harbor (August 10, 2004)](image)

**Figure 2.8** Revetment at the Base of Eroding Dune, South of Michigan City Harbor (August 10, 2004)

In Figure 2.9, a waterfront home is separated from the lake by a very large concrete seawall, which protects the property from storm activity during high lake levels. During the low water conditions in 2004, a wide beach was present in front of the seawall, which highlights the low water benefits for this stretch of shoreline.

![Figure 2.9 Seawalls Protecting Waterfront Development North of Michigan City (August 10, 2004)](image)

**Figure 2.9** Seawalls Protecting Waterfront Development North of Michigan City (August 10, 2004)
3.0 LITERATURE REVIEW AND PREVIOUS STUDIES

Section 3.0 of the report will review relevant literature and related studies for the Low Water Performance Indicator.

3.1 Previous Large Lake Impact Studies

Previous large lake studies have not focused specifically on low water impacts for riparian property, since the impetus for these studies has often been hazardous conditions associated with high lake levels. However, there was some valuable research done on low water impacts for sandy beaches in the Lake Michigan Potential Damages Study. Further, the influence of lake levels on recreational beach width was investigated during the IJC Lake Ontario – St. Lawrence River Study. Both are described below.

3.1.1 Lake Michigan Potential Damages Study

The Lake Michigan Potential Damages Study did not specifically study low water impacts on private property, however, it did investigate the impacts of low water periods or lake level cycles on sandy beaches. Specifically, a methodology was developed to quantify the cross-shore transport of sand (e.g. from beach to nearshore and from nearshore to beach) during rising and falling water levels for temporal periods spanning several years to decades. Figures 3.1 and 3.2 highlight the predictive ability of the tool, known as the Profile Shift Module of the FEPS (Baird, 2003). The theory for the cross-shore re-distribution of sand is based partially on the work of Per Bruun (1983 and 1987) and augmented with in-lake data that documented cross-shore transport of sand during rising and falling lake levels (Hands, 1979 and 1984; Baird, 2001). The predictive capabilities of the tool were validated during a detailed sediment budget study for the sandy coastlines in Allegan and Ottawa Counties, Lake Michigan (Baird, 2003).

Figure 3.1 Dune Erosion and Cross-shore Re-distribution of Sand During Rising Lake Levels
The inputs for the Profile Shift Module include: 1) a 2D beach profile, extending lakeward of the depth of closure and landward of the dune crest, 2) toe of beach on x-axis, 3) toe of dune on x-axis, 4) lake level when profile data was collected, and 5) future lake level condition/scenario. Based on the water level difference (i.e. delta between #4 and #5), the nearshore bar is shifted vertically and horizontally as seen in Figures 3.1 and 3.2, while maintaining the overall profile volume. This is a key advancement of the tool over the original Bruun theory, which did not integrate dune erosion when maintaining the overall profile volume. For example, as demonstrated in Figure 3.1, a 1.16 m rise in lake levels results in the landward shift of the nearshore bar and sufficient dune erosion to maintain the original profile volume. Consequently, the model predicts less erosion for larger dunes during a period of rising lake levels than for smaller dunes.

During a period of falling lake levels, as seen in Figure 3.2, the nearshore bar migrates offshore and decreases in elevation. This profile adjustment to the lower lake level regime creates excess sediment in the nearshore and thus the beach increases in volume and width. This response has been observed throughout the Great Lakes since the period of low to average lake levels began in 1998.

### 3.1.2 Beach Performance Indicator, Lake Ontario

In 2005, Baird completed a visitor survey for two beaches (Sandbanks Provincial Park in Prince Edward County, Ontario, and Hamlin State Park in Monroe County, New York) on Lake Ontario for the Beach Performance Indicator, which was investigated during the IJC’s Lake Ontario-St. Lawrence Study. The purpose of the survey was to determine how beach visitation would be affected by changes in beach width due to fluctuating lake levels. Figure 3.1 shows a beach profile at Sandbanks with flags representing various water level elevations along the profile (elevations on Y2 axis) and the visitation distribution for beach users at each elevation (Y1 axis) based on the
survey results. As the pink line indicates, visitation was predicted to be sensitive to water levels and thus beach width, with a drop in total visitation for both extreme high and low lake levels. When lake levels were between 1.5 and 0.5 m above Low Water Datum, visitation was above 90% based on the survey.

Economic and visitation data were obtained from: (1) Ontario Parks Park User Surveys and Park Statistic reports, and (2) the New York State Office of Parks, Recreation and Historic Preservation visitation records. The published data indicates the annual recreational value of Canadian beaches on Lake Ontario ranges from $23.5 to $32 million, while the annual recreational value of U.S. beaches on Lake Ontario ranges from $58 to $77 million.

Since the beach survey determined future visitation would be sensitive to lake levels and thus beach width, it can be concluded water levels play an important role on the economic benefits generated by beaches within the limits of the Upper Great Lakes study. Therefore, by extension, the inclusion of low water impacts on recreational beaches, whether municipal/public or part of the State, Provincial or Federal parks system, is important.

![Sandbanks Provincial Park Visitation Distribution as a Function of Water Level](image)

**Figure 3.3 Sandbanks Provincial Park Visitation Distribution as a Function of Water Level (Elevation Along Y2 Axis with Flags Representing Varying Water Level Elevation. Visitation Distribution Along Y1 Axis for Water Levels at Each Flag)**
3.2 Other Studies

Two additional studies are reviewed that document the economic value of Great Lakes beaches and the role of beach width on market values for ocean front property.

3.2.1 Value of Lake Erie Beaches (1999)

Researchers from Ohio State University and the Ohio Sea Grant Extension Program conducted an economic study at two beaches on Lake Erie: Maumee Bay State Park beach, and Headlands State Park Beach (Ohio Sea Grant College Program, 1999). They surveyed beach users and found that on average, expenditures for single day trip users ranged from $21/trip at Headlands to $34/trip at Maumee (or $3.3 million/year at Headlands and $6.2 million/year at Maumee in local economic expenditures). They also completed a travel cost model and determined that the value of satisfaction at the beaches is $3.5 million at Headlands and $6.1 million at Maumee. Considering the beach area, the study found that each acre of beach is worth $2.3 million at Headlands and $5.5 million at Maumee (combining the economic and satisfaction values). This is significantly higher than riparian owned land which averaged $24,000-$29,000/acre in the area. By extension, considering the sensitivity of beach width and visitation to water level fluctuations, the beaches in the study area will be sensitive to both high and low water levels.

3.2.2 Effect of Beach Width on Market Values (1994)

As mentioned previously, wider beaches can reduce erosion, provide larger zones of transition habitat and more recreational area, as well as provide enhanced storm protection for communities located shoreward of beaches. Rinehard and Pompe (1994) used a hedonic model to look at the effect beach width has on coastal property values along two beaches in South Carolina: Garden City and Surfside Beach. Their study indicated that beach width has a positive effect on the price of nearby housing (a 10% increase in beach width increases nearby home values by 2.6%), with the largest effects seen on houses located near the beach. Similar effects may exist for waterfront property along the open coast of the Great Lakes.

3.3 2008 CDM Federal Programs Corporation Scoping Report

CDM conducted an extensive literature review for the U.S. Army Corps of Engineers and the CZTWG of the IUGLS to define the potential impacts of low water on riparian landowners and the associated methodologies for evaluating those impacts. From a review of sixty-seven documents, it was concluded that properties with more lake-frontage (proximity), easier access and better views of the lake, have higher price premiums associated with them. It was also concluded that lower water levels lead to lower property values.

Many of the reviewed documents assessed the impact of low water levels on housing prices around reservoirs or other small bodies of water. The observed trend of a decline in property values with decreasing water level may be representative of shorelines located in the embayments around the
Great Lakes (e.g. Green Bay and Saginaw Bay) or locations that feature a gentle nearshore slope and low wave action.

One study reviewed by CDM (No. 26, Beach Quality and the Enhancement of Recreational Property Values, by Pompe and Rinehart (1993) describes how property values in South Carolina increase with increasing beach width (which may be analogous with a situation of falling lake levels). A one foot width increase of beach increased values of developed and undeveloped lots by $558 and $754, respectively. This trend of increasing property values with increasing beach width appears to be most representative of waterfront property along the open coast of the Great Lakes.

Ultimately, further lake-specific technical studies are required to establish the trends for the upper Great Lakes study area. Given the vast geography and range of shoreline conditions (e.g. geology, nearshore slope, and wave exposure), it is possibly that the impacts of low water on property values will vary throughout the system.
4.0 SUMMARY OF KEY FINDINGS

Low water can impact shorelines positively (habitat creation, beach width increases, increased property values) or negatively (decrease aesthetics, poor water accessibility, and lower property values). Based on the initial review completed for this report, two general conclusions are provided: (1) areas with gently sloping nearshore bathymetry, low wave energy (e.g. embayments) and developed shorelines will be impacted negatively by periods of low water, and (2) exposed beach shorelines with a steep nearshore slope and high wave energy will benefit from periods of low water.

Beach visitation generates significant economic benefits within the Great Lakes and beach width and visitation have been linked to lake level fluctuations. Therefore, the impacts of low water levels on the beaches within National, State or Provincial Parks should be considered in future studies. There will be impacts to beaches outside these government parks too, however, without visitation statistics, it is difficult to make quantitative predictions about impacts due to lake level fluctuations.

In addition to impacts on beaches and property values, other low water impacts in the coastal zone include navigation channel sedimentation and increased dredging costs, negative impacts to commercial and industrial lands due to restricted access, drinking water intakes and outfalls, and industrial operations that withdraw and discharge water into the lakes. To put all of these impacts in context, further technical studies should focus on a wide range of shore types and land uses throughout the study area.
5.0 REFERENCES


Appendix E:
Summary Report for Real Estate Professional Survey

Pages 116 to 132
Development of Low Water Stage-Impact Relationships for Identified Study Sites:

Report to the Coastal Zone Technical Working Group on Task 2 - Undertake focus group sessions to establish professional perspectives on the impacts of below average water levels

Prepared by Mark Dunning and Donielle Jordan, CDM

Revised 30 Nov 2010

Purpose

This report presents observations from interviews with real estate professionals that address the key research topics outlined in the Focus Group Plan dated 9 April 2010 previously submitted to the CZ-TWG.

- Current state of local real estate market, dynamics of market, key factors influencing price of residential real estate
- Impact of shoreline (waterview) location in the residential market: what is the premium for these locations?
- Impact of recent/historical periods of high and low water on real estate prices for shoreline and waterview properties.
- Key services, amenities perceived to be discounted by prolonged low water conditions (view, proximity, access, use, etc.)
- Existence of low water level thresholds—how long would low water levels need to persist, how low would lake levels need to be for a re-pricing of shoreline/waterview properties to occur?
- Relationship between water levels and shoreline/waterview real estate prices

Obtaining Information from Real Estate Professionals

The original plan as described in Task 2\(^1\) of the Scope of Work was to conduct focus groups comprised of real estate professionals at five study sites selected by the CZ-TWG (Holland, MI; Saginaw Bay, MI; Duluth, MN; Georgian Bay, ON; and Windsor, ON). Additionally, CDM agreed to conduct telephonic interviews at an additional site – Goulais Bay, ON. Unfortunately, as described in the CDM memo of 11 May 2010, the original plan for conducting focus groups proved unworkable with private real estate

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\(^1\) Task 2: Undertake focus group sessions to establish professional perspectives on the impacts of below average water levels: The contractor will organize and undertake focus group sessions for defined study sites to establish variables and services perceived to be at risk at a range of water levels. While a range of water levels are of interest, particular emphasis should be placed on below average water levels. The contractor will prepare key focus group questions and work with representatives of the Coastal Zone TWG to refine in the context of specific study needs. The goal is to start identifying water levels at which real estate professionals might define significant shifts in sensitivity. Additionally, information should be gathered to support what the impacts of low water levels may be on property values in order to later determine the attributes of property ownership that are impacted by fluctuating water levels.
professionals due to scheduling constraints. CDM then moved to a telephone interview format with individual agents. During the period 6/28/10 – 7/30/10 twelve interviews with real estate professionals were conducted. Table 1 shows the distribution of interviews.

