



Fact Sheet 044

Coastal erosion and the residential property market

Warren Kriesel, Extension Economist & Frank Lichtkoppler, District Extension Specialist

CIRCULATING COPY
Sea Grant Depository

Introduction

Many lake shore homeowners need information on coastal erosion and the potential benefits of protecting their property from erosion. Real estate professionals and others need information on how erosion and erosion protection devices affect coastal property values. This fact sheet, the results of Ohio Sea Grant research on the role of Lake Erie shoreline erosion in Ohio's housing market, provides information these people can use.

In this research, coastal erosion is defined as the loss of land into the lake. If nothing is done about erosion, buildings on some properties may fall into the lake. Coastal erosion is one of the characteristics of lake shore homes. As erosion causes a house to be more visibly at risk, prospective buyers will pay a lower price for it. These price differences have been analyzed by statistical techniques. From the analysis one can calculate how property value is affected by constructing an erosion control device. This research concludes that erosion characteristic is the more important determinant of lake shore property price.

Data for the study

Ohio Sea Grant researchers obtained data from courthouse records and from a survey of coastal homeowners in the five-county study area--Ashtabula, Lake, Cuyahoga, Lorain and Erie. Table 1 summarizes the information from courthouse records for all lake shore properties sold between January 1984 and April 1988. Coastal homes sold at an annual rate of less than four percent. This can be compared with the national average of ten percent per year. Owners of lake front homes hold their property for a much longer time than the average homeowner. In Lake,

Ashtabula and Erie counties, the higher percentage of absentee owners indicates a higher proportion of vacation homes.

The 459 coastal properties, under the heading "Number Sold" in Table 1, served as the sampling frame for a mail survey. The survey was needed to obtain more detailed data. The results are summarized in Table 2. With undelivered surveys, surveys with missing data and vacant lots, there was a total of 228 usable surveys.

In the computer model, the reported selling price of a coastal residence depends upon its features as they existed at the time of purchase. Property-specific characteristics are the following:

DIST is the mileage from the property to Cleveland's Public Square.

LOT is the square footage of the property lot.

FIREP is the number of fireplaces in the home.

GARAGE is the presence of a garage on the property.

HAREA is the square footage of the house.

AGE is the age of the house.

ROOMS is the number of rooms on the home's first floor. **BATH** is the number of bathrooms.

AC is the presence of air conditioning in the house.

STONE is the presence of stone or brick exterior finish.

Only one neighborhood variable was considered. This was the mean income (MINCOME) of survey respondents within a coastal township or city. MINCOME was used instead of other neighborhood quality measures, such as the school quality or crime rate variables. This is because coastal residences are often quite different in appearance and value from residences just one block inland. In effect, the thin strip of coastal properties are a separate neigh-

**Table 1: Summary statistics for all lake shore residential properties sold¹
January 1984 to April 1988**

County	Total Prop ²	Number Sold	Annual Sales Rate ³	Average Price	Percent Absent ⁴	Percent Unimprvd ⁵
Ashtabula	437	67	3.54%	\$41,494	44.8%	19.4%
Lake	615	101	3.79%	\$72,849	21.0%	6.7%
Cuyahoga	644	122	4.38%	\$195,647	2.4%	2.5%
Lorain	680	102	3.46%	\$106,969	5.9%	12.9%
Erie ⁶	382	67	4.05%	\$97,467	38.8%	13.9%
Totals	2758	459	3.84%	\$112,327	18.3%	10.1%

¹ "Sales" are transactions between people with different last names and for which there was a transfer tax recorded on the property deed.

² Total number of lake shore properties, as enumerated by Bedford.

³ The rate was calculated as: ((# sales/4.33 years)/# residential properties).

⁴ Absentee ownership, as indicated by differing owners' address and property address on county records.

⁵ Unimproved property, as indicated by the absence of a tax assessment for property improvements.

⁶ Only the high bluff portion of Erie County was used, i.e. from Cedar Point east to Lorain County.



Ohio Sea Grant College Program
1314 Kinnear Road
Columbus, Ohio 43212-1194
614/292-8949

OCES
OHSU-FS-044
1989.

borhood for which the "usual" neighborhood quality variables do not apply.

Table 2, shows the highest erosion rate (ERODE) is in Lake County, while the lowest is Cuyahoga. Erie County has the highest percentage of control devices (DEVICE) and Ashtabula has the least. The data summarized in Table 2 was used in a computer model to estimate the impact of erosion on property values.

Property damage from coastal erosion is caused by three factors: 1) the natural erodibility of the land, 2) the distance the home is set back from the shore and 3) the presence of an erosion control structure.