The questionnaire employed in the telephone interviews with real estate agents is shown in Appendix 1. Table 2 shows the relationship of interview questions to key topics. While the telephonic interview format provided a viable means of collecting useful information about low water impacts on real estate prices the approach had a number of limitations. First, telephonic interviews were conducted with individuals rather than in a group setting so that potential group discussion and synergistic insights were not possible. Additionally, telephonic interviews make it difficult to identify non-verbal cues such as facial expressions and inflections that can sometimes add additional meaning to responses. Finally, and most significantly, the format did not lend itself to questions focused on drawing insights about possible stage-impact relationships using pictures and graphs. For this reason the questionnaire could only gather general insights and views about the possibility of relationships between prolonged low water levels and shoreline real estate prices. Nevertheless, the interview process worked well. Respondents understood the questions and offered their views without reservation or difficulty.

Table 1. Study Site Interviews

<table>
<thead>
<tr>
<th>Site</th>
<th>Interviews Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, MI</td>
<td>4</td>
</tr>
<tr>
<td>Holland, MI</td>
<td>2</td>
</tr>
<tr>
<td>Saginaw Bay, MI</td>
<td>2</td>
</tr>
<tr>
<td>Georgian Bay, ON</td>
<td>1</td>
</tr>
<tr>
<td>Windsor, ON</td>
<td>2</td>
</tr>
<tr>
<td>Goulais Bay, ON</td>
<td>1</td>
</tr>
</tbody>
</table>

2 Background web research for each study site was conducted to identify real estate companies in the study area. Where possible agents at companies noting they specialized in waterfront properties were sought out. Agents were sent an initial e-mail introducing the International Upper Great Lakes Study (with a web link to the study site), and soliciting their assistance in providing information about local real estate conditions. Agents are asked to reply to the e-mail if they were interested in answering a short questionnaire. Those agents who responded were contacted and interviewed telephonically. Additionally, those agents interviewed were asked to provide names of other agents whom they believed might be interested in participating. These agents were contacted and asked to participate. In most cases real estate professionals who agreed to participate in interviews had some direct association or interest in waterfront real estate, either in that they specialized in waterfront properties, they owned property on the water, were avid boaters, or all three factors.
Table 2. Relationship between interview questions and key topics

<table>
<thead>
<tr>
<th>Key Topic Addressed</th>
<th>Interview Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current state of local real estate market, dynamics of market, key factors influencing price of residential real estate</td>
<td>1, 2</td>
</tr>
<tr>
<td>Impact of shoreline (waterview) location in the residential market: what is the premium for these locations?</td>
<td>3</td>
</tr>
<tr>
<td>Impact of recent/historical periods of high and low water on real estate prices for shoreline and waterview properties.</td>
<td>4, 5, 6, 7, 8</td>
</tr>
<tr>
<td>Key services, amenities perceived to be discounted by prolonged low water conditions (view, proximity, access, use, etc.)</td>
<td>9</td>
</tr>
<tr>
<td>Perceptions of dynamics of thresholds regarding low water levels – how long would low water levels need to persist, how low would levels need to reach for a re-pricing of shoreline/waterview properties to occur?</td>
<td>10</td>
</tr>
</tbody>
</table>

**Results Obtained**

This section presents summary observations obtained from the interviews organized by the key topic areas of interest. The text represents a synthesis of view. Additionally, verbatim quotes from interviews are presented in text boxes.

**Current state of local real estate market, dynamics of market**

Real estate market conditions vary over the study sites (see Box 1). The Duluth and Saginaw Bay real estate markets were characterized as slow and impacted by relatively poor economies. The Georgian Bay market was characterized as quiet. The Windsor market was characterized as negatively impacted by a slow economy, particularly the auto manufacturing sector, but also as being positively affected by an influx of homebuyers moving into the area from the Toronto area. The Holland market was characterized as improving, and the Goulais Bay market was characterized as excellent.
The market is considerably slower than a few years ago. This has nothing to do with lake levels – they’re now only about 15” down, and you really don’t notice it that much – really just gives you a bit of extra beach, and on the North Shore with its vertical drops you don’t notice it at all. (Duluth)

There is a lack of consumer confidence that has reduced demand. In the past most of the buyers for coastal real estate were coming from the Twin Cities for second homes. Now there is an oversupply of coastal real estate properties. (Duluth)

Our real estate is affected by the economy right now. Not to the degree in the states but it is quiet, prices are holding steady. 99% of houses here are waterfront properties on the islands. We really don’t have waterview-only properties. People here buy an entire island or a portion of the island. Homes can only be accessed during the summer months – June through September and only by boat or by plane. (Georgian Bay)

The market is excellent – the best in years! Lake levels do impact us some. In Goulais Bay there’s a major impact because it’s shallow and gets reedy and swampy. The west side of the Bay not so much as it’s deeper. (Goulais Bay)

The market right now is slow and soft due to unemployment. This area was once a manufacturing town, but many manufacturing jobs are now gone and the area has been inundated with foreclosures. (Saginaw Bay)

The market here is better than last year but not great. All economy related though, this has nothing to do with lake levels. (Holland)

Box 1. Selected comments from interviews about market conditions and dynamics at study site locations

Key factors influencing the price of residential real estate

Waterfront properties command a premium in all markets, and the factors that influence price identified by agents were generally the same in all markets: lot size, beach frontage, direct access to lake amenities (fishing, boating, swimming), and proximity to town and services. Agents in both Duluth and Holland indicated that a property’s erosion-resistance was an important consideration. Quality of view afforded by the property was deemed to be important in both Duluth and Holland; however, in Duluth the view was seen to be more a factor of improving overall “sellability” versus adding to a property’s price (Box 2).
Amount of waterfront (number of feet), accessibility to lake. For example, if the home is situated on a rock cliff which necessitates getting to the water by going down rock stairs cut into the cliff it will be valued less than a comparable home on a beach. (Duluth)

Price for waterfront is based on the size of the lot and how it is situated. Those lots with unobstructed views of the lake and with “awe-inspiring” views command the highest prices. Also, on the North Shore lots with accessibility and ease of access to the water (i.e. not too steep of a lot down to the water), and which are considered to be more erosion-resistant command the highest prices. (Duluth)

Location, views, (there are 30,000 islands in the bay so people have lots of options as far as views and they want the very best there is to offer), topography – meaning tree cover, water depth, user friendliness of land. (Georgian Bay)

The most desirable locations are the places with the shallowest water because this is where the views are amazing. Where the islands are more scattered is where the best views are located – these are referred to as the outlier islands. People see these views and seem to overlook lake levels to be in this area. (Georgian Bay)

Above all, beach-front, and access. Having rural services (well and septic) is also important. In this area we have a lot of shore wells. These are tiles that draw water from the lake through sand for filtering and into the house for potable uses. If the lake levels go down then shore wells don’t work and need to be deepened. (Goulais Bay)

Nice beach area – walking beach. Lower Bluff demands higher price – few steps to the beach. Depth of lot due to lake levels. (area for pools, etc.). People also want to be closer to town and closer to marinas, etc. (Holland)

Condition of the bluff – stability. The quality of the view. Condition of the beach below the bluff and the amount of beach frontage. (Holland)

View and water access for boating, fishing, etc. (Windsor)

Box 2 Selected comments from interviews about key factors influencing the price of shoreline residential real estate at study site locations
**Premium for waterfront/waterview location**

Properties located on the water command a premium in price in all markets, however, the size of the premium paid for waterfront property varies considerably by market. Waterfront homes in the Holland market command $4K - $20k per lineal foot of frontage and average over a million dollars in price versus $300K for comparable inland properties. Premiums expressed as the percent of price being paid for waterfront properties in other markets: 31 – 63% in Duluth, 25 – 50% in Saginaw Bay, ~ 50% in Goulaits Bay, ~ 100% in Georgian Bay, and 75 - 111% in Windsor. Waterview properties (i.e. properties not located on the shoreline, but having a view) were believed to command some premium in most markets, however, the premium was believed to be less than that for waterfront properties. In the Duluth market it was believed that waterview might enhance the ease with which a property could be sold but might not contribute much to actual sales price increases.

**Impact of lower water levels on real estate prices**

Agents generally believe that periods of high water and low water are priced into the real estate market, and low water levels have not had a great deal of impact on prices. However, interviewees in the Saginaw Bay, Windsor, and Goulaits Bay markets expressed more of a belief that low water levels at the moment were making waterfront properties harder to sell, and that they tended to stay on the market longer. There was also a belief among agents in Saginaw Bay and Windsor that lower lake levels were resulting in lower real estate prices for waterfront homes. Interviewees in Duluth, and Holland felt that the character of the economy was more influential on real estate prices than water levels (Box 3).

**Key services, amenities perceived to be discounted by prolonged low water conditions**

The general view among those interviewed appears to be that when low lake levels create a loss of access and use of the water for recreation it will impact negatively on the real estate market – making properties harder to sell and reducing the price. While recent low water levels coincided with a severe recession in the U.S. this was not so much the case in Canada and the same relationship between low water level impacts on access and use of the water and real estate prices was noted. In Duluth the water is generally deeper and shorelines steeper so that lower water levels were not perceived as a problem – in fact, some believe them to be more of a positive, one realtor noting that low water levels “creates more beach for us.” In Holland, similarly, lower water levels were mentioned in a positive light as creating more beachfront and reducing erosion problems. Higher water levels were mentioned as being a problem in Holland for producing erosion of bluffs along Lake Michigan.
There is no real impact. Lower water levels just provide more beach. (Duluth)

In regards to water levels I’ve never heard anyone say “water levels are down, I’m going to pay less for waterfront.” This may apply more to our inland lakes where water levels have been a more severe problem. (Duluth)

People that are interested in these properties know that water levels will fluctuate and they realize that levels will always be changing. Access and egress is very important in island properties, as long as there are no access issues, prices will not change. Once there are access issues the properties will not have any value as they cannot be reached. (Georgian Bay)

When water levels are high you can get $1,000 per lineal foot for shoreline location, but if water levels are low and you have a sand bar showing in front of the house it’s not going to sell as well at the asking price. It really depends on the character of the water frontage – shallower areas have greater impacts. When they see gabions sitting 5’ out of the water they ask “is this ever going to come back?” It’s a big concern with buyers. (Goulais Bay)

Lake levels really haven’t affected prices to any great degree. Buyers either want waterfront or they don’t, and they figure it was like this in 1932 and it’ll get better again. But it has been bad – people can’t get their boats out. (Goulais Bay)

Have not noticed changes, although changing lake levels allow more beach area. Even though the beach homes are more desirable during low water, people are not rushing to buy. They understand that water levels change. There is only concern when the water levels are high enough to cause bluff erosion issues and there is a lack of beach frontage. (Holland)

Beaches being closed due to e-coli in water samples, etc has pushed people away from water-front properties. There are also costs in maintaining beaches that are causing people to move away from beach front. Muck appeared this year in late April and has not gone away yet. Home market has become slower within the past 6 years. (Saginaw Bay)

When water front property is purchased you are paying more than the house is worth, the purchaser is paying for location. While people realize that water fluctuates, exposure of bottomlands creates horrendous problems. People will not buy a property if they have to walk far to get to the shore. Aplin Beach has a tremendous problem with maintaining beaches and having the corps cut the grass. Lower water levels and beach maintenance issues cause property levels to drop drastically. There are also issues with people “partying” on bottomlands near other homes. Aplin Beach has some of the lowest property values for this reason. (Saginaw Bay)

Yes, they’re harder to sell, and that always affects price. With low water levels the property’s not as appealing. Instead of a sandy beach you have weeds and exposed junk. You may need to get a machine in to cut the weeds. I really don’t have hard data to tell you how much but my gut says that prices declined about 10 – 15% when we have low water levels that create those impacts. Currently, the lake is 16” under what it should be. (Windsor)

There’s not any huge difference in prices due to water levels. Water levels are up some years, and down some years. In Michigan I’ve heard there are significant problems with lower water levels, but not so much here. Also Toronto and Lake Ontario, but we really haven’t experienced this problem of lake levels being a reason for lower prices. Sometimes people may ask “how’s the lake level?” It goes up, and it goes down. Last year it was fairly high, this year it’s lower. When people have trouble getting their boats into the water then it becomes more of a concern. I’ve heard them say “Oh, I can’t buy this property because I can’t get my boat into shore.” But that’s pretty rare. (Windsor)

Box 3 Selected comments from interviews about the impact of lower water levels on real estate prices of shoreline residential real estate at study site locations

It is interesting to note that real estate agents at two sites called attention to negative impacts of low water levels on prices for residential real estate at inland lakes, where impacts of low water levels were said to be more visible and more severe:
“There is a large lake to the west, Island Lake, that is owned by a power company which draws the lake water down for producing electricity. There are a lot of really expensive homes on this lake and prices really plummeted when the power company lowered the lake and didn’t refill it. There are pictures of boats stuck in the middle of the lake, docks without water and so forth that show the impact on this lake and real estate prices have really fallen there.” (Duluth)

“In the inland lakes overgrowth and muck is an issue as some lake levels are low and are affected more as these areas are being filled in with cattails. In this case homes lose value. The recreation value of these inland lakes declines remarkably.” (Holland)

The effect of low lake levels on commercial navigation and its secondary effect on the real estate market was also noted by a realtor in Duluth:

“The most fundamental impact of lower lake levels is on shipping. Our harbor is not deep and with lower lake levels loads have to be lightened. Grain can be and is being shipped via other modes — it is going West to western deep water ports. Iron ore is still being shipped but loads are lightened. This all adds up to a reduction in our economy – fewer jobs, and less disposable income, and reduced demand for real estate.” (Duluth)

Existence of low water level thresholds

Agents tended to believe that a prolonged period of extremely low levels by historical standards might ultimately result in a repricing of property – possibly price increases where amenities are enhanced by lower water levels (e.g. Duluth and Holland), and possibly price decreases where those amenities are negatively impacted (Goulais Bay, Saginaw Bay, Windsor). Agents were generally not willing to speculate on how far water levels would need to fall or how long low levels would have to persist for such repricing to occur (Box 4). However, one real estate agent in Saginaw Bay area believed that the perceived loss of riparian area use and access over the regulation of emerging wetlands (consisting of native and non-native vegetation, including phragmites) in riparian areas previously covered by lake waters had already reduced property values of waterfront homeowners.³

³ State and federal governmental efforts to regulate near shore areas during low water caused shoreline owners to organize, forming the group "Save Our Shoreline" in 2001. That group raised awareness of the proliferation of phragmites on Saginaw Bay beaches, and employed various means to oppose regulatory efforts to prevent shoreline maintenance, including federal and state legislation, federal and state court action, and federal and state administrative proceedings. The issues of regulatory grooming jurisdiction and ownership over near shore areas remain hotly contested.
“Yes, the DEQ claimed wetlands. Any place where this happened has greatly affected property values negatively. People fear that shoreline will be declared wetlands and therefore must be maintained by the State. This causes individuals to lose their waterfront amenities. People cannot get rid of the growth and the beaches have disappeared. This is a big issue, it is the only pricing threshold we have seen.” (Saginaw Bay)

Lake levels are so unpredictable so as far as I have seen no one seriously thinks that the Bay is going to go dry. Of course if the Bay did dry up then the land would have little value, but we don’t see that happening. (Georgian Bay)

Three years ago levels were a foot lower than they are now and this caused a shift in prices. It’s hard to say how much because the properties are so different – a home with a view to the west will sell for more than a home with a view to the east, for example. Only the most cautious buyer will rethink a purchase as a result of lake levels. (Georgian Bay)

There really is not a significant change in price, and therefore the same factors apply regardless of water level. Of course Lake Michigan low water leads to great beach activities and access, and little concern of bluff condition. Because people understand the cycle they want a deeper lot so that when water levels are high they still have a beach area. (Holland)

People understand that these cycles come and go for all lakes and therefore at this time I do not anticipate a re-pricing. Prices really do not change as buyers understand the lake cycle. (Holland)

Only in the cases of high water levels – mid 80’s early 90’s. This would definitely result in re-pricing if the water stayed this high. The times that the water was that high though, it really doesn’t last long enough to see a shift in pricing. (Holland)

Yes, the DEQ claimed wetlands. Any place where this happened has greatly affected property values negatively. People fear that shoreline will be declared wetlands and therefore must be maintained by the State. This causes individuals to lose their waterfront amenities. People cannot get rid of the growth and the beaches have disappeared. This is a big issue, it is the only pricing threshold we have seen (Saginaw Bay)

[Sustained low water levels]… would probably result in re-pricing of real estate because docks would have to be built and the beach would be very difficult to maintain due to weeds and plant growth. For example Aplin Beach has remained low and property values are falling in that area because of this. (Saginaw Bay)

You might need a new dock and need to go further out to get your boat in. The stench from stagnant vegetation creates problems that all could add up to repricing real estate. (Windsor)

In the ‘70s and ‘80s the concern was with high water, and people were building breakwalls to prevent shoreline flooding. So, it’s all part of living along the shore. Back in the 60’s there were mudflats and marshland out a distance into the lake and that was very difficult. I don’t know if we’ll see that again – it’s hard to anticipate. We’re never quite sure what the “low-low” will be and what the “high – high” will be – it depends on so many things. (Windsor)

Box 4. Selected comments from interviews about the possibility of low water level threshold effects on real estate prices of shoreline residential real estate at study site locations
Summary of Interview Findings

- Waterfront properties command a premium in all markets, and the factors that influence price identified by agents were generally the same in all markets: lot size, beach frontage, direct access to lake amenities (fishing, boating, swimming), and proximity to town and services. Agents in both Duluth and Holland indicated that a property’s erosion-resistance was an important consideration. Quality of view afforded by the property was deemed to be important in Duluth, Holland, and Georgian Bay; however, in Duluth the view was seen to be more a factor of improving overall “sellability” versus adding to a property’s price.

- The size of the premium paid for waterfront property varies considerably by market. Waterfront homes in the Holland market command $4K - $20k per lineal foot of frontage and average over a million dollars in price versus $300K for comparable inland properties. Premiums expressed as the percent of price being paid for the property attributed to waterfront location in other markets: 18 – 33% in Duluth, ~ 25% in Saginaw Bay, ~ 50% in Goulais Bay, “about double” versus comparable non-island properties for Georgian Bay.

- The general view among those interviewed appears to be that when low lake levels create a loss of access and use of the water for recreation it will impact negatively on the real estate market – making properties harder to sell and reducing the price. While recent low water levels coincided with a severe recession in the U.S. this was not so much the case in Canada and the same relationship between low water level impacts on access and use of the water and real estate prices was noted. In Duluth the character the water is generally deeper and shorelines steeper so that lower water levels were not perceived as a problem – in fact, more of a positive “creates more beach for us.” In Holland, similarly, lower water levels were mentioned in a positive light for Lake Michigan shoreline as creating more beachfront. Higher water levels were mentioned as being a problem in Holland for producing erosion of bluffs along Lake Michigan.

- The expectation of periods of high water and low water are generally priced into the real estate market, and low water levels don’t have a great deal of impact on prices. Agents speculated that a prolonged period of extremely low levels by historical standards might ultimately result in a repricing of property – possibly price increases where amenities are enhanced by lower water levels (e.g. Duluth and Holland), and possibly price decreases where those amenities are negatively impacted (Goulais Bay, Saginaw Bay). However, agents were not willing to speculate on the extent of change or how long it might take for a prolonged period of time to elapse for such repricing to occur.

- Real estate markets in regional economies that are heavily dependent on commercial navigation, and possibly lake-oriented recreation and tourism may be affected by impacts on...
those sectors produced by low lake levels. Should economic activity in those sectors be negatively affected by water level changes it is possible that such impacts would be reflected in reduced demand for real estate and ultimately lowered prices.

Table 3 summarizes key findings and conclusions from interviews.

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Real Estate Market Condition</th>
<th>Premium for Waterfront/Waterview Location</th>
<th>Relationship Between Low Water Levels and RE Prices</th>
<th>Key Services/ Amenities Impacted</th>
<th>Low Water Level Thresholds?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, MN</td>
<td>Downturn, slow</td>
<td>31 – 63%</td>
<td>Water level fluctuations priced into market</td>
<td>Possibility of more beach areas being created a positive impact</td>
<td>Not generally believed to be a factor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 – 18% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holland, MI</td>
<td>Improving second home market</td>
<td>360 – 480%</td>
<td>Prices are mostly affected by economy. Lower water levels help sales</td>
<td>Possibility of more beach areas being created a positive impact</td>
<td>People understand cyclical nature of lake levels and generally believe lake levels will always fluctuate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>67% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saginaw Bay, MI</td>
<td>Downturn due to economy</td>
<td>25 – 50%</td>
<td>Some areas have seen drops in values because of shallow water and growth in shoreline vegetation.</td>
<td>Access to shoreline, private use of shoreline</td>
<td>DEQ control over wetlands is creating a pricing threshold effect right now</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgian Bay, ON</td>
<td>Quiet</td>
<td>100%</td>
<td>Generally priced into market.</td>
<td>Access</td>
<td>Doubtful</td>
</tr>
<tr>
<td>Windsor, ON</td>
<td>Slowed down due to economy</td>
<td>75 - 111%</td>
<td>When shore amenities negatively impacted prices fall – estimated impact of ~ 10 – 15 percent for lake levels experienced to date.</td>
<td>Access to boats and channels</td>
<td>Yes, it can happen with very low or very high water levels.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goulais Bay, ON</td>
<td>Excellent</td>
<td>50%</td>
<td>Somewhat – shallower areas</td>
<td>Shore wells, visual quality</td>
<td>Possible, but people buy for an</td>
</tr>
<tr>
<td>Study Site</td>
<td>Real Estate Market Condition</td>
<td>Premium for Waterfront/Waterview Location</td>
<td>Relationship Between Low Water Levels and RE Prices</td>
<td>Key Services/Amenities Impacted</td>
<td>Low Water Level Thresholds?</td>
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<tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td>are more negatively impacted, and are more difficult to sell.</td>
<td>(presence of sandbars, etc.), access for boats</td>
<td>entire lifestyle of which water is just one part</td>
</tr>
</tbody>
</table>
Appendix 1

Low Water Stage-Impact Relationships Interview Questionnaire

Hello, my name is [ ]. I am working for the International Upper Great Lakes Study to gather information from real estate professionals about prices for coastal real estate and the relationship between lake water levels and residential real estate prices. I would like to ask you a few questions about real estate conditions and prices in the [name of area]. This should take about 10 minutes. Your answers will be grouped with other answers and will not be attributed to any person. The information provided will be used in the International Upper Great Lakes Study, and names of persons interviewed will be a matter of public record.

Could we talk now?

If not is there a time when I can call you back?

We are interested in two categories of residential properties:

- **Waterfront**: situated on shoreline, generally, with direct access to beach and/or water
- **Waterview**: not situated on shoreline, but with view of water

1. General information about the real estate market in the [area] area

   a. Please describe the current residential real estate market for waterfront properties and for waterview properties.

   b. Please describe a typical or representative waterfront property, and waterview property in terms of size (square feet), number of bedrooms, age, condition, price range, and average price in the [area].

<table>
<thead>
<tr>
<th></th>
<th>Waterfront</th>
<th>Waterview</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (square feet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td># of bedrooms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Price Range</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. In general, apart from features/characteristics of the home itself (such as square footage, number of bedrooms, age, condition, quality of fixtures, appliances, etc.) what are some key factors that influence the price of real estate for waterfront property and waterview property in this area (Place a check mark in appropriate boxes). [Let the respondent come up with their own factors unless they are completely stuck, and then go down the list)

<table>
<thead>
<tr>
<th></th>
<th>Waterfront (choose top 3 -5)</th>
<th>Waterview (choose top 3 -5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of view</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proximity to wetlands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to water-oriented recreation facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public beach access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private beach access</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linear feet of shoreline owned</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water quality</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nearshore aesthetics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shore protection structures</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ease of access to shopping, transportation, etc.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Good schools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please enumerate below)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3. In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterfront property over a comparably sized and configured inland property? In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterview property over a comparably sized and configured inland property?
4. a. In general, during periods of lower lake levels (i.e. such as observed in 2008) do you discern changes in real estate prices for waterfront and waterview properties that might be attributed to lower lake levels? Please describe the changes in prices paid for such real estate.

b. If respondent reports prices fell during 2008: During the 2008 period we were also in the middle of a severe recession so it is possible that some of the price decreases were the result of the recession. How much did inland property prices decrease on a percentage basis during the recession period?

5. Does the possibility of lower lake levels or the duration of lower lake levels come up as a matter of concern to prospective buyers of waterfront or waterview properties? Is it a frequent concern? What impacts of lower levels are potential buyers concerned about?

6. Is the possibility of lower lake levels or the duration of lower lake levels ever identified as a positive factor by prospective buyers of waterfront or waterview properties? Is this a frequently mentioned sentiment? What positive aspects of lower levels do potential buyers mention?

7. In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterfront property over comparably sized and configured inland properties during periods of “Average” water levels? In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterview property over comparably sized and configured inland properties during periods of “Average” water levels?
8. In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterfront property over comparably sized and configured inland properties during periods of *Low* water levels like those experienced in 2008? In general, what is the average premium in percentage terms that a buyer could expect to pay for a waterview property over comparably sized and configured inland properties during periods of *Low* water levels like those experienced in 2008?

<table>
<thead>
<tr>
<th>Waterfront Property:</th>
<th>Waterview Property:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average percentage premium that a buyer would likely pay over a comparably sized and configured inland property during “Average” water levels:</td>
<td>Average percentage premium that a buyer would likely pay over a comparably sized and configured inland property during “Average” water levels:</td>
</tr>
<tr>
<td>_____ %</td>
<td>_____ %</td>
</tr>
</tbody>
</table>

9. What factors would most likely account for changes in premiums in prices paid for real estate for *Low* water levels versus *Average* water levels? (Let the respondent come up with their own factors unless they are completely stuck, and then go down the list)

<table>
<thead>
<tr>
<th>Waterfront (choose top 3 -5)</th>
<th>Waterview (choose top 3 -5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of view</td>
<td></td>
</tr>
<tr>
<td>Proximity to wetlands</td>
<td></td>
</tr>
<tr>
<td>Access to water-oriented recreation facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Waterfront (choose top 3 -5)</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Public beach access</td>
<td></td>
</tr>
<tr>
<td>Private beach access</td>
<td></td>
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<tr>
<td>Linear feet of shoreline owned</td>
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<tr>
<td>Water quality</td>
<td></td>
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<tr>
<td>Nearshore aesthetics</td>
<td></td>
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<tr>
<td>Shore protection structures</td>
<td></td>
</tr>
<tr>
<td>Other (please enumerate below)</td>
<td></td>
</tr>
</tbody>
</table>

10. Would you anticipate that there could be low water level thresholds that, if exceeded, could result in re-pricing of waterfront and waterview property? What might those thresholds be in terms of length of time of low water levels, and/or in terms of lake level?

11. Please provide any additional key points you wish to make that would help us better understand the local residential real estate market for coastal properties, and the effects of lake levels on those properties.

12. Finally, we would like to talk with other knowledgeable real estate professionals in the area. Please provide the names and contact information of other real estate professionals, including appraisers, who are knowledgeable about coastal real estate whom we can contact.

THANK YOU FOR YOUR HELP!
Appendix F:
Benefit Transfer Report

Pages 134 to 150
Development of Low Water Stage-Impact Relationships for Identified Study Sites:

Report to the Coastal Zone Technical Working Group on Task 3 – *Development of preliminary stage-impact relationships using benefit transfer approach*

Prepared by Mark Dunning and Donielle Jordan, CDM

Revised November 30, 2010

Benefits Transfer (BT) is a structured way of extrapolating benefit assessments or demand functions from existing valuation studies to a target application (Young 2005). Potential studies that provide estimates of values of interest are evaluated for their suitability on a number of criteria, and those studies found to meet the criteria are employed to provide estimates of the values under investigation. In Task 3 of the Coastal Zone Technical Working Group (CZ-TWG) scope of work the CZ-TWG specified that a BT was to be performed to estimate the relationship between water levels and residential shoreline property values for five study sites selected by the CZ-TWG in the Upper Great Lakes (Saginaw Bay, Holland, MI, Duluth, MN, Georgian Bay, ON, and Windsor, ON) \(^1\). This paper documents the approach employed to perform the BT and presents the results of the analysis.

**Approach**

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\(^1\) Task 3: *Development of preliminary stage-impact relationships using benefit transfer approach*: Using the information from Task 2 as a basis for defining impacts, preliminary stage-impact curves using a benefit transfer approach are required as an initial attempt to link water levels and low water impacts for the specific study sites. The preference is the use of property values but other metrics may be deemed appropriate based on the focus group sessions. The benefit transfer should attempt to use existing data relating water levels to property values based on available research. Priority should be given to within-basin information with results from outside the basin used if no local data is available. The benefit transfer approach is intended as a preliminary and simple means of providing the Plan Formulation and Evaluation Group (PFEG) with some sense of the relationship between water levels and residential shoreline property values (including potential thresholds if applicable). The analysis might include access, view, and proximity to the shoreline. An extensive literature review has been undertaken for the Coastal Zone TWG (Morris, 2008) and should be used as the basis for the benefit transfer. Information from past IJC studies may also be useful as a comparison (e.g. crisis level information from the Levels Reference Study). In addition to the curves for each defined study site, the contractor should develop a brief document outlining the methods and data sources utilized in the benefit transfer, primary assumptions, and identified limitations.
• Perform a literature review to identify studies (1) which have addressed issues of valuation of waterfront residential properties, and/or (2) which have estimated the relationship between changes in water levels in lakes and values for waterfront residential properties.

• Evaluate the studies on a number of criteria to identify those most applicable to the needs of the current project.

• Prepare an analysis of conclusions and findings from the most appropriate valuation studies.

• Include insights and findings from interviews with real estate professionals in study locations conducted in Task 2.

• Develop BT stage-impact relationships and valuation estimates derived from the analysis of stage-impact valuation studies, and adjusted based on insights about the influence of factors such as access, view, proximity to shoreline, and shoreline configuration and characteristics obtained through the interviews with real estate professionals conducted in Task 2.

Benefits Literature Search

The CDM Scoping Exercise report (Morris 2008) provides brief abstracts of 67 studies and methodological reviews relevant to understanding economic impacts of water levels on waterfront riparian property values. Additionally, a number of additional literature searches were made including the Environmental Valuation Reference Inventory (EVRI) website (https://www.evri.ca/Global/Splash.aspx) maintained by Environment Canada, the Journal of the American Water Resources Association, and a general Google search.

Evaluation of Studies

Studies identified in these sources were evaluated on the basis of the factors identified below to select those that were most appropriate to the estimation of lake level change impacts on residential property values in the Great Lakes.

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2 Task 2 of the CZ-TWG scope of work required the conduct of focus groups with real estate professionals at five study sites selected by the CZ-TWG to obtain perspectives about the impacts of lake water levels on residential property values. Unfortunately focus groups proved unworkable and telephone interviews with real estate professionals in each of the study sites were conducted to obtain information about waterfront and waterview residential properties and the factors affecting prices for these properties.
• Evaluation factors:
  
  - preference for valuation studies focused on the Great Lakes region
  
  - preference for studies providing estimates of residential property values
  
  - preference for studies providing estimates of impacts of changes in lake levels
  
  - preference for valuation estimates obtained by hedonic pricing method versus contingent valuation (CVM) or other methods
  
  - preference for more recent valuation studies

Of the studies and reports identified nine were deemed to be most relevant to the objective of developing a BT for estimating the relationship between water level changes and residential property values. The nine studies are presented in Table 1. Three of the nine focus on residential property values in the Great Lakes region, seven of the nine employ the hedonic price method to ascertain property values. Six of the nine are concerned with examining the relationship between changes in water levels at lakes and changes in residential property values.

Table 1. Studies Selected for BT Exercise

<table>
<thead>
<tr>
<th>Study</th>
<th>Region/(Water Body)</th>
<th>Residential Property Values Focus?</th>
<th>Examine Lake Level Changes?</th>
<th>Hedonic Price Model Employed?</th>
<th>Date of Study Publication</th>
<th>Focus of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond, et al</td>
<td>GL (Lake Erie)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>2002</td>
<td>Value of lake views</td>
</tr>
<tr>
<td>Hanson, et al</td>
<td>SE (Six reservoirs in AL)</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>1999</td>
<td>Reservoir water level change impacts</td>
</tr>
</tbody>
</table>

3 The hedonic price method discerns the value of one attribute of a multi-attribute good or service through statistical analysis of market transactions (see Young 2005, p. 330) and is generally considered a stronger method of estimating values than the CVM which relies on obtaining the subjective judgments of respondents through personal interviews, mail surveys, or gaming situations. While the consensus among experts is that the CVM can be appropriate for obtaining valuation estimates there are numerous cautions about guarding against various types of bias in formulating and posing questions to respondents. For a fuller discussion of CVM see Young 2005, pp 135-147).
<table>
<thead>
<tr>
<th>Study</th>
<th>Region/(Water Body)</th>
<th>Residential Property Values Focus?</th>
<th>Examine Lake Level Changes?</th>
<th>Hedonic Price Model Employed?</th>
<th>Date of Study Publication</th>
<th>Focus of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kashian</td>
<td>GL (Lake Koshkonong, WI)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2007</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Lansford &amp; Jones</td>
<td>SW (Lake Travis, TX)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>1995</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Loomis &amp; Feldman</td>
<td>Pacific SW (Lake Almanor, CA)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2003</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Muller</td>
<td>MW (Lake Monroe, IN) &amp; NE (Candlewood Lake, CT)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2007</td>
<td>Hedonic model construction; value of lake amenity factors</td>
</tr>
<tr>
<td>Baird</td>
<td>GL</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>2010</td>
<td>Low water level impacts</td>
</tr>
<tr>
<td>Feather</td>
<td>Mid-Atlantic (Chesapeake Bay)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>2008</td>
<td>Coastal erosion susceptibility impacts on property values</td>
</tr>
</tbody>
</table>

**Analysis of Studies**

Studies show that waterfront and waterview properties command a premium over other properties. The premium paid for waterfront/waterview locations is fairly consistent in the studies ranging from 54 – 84 percent more than for comparable non-waterfront/non-waterview properties (Table 2). Some studies (e.g. Benson, et al.; Bond, et al.) noted that the amenity factor of “view” likely encompasses a variety of other access amenity factors such as direct access to beach, boating and fishing that all waterview locations may not possess to the same degree. Where waterfront location was differentiated from waterview location the hypothesized difference in price between waterfront and waterview locations was supported.
Table 2. Summary of Premium Paid for Waterfront/Waterview Properties

<table>
<thead>
<tr>
<th>Study</th>
<th>Region/(Water Body)</th>
<th>Premium Paid for Waterfront Property/Waterview Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benson et al</td>
<td>Pacific NW (Puget Sound, WA)</td>
<td>Ocean views (includes waterfront and waterview properties) command a 68% premium at shorefront, and decline to 30% two miles from shore. Properties with “poor partial views” command a 26% premium at the shorefront and decline to about 4% two miles from the shore.</td>
</tr>
<tr>
<td>Bond, et al</td>
<td>GL (Lake Erie)</td>
<td>Properties with water views command a 84% premium (includes waterfront and waterview properties)</td>
</tr>
<tr>
<td>Hanson</td>
<td>SE (Six reservoirs, AL)</td>
<td></td>
</tr>
<tr>
<td>Kashian</td>
<td>GL (Lake Koshkonong, WI)</td>
<td></td>
</tr>
<tr>
<td>Lansford &amp; Jones</td>
<td>SW (Lake Travis, TX)</td>
<td>Premium for waterfront property ranges from 63 – 82%. Somewhere between 1,000 – 4,000 feet from shoreline homebuyers stop paying a premium for lake location (marginal price for location drops to $0)</td>
</tr>
<tr>
<td>Loomis &amp; Feldman</td>
<td>Pacific SW (Lake Almanor, CA)</td>
<td>Waterfront property commands a 70% premium</td>
</tr>
<tr>
<td>Muller</td>
<td>MW (Lake Monroe,IN) &amp; NE (Candlewood Lake, CT)</td>
<td>Connecticut lake waterfront property commanded a 60% premium; Indiana lake that experienced large lake level fluctuations showed no premium for waterfront property but had a 34% premium for waterview properties</td>
</tr>
<tr>
<td>Baird</td>
<td>GL</td>
<td></td>
</tr>
<tr>
<td>Feather</td>
<td>Mid-Atlantic (Chesapeake Bay)</td>
<td>On average shorefront properties command a 54% premium versus non-shorefront properties</td>
</tr>
</tbody>
</table>

The impact of waterfront/waterview location declines with distance from the shoreline. One study (Lansford and Jones) indicated that the effect is present at a decreasing rate out to a range of about 4,000 feet from the shoreline while another study (Benson, et al) found that the effect is present within about two miles of the shoreline.
A number of studies have examined the effect of changing water levels on residential property values. The results of these studies are presented in Table 3 below. Several studies focused on fluctuating water levels associated with water management operations for flood control, hydropower, and water supply – irrigation at inland reservoirs. While it might be suspected that lake level variations on such reservoirs would be expected and that property values might take such “normal” practices into account the studies did find that even normal fluctuations in pool levels were associated with changes in residential property values. Two studies (Loomis and Feldman; Lansford and Jones) found very modest decreases in property values (0.03 percent, and 0.6 percent respectively of a property’s value) for each foot decrease in lake level.

The Hanson, et al study using a Contingent Value approach explored the effect that proposed permanent water management changes at six Alabama reservoirs might have on lakefront residential property values. The proposed changes could result in significant permanent drawdowns in lake levels of one to eight feet. Hanson, et al. reported that homeowners estimated that their properties would decline between 4 – 15 percent for each foot drop in lake levels when they were asked for their estimate of the impact of a permanent change in lake levels on residential property values. The Hanson, et al study also examined home owners’ estimates of the impacts of seasonal water level changes from permanent changes to lake operations and found that impacts on property values were estimated to be greater the longer the lower lake levels persisted. Respondents estimated the decline in property values to be 11 – 18 percent for low lake levels that persisted 60 days, and 19 – 35 percent for low lake levels that persisted 120 days or more. Kashian (2007) found that a 2” permanent reduction in lake level at Lake Koshkonong, WI slowed the appreciation of lakeside residential properties about 12 percent compared with a control lake’s property appreciation.

The Baird report notes that the character of shoreline conditions is likely to influence the nature of the relationship between low water levels and property values. Baird concludes (p. 22) that for exposed beach shorelines with a steep nearshore slope lower water levels are likely to reduce chances of erosion, and result in increased beach area. Such impacts are likely to result in increased property values. In contrast, for developed shorelines with gently sloping nearshore bathymetry and low wave energy, such as embayments, low water levels are likely to expose mud flats, encourage growth of undesirable vegetation, and reduce access to water-oriented recreation amenities. These impacts are likely to be translated through market processes into reductions in real estate property values.

Finally, while not focused on the relationship between low water levels and property values, the Feather report on the relationship between coastal erosion susceptibility and property values supports the idea that a coastal factor deemed to have negative effects on property is priced into real estate values. Feather found that properties located near to high or medium eroding shorelines were worth 17 percent less on average (Feather 2008).
Table 3. Summary of Study Findings on the Impact of Water Level Changes on Property Values

<table>
<thead>
<tr>
<th>Study</th>
<th>Region/(Water Body)</th>
<th>Impact of Water Level Changes on Property Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benson et al</td>
<td>Pacific NW (Puget Sound, WA)</td>
<td>NA</td>
</tr>
<tr>
<td>Bond, et al</td>
<td>GL (Lake Erie)</td>
<td>NA</td>
</tr>
<tr>
<td>Hanson</td>
<td>SE (Six reservoirs, AL)</td>
<td>Contingent value-derived imputed lake front property values decreased by 4 – 15% on average for each foot below full summer pool level for a range of pool reductions of 0 – 5’ at six Alabama reservoirs. The longer the duration of summer drawdowns below full pool created by permanent changes to operations the greater the reduction in imputed property values. Reducing summer full pool levels for 60 days decreased property values 11 – 18% on average while reducing summer full pool levels for 120 days showed a 19 – 35% reduction in property values on average at the six reservoirs.</td>
</tr>
<tr>
<td>Kashian</td>
<td>GL (Lake Koshkonong, WI)</td>
<td>Lowering of water levels by 2” on a WI lake resulted in a reduction of appreciation of lake front property values. In comparison with a control lake which appreciated 90% in the study period the WI lake only appreciated by 79%.</td>
</tr>
<tr>
<td>Lansford &amp; Jones</td>
<td>SW (Lake Travis, TX)</td>
<td>Table 6 of the study suggests that each foot of decrease in lake level is associated with a decrease of 0.6% in housing values.</td>
</tr>
<tr>
<td>Loomis &amp; Feldman</td>
<td>Pacific SW (Lake Almanor, CA)</td>
<td>Each additional foot of shoreline exposed by low water decreases property value by 0.03% ($119 on average).</td>
</tr>
<tr>
<td>Muller</td>
<td>MW (Lake Monroe, IN) &amp; NE (Candlewood Lake, CT)</td>
<td></td>
</tr>
<tr>
<td>Baird</td>
<td>GL</td>
<td>After review of various studies Baird concludes that lower water levels are likely to have a positive effect on exposed beach shorelines with a steep nearshore slope in that lower water is likely to reduce chances of erosion, and result in increased beach area. In contrast, for developed shorelines with gently sloping nearshore bathymetry and low wave energy, such as embayments, the effects are likely to be perceived as negative through exposure of flats, encouragement of growth of undesirable vegetation, and reduced access to water-oriented recreation amenities. These impacts are likely to be translated through market processes into reductions in real estate property values.</td>
</tr>
<tr>
<td>Feather</td>
<td>Mid-Atlantic (Chesapeake)</td>
<td>NA</td>
</tr>
</tbody>
</table>

* Chesapeake Bay shoreline properties near high or medium eroding shorelines were
<table>
<thead>
<tr>
<th>Study Region/(Water Body)</th>
<th>Impact of Water Level Changes on Property Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, MI</td>
<td>worth 17 percent less on average.</td>
</tr>
<tr>
<td>Holland, MI</td>
<td></td>
</tr>
<tr>
<td>Saginaw Bay, MI</td>
<td></td>
</tr>
<tr>
<td>Georgian Bay, ON</td>
<td></td>
</tr>
<tr>
<td>Windsor, ON</td>
<td></td>
</tr>
<tr>
<td>Goulais Bay, ON</td>
<td></td>
</tr>
</tbody>
</table>

**Interviews with Real Estate Professionals**

Telephone interviews were conducted with real estate professionals in the five study sites selected by the CZ-TWG (Holland, MI; Saginaw Bay, MI; Duluth, MN; Georgian Bay, ON; and Windsor, ON). Additionally, one telephone interview was conducted at a sixth site, Goulais Bay, ON at the request of the CZ-TWG. In all, 12 interviews were conducted (Table 4). Questions posed to real estate professionals focused on the following topics:

- Current state of local real estate market, dynamics of market, key factors influencing price of residential real estate
- Impact of shoreline (waterview) location in the residential market: what is the premium for these locations?
- Impact of recent/historical periods of high and low water on real estate prices for shoreline and waterview properties.
- Key services, amenities perceived to be discounted by prolonged low water conditions (view, proximity, access, use, etc.)
- Relationship between water levels and shoreline/waterview real estate prices
- Existence of low water level thresholds—how long would low water levels need to persist, how low would lake levels need to be for a re-pricing of shoreline/waterview properties to occur?

**Table 4. Study Site Interviews**

<table>
<thead>
<tr>
<th>Site</th>
<th>Interviews Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, MI</td>
<td>4</td>
</tr>
<tr>
<td>Holland, MI</td>
<td>2</td>
</tr>
<tr>
<td>Saginaw Bay, MI</td>
<td>2</td>
</tr>
<tr>
<td>Georgian Bay, ON</td>
<td>1</td>
</tr>
<tr>
<td>Windsor, ON</td>
<td>2</td>
</tr>
<tr>
<td>Goulais Bay, ON</td>
<td>1</td>
</tr>
</tbody>
</table>

Key observations from the interviews are presented below and summarized in Table 5.

- **Current state of local real estate market.** Real estate market conditions vary over the study sites. The Duluth and Saginaw Bay real estate markets were characterized as slow and impacted by relatively poor economies. The Georgian Bay market was characterized as quiet. The Windsor

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4 For a more in-depth report on the interviews see Dunning and Jordan 2010.
market was characterized as negatively impacted by a slow economy, particularly the auto manufacturing sector, but also as being positively affected by an influx of homebuyers moving into the area from the Toronto area. The Holland market was characterized as improving, and the Goulais Bay market was characterized as excellent.

- **Impact of shoreline (waterview) location in the residential market:** Waterfront properties command a premium in all markets, and the factors that influence price identified by agents were generally the same in all markets: lot size, beach frontage, direct access to lake amenities (fishing, boating, swimming), and proximity to town and services. Agents in both Duluth and Holland indicated that a property’s erosion-resistance was an important consideration. Quality of view afforded by the property was deemed to be important in both Duluth and Holland; however, in Duluth the view was seen to be more a factor of improving overall “sellability” versus adding to a property’s price.

- **Premium for waterfront/waterview location:** The size of the premium paid for waterfront property varies considerably by market. Waterfront homes in the Holland market command $4K - $20k per lineal foot of frontage and average over a million dollars in price versus $300K for comparable inland properties. Premiums expressed as the percent of price being paid for the property attributed to waterfront location in other markets: 31 – 63% in Duluth, 25 - 50% in Saginaw Bay, ~ 50% in Goulais Bay, ~ 100% in Georgian Bay, and 75 - 111% in Windsor.

- **Relationship between water levels and shoreline/waterview real estate prices:** Agents generally believe that periods of high water and low water are priced into the real estate market, and low water levels have not had a great deal of impact on prices. However, interviewees in the Saginaw Bay, Windsor, and Goulais Bay markets expressed more of a belief that low water levels at the moment were making waterfront properties harder to sell, and that they tended to stay on the market longer. There was also a belief among agents in Saginaw Bay and Windsor that lower lake levels were resulting in lower real estate prices for waterfront homes. Interviewees in Duluth, and Holland felt that the character of the economy was more influential on real estate prices than water levels.

- **Key services, amenities perceived to be discounted by prolonged low water conditions:** The general view among those interviewed appears to be that when low lake levels create a loss of access and use of the water for recreation it will impact negatively on the real estate market – making properties harder to sell and reducing the price. While recent low water levels coincided with a severe recession in the U.S. this was not so much the case in Canada and the same relationship between low water level impacts on access and use of the water and real estate prices was noted. In Duluth the water is generally deeper and shorelines steeper so that lower water levels were not perceived as a problem – in fact, some believe them to be more of a positive, one realtor noting that low water levels “creates more beach for us.” In Holland,
similarly, lower water levels were mentioned in a positive light as creating more beachfront and reducing erosion problems. Higher water levels were mentioned as being a problem in Holland for producing erosion of bluffs along Lake Michigan.

**Existence of low water level thresholds:** Agents tended to believe that a prolonged period of extremely low levels by historical standards might ultimately result in a repricing of property – possibly price increases where amenities are enhanced by lower water levels (e.g. Duluth and Holland), and possibly price decreases where those amenities are negatively impacted (Goulais Bay, Saginaw Bay, Windsor). Agents were generally not willing to speculate on how far water levels would need to fall or how long low levels would have to persist for such repricing to occur. However, one real estate agent in Saginaw Bay area believed that the perceived loss of riparian area use and access as a result of the regulation of emerging wetlands (consisting of native and non-native vegetation, including phragmites) in riparian areas previously covered by lake waters had already reduced property values of waterfront property.5

“Yes, the DEQ claimed wetlands. Any place where this happened has greatly affected property values negatively. People fear that shoreline will be declared wetlands and therefore must be maintained by the State. This causes individuals to lose their waterfront amenities. People cannot get rid of the growth and the beaches have disappeared. This is a big issue, it is the only pricing threshold we have seen.” (Saginaw Bay)

This realtor described the magnitude of price impacts on home prices where these issues occurred as “significant,” but could not estimate a percentage decline in home prices attributable to the situation.

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5 State and federal governmental efforts to regulate near shore areas during low water caused shoreline owners to organize, forming the group "Save Our Shoreline" in 2001. That group raised awareness of the proliferation of phragmites on Saginaw Bay beaches, and employed various means to oppose regulatory efforts to prevent shoreline maintenance, including federal and state legislation, federal and state court action, and federal and state administrative proceedings. The issues of regulatory grooming jurisdiction and ownership over near shore areas remain hotly contested.
### Table 5. Summary of Interview Results with Real Estate Professionals at Study Sites

<table>
<thead>
<tr>
<th>Study Site</th>
<th>Real Estate Market Condition</th>
<th>Premium for Waterfront/Waterview Location</th>
<th>Relationship Between Low Water Levels and RE Prices</th>
<th>Key Services/Amenities Impacted</th>
<th>Low Water Level Thresholds?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duluth, MN</td>
<td>Downtown, slow</td>
<td>31 – 63%</td>
<td>Water level fluctuations priced into market</td>
<td>Possibility of more beach areas being created a positive impact</td>
<td>Not generally believed to be a factor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 – 18% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Holland, MI</td>
<td>Improving second home market</td>
<td>360 – 480%</td>
<td>Prices are mostly affected by economy. Lower water levels help sales</td>
<td>Possibility of more beach areas being created a positive impact</td>
<td>People understand cyclical nature of lake levels and generally believe lake levels will always fluctuate</td>
</tr>
<tr>
<td></td>
<td></td>
<td>67% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saginaw Bay, MI</td>
<td>Downturn due to economy</td>
<td>25 – 50%</td>
<td>Some areas have seen drops in values because of shallow water and growth in shoreline vegetation.</td>
<td>Access to shoreline, private use of shoreline</td>
<td>Wetlands issues could be creating a pricing threshold effect right now</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0% (WV)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Georgian Bay, ON</td>
<td>Quiet</td>
<td>100%</td>
<td>Generally priced into market.</td>
<td>Access</td>
<td>Doubtful</td>
</tr>
<tr>
<td>Windsor, ON</td>
<td>Slowed down due to economy</td>
<td>75 - 111%</td>
<td>When shore amenities negatively impacted prices fall – estimated impact of ~ 10 – 15 percent for lake levels experienced to date.</td>
<td>Access to boats and channels</td>
<td>Yes, it can happen with very low or very high water levels.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goulais Bay, ON</td>
<td>Excellent</td>
<td>50%</td>
<td>Somewhat – shallower areas</td>
<td>Shore wells, visual quality</td>
<td>Possible, but people buy for</td>
</tr>
<tr>
<td>Study Site</td>
<td>Real Estate Market Condition</td>
<td>Premium for Waterfront/Waterview Location</td>
<td>Relationship Between Low Water Levels and RE Prices</td>
<td>Key Services/Amenities</td>
<td>Low Water Level Thresholds?</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>------------------------</td>
<td>---------------------------</td>
</tr>
</tbody>
</table>
|            |                             |                                          | are more negatively impacted, and are more difficult to sell. | (presence of sandbars, etc.), access for boats | an entire lifestyle of which water is just one part |}

**General Conclusions Relevant to Developing Stage-Impact Curves**

1. Waterfront residential properties command a higher premium in price than residential properties having only waterviews and residential properties having neither waterfrontage nor waterviews. Studies reviewed showed the percentage premium paid for waterfront properties to be in the range of 54 – 84 percent, while the ranges for property premiums for waterfront properties in the study sites (excepting Holland, Georgian Bay, and Windsor) ranged from 25 – 75 percent. Interviews with real estate personnel also confirmed that waterview properties tend to be valued less than waterfront properties, which generally is consistent with the findings in the literature.

2. The enhanced price for waterfront properties appear to be based on possession of a bundle of water-oriented “lifestyle” amenities including water views and direct access to shoreside water recreation pursuits such as beach access, swimming, sunbathing, boating, and fishing.

3. When lake water levels are identified as interfering with key water-oriented amenities a negative effect on residential property prices can be experienced. The hedonic price method studies suggest that this effect is minor (0.03 – 0.6 percent of property value per foot of drop) which supports most real estate professionals’ opinions that water level fluctuations are generally priced into market prices, and while some changes in real estate prices may occur during low water periods they are generally minor.

4. Specific shoreline characteristics may accentuate the negative effects of low water levels. Gently sloping shorelines are more likely to experience growth of shoreline vegetation and impedance to boating access under low water conditions. Similarly, Georgian Bay island properties that are only accessible by boat are especially vulnerable to low water levels. When impacts of low water levels occur in such locations price drops can be more severe as suggested in the Windsor and Saginaw Bay interviews. While the Georgian Bay interviewee took care to note that low water impacts had not been severe thus far, it was noted that should water levels fall below a level that permitted boat access to islands that properties on such islands would lose their value.
5. Threshold effects are apparent in the literature. Hansen, et al. found that owners of waterfront properties believed that a proposed water management policy change that would permanently lower lake water levels would have a substantially larger negative impact on home values averaging 4 – 15 percent of property value for each one-foot drop in lake level below normal levels. Feather also found that shorefront properties located near highly erodible areas were valued less than other properties. In this case, location in a suspect area might be considered as a threshold effect.

Currently most appear to believe that water levels in the study areas are fluctuating within “normal” limits, and that permanent or long-lasting low water conditions and resultant impacts are not likely. However, a potential threshold effect was suggested as possibly occurring in the Saginaw Bay area over regulatory actions to declare shoreline areas previously submerged but now exposed by low water levels as “wetland areas.” In this context, when the impacts of lower water levels appear to be permanent or not easily mitigated it is possible that the real estate market may take such circumstances into account with a result being that property values in such locations could be reduced.

Benefit Transfer Stage-Damage Relationships

Figure 1 presents stage-impact relationships compiled from the literature review and also shows two data points of stage impact relationships obtained from interviews. The curve labeled “Lansford” shows the modest relationship noted in the hedonic price analysis between “normal” lake level fluctuations and property values. The curve was plotted on the relationship reported in the study of a .6 percent change in values for shoreline residential properties for each foot that lake levels dropped. The curve labeled “Hanson” shows the much more significant impact on residential property values that proposed permanent changes in lake levels was expected to have. Again the curve is plotted showing the average total change in residential property values reported. Information provided by most real estate professionals is generally consistent with the stage-impact relationship shown in Figure 1 corresponding to the curve labeled “Lansford.” That is, there are likely to be small changes in real estate prices attributable to lower lake levels where minor negative effects are being observed. Additionally, since the predominant belief still seems to be that low lake levels are part of a cycle and will bounce back to normal levels in the future, impacts of lower water levels are reflected more in slower sales pace rather than noticeable decreases in home prices.

It is possible that a shift in real estate market prices from what is considered normal to a significant repricing is as much a social phenomenon as one determined strictly by physical conditions. In his book The Tipping Point, Malcolm Gladwell identifies tipping points as fundamental shifts in the interpretation or valuation of events. Tipping points are created by the influence of media, opinion leaders within personal networks, and by the presence of compelling images. If a “tipping point” is reached whereby low lake levels and their attendant negative impacts are perceived to be severe, permanent, or possibly where the ability to mitigate negative impacts is constrained by policy (e.g. prohibitions against
grooming of shoreline wetland areas) it could be expected that more significant reductions in property values could occur. The curve labeled “Hanson” may represent a situation where the definition of changes in water levels has moved from “normal” fluctuations to a more permanent change – either created by policy changes or by a more widely held belief in the permanence of climatic changes. As can be seen the point on the graph labeled “Windsor” falls close to the Hanson curve. While it is broad speculation at this point, one interpretation would be that something of a threshold or tipping point effect may be occurring in parts of that market experiencing negative effects of current low lake levels such as growth in shoreline vegetation and loss of boating access. 

**Figure 1. Stage – Impact Relationships Suggested by Benefit Transfer and Interview Data**

Limitations and Caveats

It must be acknowledged that the curves and data points in Figure 1 could convey greater precision and specificity than is warranted. Relatively few studies have explored the relationship between lake water level changes and property values, and relatively few interviews were completed. Additionally, the Hanson study employed a CVM approach to obtain the values identified. Since this method is based on

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6 Similarly, an interview in the Saginaw Bay suggested that waterfront properties were experiencing significant price drops associated with the prevalence of shoreline vegetation and limitations on boating access; however, no estimate of the magnitude of such decreases could be obtained.
expressed willingness to pay or to accept payment as opposed to actual market transactions it is open to a number of potential sources of error or bias. Finally, while the views of real estate professionals are likely to reflect market conditions there is still the possibility that interviewees may have difficulty distinguishing the effects of economic conditions on price levels from lake level change impacts. Additionally, other sources of bias could be introduced through the selection of interviewees or in the way interviews were conducted. For all of these reasons the benefits transfer relationships expressed in Figure 1 should only be used as very rough approximations for exploring potential situations and options.

Implications

Subject to the limitations and caveats expressed above, the benefits transfer research and real estate interviews suggest:

1. For gently sloping shorelines where low water levels are associated with negative impacts on boating access or undesirable shoreline vegetation the “Lansford” curve could be applied to assess impacts on waterfront properties.

2. For gently sloping shorelines where low water levels may have created severe negative impacts relating to impeding access and growth of undesirable shoreline vegetation, and there is the expectation of such impacts’ permanence or intractability such as was noted in Windsor and suggested in Saginaw Bay the “Hanson” curve may be more relevant to assess impacts on waterfront properties.

3. For shorelines where low water levels are not associated with negative impacts on access or aesthetics such as was noted in Holland and Duluth neither the “Lansford” nor the “Hanson” curves would apply.

Further Research

The CZ-TWG anticipated that the benefits transfer research would likely not yield unequivocal results and noted in its scope of work that an assessment of the need for a hedonic price model (HPM) should also be produced. Certainly, there is much to argue for the conduct of HPM study to obtain more specific and precise understanding of the relationship between lake level changes and real estate prices while controlling for other confounding variables such as economic conditions and property characteristics. Other, less desirable, alternatives for obtaining estimated stage-impact relationships could include engaging in a mail survey of a broad sample of real estate professionals, and conducting a CVM study of waterfront and waterview property owners.
References


Feather, Tim. 2008. Property Value Impacts from Coastal Erosion on Chesapeake Bay, Maryland. Prepared for Baltimore District, Corps of Engineers. CDM Federal Programs, Carbondale, IL.


Appendix G:
Hedonic Price Model Methodology Report

Pages 152 to 169
Development of Low Water Stage-Impact Relationships for Identified Study Sites:

Report to the Coastal Zone Technical Working Group on Task 4 – Preparation of strategy for development of hedonic pricing model

Prepared by Mark Dunning and Donielle Jordan, CDM¹

Revised November 30, 2010

Purpose

Hedonic pricing models (HPM) can be used to estimate the contribution of amenities such as waterfront location to market prices for real estate. They can also be used to explore how factors such as changes in lake levels may impact real estate prices. The Coastal Zone Technical Working Group (CZ-TWG) has specified in Task 4² that an assessment of the feasibility and approach for developing an HPM be made. This report addresses the following topics:

- Overview of HPM
- Constructing an HPM
- Data collection
- Preferred sites
- HPM costs and benefits versus alternative approaches
- Model framework and operation

¹ Tim Feather of CDM had a significant role in the review of the draft report as it was being developed.

² The contractor will develop a brief outline of the strategy for the potential development of hedonic pricing models at the defined study sites. The outline should identify required data including that determined in the focus groups, options for data sources, along with costs to obtain the data (if purchasing is necessary). Within the strategy, the contractor will outline the pros and cons of undertaking such an analysis given the outcomes of Tasks 2 and 3 above. Coastal TWG and Plan Formulation and Evaluation Group representatives should be included in discussions of modeling strategies to ensure the expectations of model operational requirements are incorporated. Such expectations include the use of open source coding and if possible, the ability to operate the model within a spreadsheet application such as MS Excel. The contractor will also propose two (2) preferred sites from the suite of potential sites to test the modeling approach (one Canadian and one U.S.).
Overview of Hedonic Pricing Models

The hedonic price method discerns the value of one attribute of a multi-attribute good or service through statistical analysis of market transactions (see Young 2005, p. 330). In the case of using HPM to identify factors contributing to real estate prices Feather (2008, p.5) notes: *the price of a residential property reflects the characteristics of that property—location, size, type of construction, neighborhood, amenities, etc. These characteristic components are part of the “asset price” of the housing bundle. To reveal the implicit hedonic price, econometric techniques “unbundle” these components. Through use of multiple regression analysis, the respective contributions of these components to the total market values of properties in a population can be inferred and statistically verified. Predictions made regarding current and future property value effects, if any, resulting from changes in the components, can be derived.*

The general form of the HPM specification is:

\[ P_i = f(S_i, N_i, Q_i) \]

Where \( P_i \) is the price of property \( i \), \( S_i \) are the structural characteristics of property \( i \), \( N_i \) are the neighborhood characteristics of \( i \), and \( Q_i \) are the environmental quality characteristics of property \( i \) (Freeman 1993).

Constructing an HPM

Research Questions the Model Should Explore

The construction of an HPM is undertaken to address questions of the influence of various characteristics or factors on the price of a good. In this case, the basic research question the HPM would explore is “What is the relationship between lake level changes and property values?” The literature reviewed for the preparation of the benefits transfer paper (Dunning and Jordan 2010a) suggests that when lake water levels are identified as interfering with key water-oriented amenities a negative effect on residential property prices can be experienced. Interviews conducted with local real estate professionals (Dunning and Jordan 2010b) suggested that when impacts of lower lake levels are visible and perceived to be severe such as growth of shoreline vegetation and impedance of boating access price drops in waterfront real estate can occur. The HPM would need to be structured to enable exploration of a number of refinements to the basic research question such as (a) Must lake levels drop beyond certain levels before housing prices are affected? (b) Must certain kinds of impacts associated
with lower water levels be present (e.g. presence of shoreline vegetation) before housing prices are impacted? (c) Are only waterfront properties affected, or does the negative impact extend to waterview and other properties?

Model Specification

An HPM is only as good as the completeness of variables comprising the model\(^3\). It is imperative to include those factors affecting real estate prices. This is particularly true when there have been overlapping conditions which could affect real estate prices such lower lake levels and a concurrent recession and economic downturn.

To begin the process of identifying variables an examination of the key independent variables used in the HPM studies previously reviewed and used in the Task 2 Benefits Transfer paper (Dunning and Jordan 2010a) was performed. Appendix 1 shows studies and the breakdown of variables used organized by the three categories (structural, neighborhood, and environment). This review shows that the most-frequently appearing variables in these HPM were:

**Structural Variables:**
- Property square footage
- # of baths
- Lot size
- # garages
- Construction quality
- Age of property

**Neighborhood Variables:**
- County of location
- School district of location

**Environmental Factors:**

\(^3\) Failure to include important variables in an explanatory model can result in Omitted Variable Bias (OVB) and can bias the parameters of regression equations. Since we are interested in determining the influence of lake levels on home prices relative to other potential factors it is important to have confidence in the coefficients produced in the regression analysis. The normal approaches for dealing with OVB are to first have a theoretically sound basis for the selection of potential explanatory variables based on an understanding and review of the literature, and second, to closely examine the error term produced in the regression equation to ensure that it meets conditions of normality (mean of 0, and constant variance).
Waterview
Waterfront location
Feet of shoreline

Other Necessary Independent Variables Suggested by Research Questions: The variables listed below were not included in the majority of the referenced studies; however, they would need to be addressed given the intent of the study and the research questions posed.

- **Lake Level**: Since the primary interest in a HPM will be determining the possible influence of lake levels on housing prices it will be important to include a lake level variable in the model. This variable could be defined as the level of the lake expressed as its mean sea level (msl) value at the time of sale of the property. A variety of formulations of this variable could be constructed and evaluated in the model to address various hypotheses regarding the influence of lake levels on prices, e.g. creating a categorical variable to represent a threshold below which negative impacts on boating and/or weed growth were most likely to occur.

- **Shore Character**: Interviews with real estate professionals as well as literature reviewed suggests that the greatest negative impacts of low water levels are experienced on shores have gently sloping relief. A dummy variable can be created such that a “1” indicates a shoreline having gently sloping relief (as revealed through charts), while a “0” indicates a shore with a different character.

- **Economic Conditions**: It can be expected that recessionary conditions exerted a powerful and confounding influence on the prices of homes. One readily available proxy measure for local economic conditions in the United States is the Bureau of Labor Statistics-reported county unemployment rate at the time of sale. Similar data is available for purchase from CANSIM (http://www.statcan.gc.ca/start-debut-eng.html) for Ontario.

**Dependent and Classification Variables:**

- **Sales price**: Since sales of properties occur over an extended period it is necessary to convert sales prices into constant dollars. Tools such as the Bureau of Labor Statistics inflation calculator (http://data.bls.gov/cgi-bin/cpicalc.pl) can be used for this purpose.

- **Date of sale**
Data Collection

Data on property sales can be obtained by accessing government or quasi-government assessment offices, and/or through purchase of data from proprietary data services, and/or generated by in-house analysis. It can be expected that a great deal of the time required to complete an HPM effort will be consumed by the process of tracking down data, obtaining it, and supplementing the data set with variables that need to be custom-created. Table 1 shows the likely availability of data from government data bases based on a quick review of government data sites, and the variables that would likely need to be custom-created.

Table 1. Availability of Data for HPM Construction

<table>
<thead>
<tr>
<th>Variable</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saginaw Bay⁴</td>
</tr>
<tr>
<td>Sales Price</td>
<td>X</td>
</tr>
<tr>
<td>Last Date of Sale</td>
<td>X</td>
</tr>
<tr>
<td>Lake Level at Time of Sale</td>
<td>+</td>
</tr>
<tr>
<td>Unemployment Rate at Time of Sale</td>
<td>+</td>
</tr>
<tr>
<td>Lot Size</td>
<td>X</td>
</tr>
<tr>
<td>Property Square Feet</td>
<td>X</td>
</tr>
<tr>
<td># Garages</td>
<td>cc</td>
</tr>
<tr>
<td>Construction Quality</td>
<td></td>
</tr>
</tbody>
</table>

---


<table>
<thead>
<tr>
<th>Variable</th>
<th>Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of Property at Time of Sale</td>
<td>X</td>
</tr>
<tr>
<td>County/ Township</td>
<td>cc</td>
</tr>
<tr>
<td>School District</td>
<td>cc</td>
</tr>
<tr>
<td>Water view</td>
<td>cc</td>
</tr>
<tr>
<td>Waterfront Location</td>
<td>cc</td>
</tr>
<tr>
<td>Feet of Shoreline</td>
<td>cc</td>
</tr>
</tbody>
</table>

X = Information is obtainable from the government assessor agency data source listed
+=Information is obtainable from another government source
$=Requires purchase (Market Model Reports, $250/CN$ each report)
CC=custom created variable

**Preferred Sites**

To be considered as a potential site for applying an HPM the ideal site should meet a number of criteria: availability of good data at reasonable cost, the site has experienced lake level changes, and those lake level changes have created perceived impacts. Based on findings from real estate interviews and evaluation of data requirements, availability, and costs a US study site and a Canadian study site will be identified as recommended sites for application of an HPM.

Based on a preliminary assessment it appears that the Saginaw Bay and Windsor sites may offer the best opportunity to explore relationships between negative impacts associated with lake level changes and prices for waterfront and waterview homes. It is also possible that Georgian Bay would also offer a suitable opportunity for constructing an HPM for a Canadian site since the islands have experienced negative impacts from low water levels related to access issues for some of the properties located on a number of islands. This impact is different from the vegetation/overgrowth issues that mainland areas are experiencing. Using the Georgian Bay Islands may be an excellent way of investigating additional impacts of low water levels.
Alternatives to HPM

An HPM study will require effort for data collection, data cleaning, and statistical analysis. Before embarking on such a task it is useful to explore alternative approaches that might yield answers to the research questions in a less time-consuming fashion. Two alternative approaches are described and illustrated here: what is termed a simplified HPM approach, and a time series analysis method.

Simplified HPM Approach

The simplified HPM approach employs the Zillow.com website to select homes that are on the market in U.S. study sites and creates an HPM-like data base of variables contained in the Zillow data. For this example, data analyzed included waterfront homes along Saginaw Bay, MI on Lake Huron. In this area, data available on Zillow.com primarily included homes currently listed on the real estate market. The dataset contained very few homes previously sold. As a result, the dependent variable in this case is asking price for the property instead of actual sales price. Additional information included square footage, number of bedrooms and bathrooms, lot size, the date the property was listed, and the price per square foot. Where data was missing or unavailable (for variables other than price) the mean of the available data was substituted. This information, when coupled with information on lake levels and other variables such as unemployment rate, waterfront, waterview, and other property identifiers can be used to perform a regression analysis on asking price. Lake level during the month the home was listed on the market (expressed in meters, and obtained from the Great Lakes Information Network, at the Essexville, MI Station). A binary (dummy) variable was created where a “1” signified a lake level that was at or higher than the long-term lake level average of 176.3 meters, and a “0” indicated lake levels below the long term average level.Unemployment rate data was also added based on the year the home was listed (data was taken from the Bureau of Labor Statistics). Data was collected for 56 waterfront homes located along the shores of Saginaw Bay. Table 2 shows the results of an example simplified HPM using properties in the study area.

Table 2. Simplified HPM Approach: Saginaw Bay Regression Analysis Utilizing Zillow.com Data

<table>
<thead>
<tr>
<th>Saginaw Bay Regression Analysis Utilizing Zillow.com Data</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>Adj. R-Square</td>
<td>0.6551</td>
<td></td>
</tr>
</tbody>
</table>

| Explanatory Variables | Parameter Estimate | Standard Error | t Value | Pr>|t| |
|-----------------------|--------------------|----------------|---------|-------|
| Intercept             | 20699500           | 19381376       | 1.07    | 0.2907|
| Lake Binaries         |                    |                |         |       |
| Lake Level            | -117800            | 110013         | -1.07   | 0.2895|

| Home Characteristics |


Results of regression analysis show that the probability of significance is greatest between price listed and square footage (strong significance is indicated by a Pr>|t| value of <.0001). From this relationship, we can conclude that the listing price of a waterfront home on Saginaw Bay, Michigan is most dependant on the square footage of the home. While the location (city) and number of the baths have some effect on the price of the home, lake levels were found to show an inverse relationship with asking price (i.e. lower the lake level the higher the asking price); however the relationship is non-significant (Pr>|t| .2895).8 Unemployment has been dropped from this model as it was nonsignificant.

Additionally, a Zillow search was performed to identify Saginaw Bay area homes currently on the market with Lake Huron views or private lake access but which were not physically located on the shoreline. While these homes are not waterfront homes, they would have close private access to lake amenities. Nine homes were identified along the bay with these attributes. These were added to the database and indicated as non-waterfront homes. A regression analysis was completed with this additional data added. The variable for waterfront vs. non-waterfront was added to the analysis. The results are displayed below in Table 3. The equation shows that home asking prices are significantly correlated with their location on the water versus near the water. This result is consistent with findings reported in the Benefits Transfer paper (Dunning and Jordan 2010a). Lake level continues to display an inverse, albeit non-significant, relationship to home asking price.

Table 3. Saginaw Bay Waterfront/Waterview Regression Analysis Utilizing Zillow.com Data

<table>
<thead>
<tr>
<th>Saginaw Bay Waterfront/Waterview Regression Analysis Utilizing Zillow.com Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Observations</td>
</tr>
<tr>
<td>Adj. R-Square</td>
</tr>
</tbody>
</table>

8 It should be stressed that this analysis is very preliminary and illustrative. More detailed analyses which is beyond the scope of this paper would include in-depth analysis of each variable’s distribution and means, as well as correlation analyses, examination of conformance of regression equation parameters to Ordinary Least Squares requirements, and examination of alternative forms of regression equations such as log-linear, and log-log transformations. Other models that might be explored include water level-price relationships at managed/inland lakes versus Great Lakes locations.
### Explanatory Variables

| Parameter Estimate | Standard Error | t Value | Pr>|t| |
|--------------------|----------------|---------|------|
| Intercept          | 14653261       | 17464750 | 0.83902 | 0.405 |
| Lake Level          | -84151         | 99158   | -0.849 | 0.400 |
| Location Binary    |                |         |       |      |
| Waterfront         | 138571         | 29846   | 4.643  | <.0001 |

### Home Characteristics

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Square Footage</td>
<td>97.2</td>
<td>16</td>
<td>6.157</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Bath</td>
<td>43135</td>
<td>15539</td>
<td>2.77598</td>
<td>0.004</td>
</tr>
</tbody>
</table>

### Location Binaries

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Au Gres</td>
<td>102276</td>
<td>39061</td>
<td>2.618</td>
<td>0.011</td>
</tr>
<tr>
<td>East Tawas</td>
<td>107859</td>
<td>40110</td>
<td>2.689</td>
<td>0.009</td>
</tr>
<tr>
<td>Tawas City</td>
<td>120193</td>
<td>40049</td>
<td>3.001</td>
<td>0.004</td>
</tr>
</tbody>
</table>

Finally, in addition to regression analyses, a T-Test statistical analysis was performed on this dataset to explore whether mean asking prices of homes differed according to water levels. Mean asking prices of waterfront homes listed when water levels were above the long term lake level average of 176.3 meters were compared with mean asking prices when water levels were below 176.3 meters\(^9\). The results of this analysis are shown in Table 4. As can be seen the asking price for homes when lake levels were below 176.3 meters averaged $338,961 while the asking price for homes listed when lake levels were higher averaged $322,657. However, the normal criteria for a T-Test is a .05 level of significance and the $P(T<=t)$ value of 0.70 shown in the table is greater than .05 and indicates that there is no significant difference between the asking prices in the two categories.

### Table 4. T-Test for Two Sample Waterfront Home Listing Price

<table>
<thead>
<tr>
<th>T-Test: Two sample Waterfront Home Listing Price</th>
<th>Lake Level &lt;176.3</th>
<th>Lake Level &gt; 176.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>$338,961$</td>
<td>$322,657$</td>
</tr>
<tr>
<td>Variance</td>
<td>19838788257</td>
<td>916586190</td>
</tr>
<tr>
<td>Observations</td>
<td>49</td>
<td>7</td>
</tr>
<tr>
<td>Hypothesized Mean Difference</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>t Stat</td>
<td>0.393784284</td>
<td></td>
</tr>
</tbody>
</table>

\(^9\) IGLD 1985 datum for Lake Huron is 176.0 meters. All but one lake level readings in the data set used for these example analyses were above the IGLD 1985 datum; the average lake level recorded for the observed data was 176.19.
### Time Series Analysis Method

The time series analysis method employs the idea proposed by Bill Werick in his memo of 3/31/10 suggesting that a time series look at selling prices for waterfront properties in relation to water levels in comparison to selling prices for other properties in relation to water levels might shed light on the presence of a possible relationship between water levels and housing prices for waterfront homes. Using Bill’s ideas we constructed a Zillow.com data base of three representative waterfront properties in the Saginaw Bay study area and used the Zillow.com ten-year look-back feature to track estimated value of these homes. These prices are then overlaid against mean monthly lake levels taken from the Essexville, MI station. The overlay presented below in Figure 1 represents the estimated home values and lake levels from January 2001 through July 2010. The figure shows that there is little or no visible correlation in estimated home values and Lake Huron lake levels. While both lake levels and home prices experience periods of highs and lows, in does not appear that these periods coincide with one another.

Correlation coefficients for each home and lake levels were determined based on estimated home values and lake levels. A strong correlation would be indicted by a value close to 1. The correlation coefficient between the home value on Killarney Beach Road and Lake Huron water levels was found to be the lowest at 0.0657. The home located on Linwood Beach Road was found to have the highest correlation with a coefficient of 0.329. The home located on Bay Shore Drive was found to have a correlation coefficient of 0.171 when comparing estimated home value with lake levels. These correlation coefficients average 0.189. Based on the average correlation coefficient for this dataset, we can conclude that there is not a strong relationship between estimated home values and lake levels for this dataset.
Figure 1. Overlay of Saginaw Bay, Michigan Area Homes with Lake Huron Lake Levels

HPM Costs and Benefits vs. Alternative Approaches

Realtors generally believe that lake level fluctuations are built into real estate prices – i.e. prices are not affected by normal fluctuations. However, views provided in Saginaw Bay and Windsor suggest that when impacts associated with low water levels become disruptive – e.g. interfere with boat access, result in loss of control of one’s shoreline, or entail costs to properties (e.g. extending a dock) – that such circumstances may negatively impact real estate prices.

The quick look at current properties for sale asking prices between 2008 and 2010 in the Saginaw Bay area failed to identify a relationship between water levels and asking price. The visual inspection and correlation analysis of the ten-year look back on sales prices of waterfront homes in the Saginaw Bay area in relation to lake levels similarly showed no statistically significant difference in prices for real estate.

Given the lack of discernable relationships between lake levels and real estate prices observed with the two alternative approaches employed it is likely that the HPM approach would be necessary to fully
investigate the relationship between lake level changes and housing prices. However, given the evidence obtained thus far, it may be premature to embark upon such a study until more severe lake level changes manifest themselves.

**Model Framework**

It is quite probable that an HPM would be constructed as a spreadsheet application. Table 5 shows how a spreadsheet model could be configured. It should be stressed however, that such a model would need custom tailoring and “tweaking” to run on different sites. It would not be a stand-alone “turnkey” product.

**Table 5. Contents of a Spreadsheet HPM**

<table>
<thead>
<tr>
<th>Tab</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data set</td>
<td>Spreadsheet rows represent cases of home sales, columns contain variables</td>
</tr>
<tr>
<td>Descriptive Statistics</td>
<td>Tables and graphs presenting means, standard deviations, minimums, maximums of each variable</td>
</tr>
<tr>
<td>Regression Equation</td>
<td>Providing coefficients, standard errors, and measures of statistical significance of coefficients</td>
</tr>
</tbody>
</table>

**HPM Development Schedule**

Should a decision be made to proceed with development of an HPM a likely schedule for completion for two sites is shown in Table 6.

**Table 6. Schedule for HPM Development**

---

Based on the lack of relationship found thus far it would be very important to include variables that identify shoreline properties negatively impacted by the results of low lake levels (e.g. having shoreline vegetation, having restrictions on vegetation removal, having docks that are unusable, etc.). Developing this information may pose added difficulties.
<table>
<thead>
<tr>
<th>Task</th>
<th>Product</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Model specification review</td>
<td>Selection of variables</td>
<td>10</td>
</tr>
<tr>
<td>2. Data collection</td>
<td>Obtain and create data sets at two sites</td>
<td>30 (coincident with task 1)</td>
</tr>
<tr>
<td>3. Data cleaning and preliminary analysis</td>
<td>Descriptive statistics and analysis of means</td>
<td>15</td>
</tr>
<tr>
<td>4. Regression analysis</td>
<td>Regression equation, analysis of errors</td>
<td>30</td>
</tr>
<tr>
<td>5. Presentation of results</td>
<td>Report on HPM analysis and results</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total time requirement</strong></td>
<td></td>
<td><strong>90 days</strong></td>
</tr>
</tbody>
</table>
Appendix 1

Comparison of Variables Used in HPM Studies Referenced in the Benefits Transfer Paper

Table 7. HPM Studies Reviewed in the Benefits Transfer Paper

<table>
<thead>
<tr>
<th>Study</th>
<th>Region</th>
<th>Residential Property Values Focus?</th>
<th>Examine Lake Level Changes?</th>
<th>Hedonic Price Model Employed?</th>
<th>Date of Study Publication</th>
<th>Focus of Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bond, et al.</td>
<td>GL (Lake Erie)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>2002</td>
<td>Value of lake views</td>
</tr>
<tr>
<td>Kashian</td>
<td>GL (WI)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2007</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Lansford &amp; Jones</td>
<td>SW (TX)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>1995</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Loomis &amp; Feldman</td>
<td>Pacific SW (CA)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2003</td>
<td>Reservoir water level change impacts</td>
</tr>
<tr>
<td>Muller</td>
<td>MW (IN) &amp; NE (CN)</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>2007</td>
<td>Hedonic model construction; value of lake amenity factors</td>
</tr>
<tr>
<td>Feather</td>
<td>Mid-Atlantic (Chesapeake Bay)</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>2008</td>
<td>Coastal erosion susceptibility impacts on property values</td>
</tr>
</tbody>
</table>

Table 8. Variables Used in Construction of HPMs in HPM Studies Reviewed in Benefits Transfer Paper

<table>
<thead>
<tr>
<th>Variables</th>
<th>Studies Referenced in Benefits Transfer Paper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dependent Variables</td>
<td>Sales price</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Inflation-adjusted sales price</td>
<td>X</td>
</tr>
</tbody>
</table>

**Explanatory Variables**

**Structural**

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td># Baths</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building sq ft</td>
<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
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**Neighborhood**

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References


Feather, Tim. 2008. Property Value Impacts from Coastal Erosion on Chesapeake Bay, Maryland. Prepared for Baltimore District, Corps of Engineers. CDM Federal Programs, Carbondale, IL.