Data for these three erosion factors were obtained from historical records and the owners' responses to the survey. They are named ERODE, SETBACK and DEVICE, respectively.

ERODE is the footage of land lost from 1876 to 1973. ERODE was obtained for each property in the study from Ohio Geological Survey records.

SETBACK is the shortest distance from the house to the bluff's edge.

DEVICE is the estimated useful lifetime of an erosion control device. A rip-rap structure was estimated to last eight years, while more complicated, engineered devices such as a bulkhead or groin were estimated to last twenty years.

These three erosion factors are used to calculate a comprehensive erosion measure, **GEOTIME**. GEOTIME is the number of years until setback distance from the house to the lake is reduced to zero, when the house will

be sitting on the edge of the cliff. GEOTIME is figured by dividing the distance between the rear of the house and the top of the bluff by the average erosion rate and then adding the number of years an effective erosion control device is expected to last. For two identical neighboring houses, the house with the least GEOTIME will sell for a lower price. Furthermore, the price difference will sharply increase as GEOTIME approaches zero. When GEOTIME is zero there is no setback between the lake bluff and the house--it's sitting on the edge of the cliff. GEOTIME can be calculated. An example is given in the appendix.

Economic analysis of erosion

This research is based upon the economic theory of asset pricing. This theory states that the most you are willing to pay for an asset is the total of discounted annual benefits (both monetary and nonmonetary) you expect to receive from owning the asset, plus the discounted resale value. Market supply and demand conditions, as well as uncertainty, will affect future expected benefits and thereby affect property prices.

One uncertainty of lake shore property is erosion problems which have been well reported in the press. Many home buyers will know that erosion can reduce the benefits of owning lake shore property. They perceive that erosion can cause a capital loss. It is reasonable to assume that the buyer knows that the risk of capital loss can be reduced by installing a protection device which involves a capital expense. Erosion risk can also be reduced by choosing a property which is physically more immune to erosion damage. If the well informed buyer wishes to reduce the risk of a capital loss, then he/she will be willing to pay more for property which carries a lower risk of damage. This is reflected by choosing either option

Table 2: Summary of characteristics influencing sales price of 228 Lake Erie coastal residential properties (In total and by county)

Variable 1	Average All Cty (228)	Average Erie (31)	Average Lorain (59)	Average Cuyahoga (71)	Average Lake (49)	Average Ashtabula (18)
SALES PRICE	\$126,981	\$109,596	\$115,708	\$202,576	\$81,482	\$45,333
DIST (miles)	27.2	54.6	24.1	8.8	27.1	60.8
LOT (sq. ft.)	32,995	17,663	38,092	34,318	31,316	41,655
FIREP (#)	2.4	1.2	1.2	2.0	1.2	0.8
GARAGE (% with)	84%	76%	89%	96%	79%	66%
HAREA (sq. ft.)	2,366	2,078	2,209	3,088	2,184	1,332
AGE (years)	46	42	43	52	45	40
ROOMS (#)	5.5	5.2	5.3	5.6	5.8	4.8
BATH (#)	2.3	1.9	2.2	2.9	2.0	1.8
AC (% with)	17%	29%	15%	29%	4%	0%
STONE (% with)	36%	32%	40%	45%	30%	16%
MINCOME	\$71,918	\$76,801	\$63,477	\$96,600	\$56,038	\$41,845
GEOTIME (years)	1,320	767	372	2,154	376	1,842
SETBACK (feet)	87	56	101	103	78	64
ERODE (ft/97 yrs)	76	82	64	38	135	94
DEVICE (% with)	47%	74%	35%	45%	49%	33%

¹ See text of this fact sheet for definitions of the variables.



Fact Sheet 044 Appendix

Coastal erosion and the residential property market

Warren Kriesel, Extension Economist & Frank Lichtkoppler, District Extension Specialist

Estimating coastal property price

This appendix to fact sheet 044 will provide an example of how to estimate the price of a Lake Erie coastal home site in Ash-tabula, Lake, Cuyahoga, Lorain or eastern Erie County.

A. First calculate **GEOTIME**. This is the number of years until the setback distance from the home to the edge of the lake bluff is reduced to zero. **GEOTIME** is the most important homesite characteristic affecting the price of coastal property. **GEOTIME** is calculated by the following formula:

$$\text{GEOTIME} = \{ \text{SETBACK} * \{ (1973-1876) / \text{ERODE} \} + \text{DEVICE} \text{ (In \# of years)} \}$$

The * means multiply, / means divide.

SETBACK is the shortest distance from the house to the bluff's edge. Measure this distance for the property you are interested in.

ERODE is the number of feet of land lost from the property in the period 1876 to 1973. The Ohio Department of Natural Resources Division of Geological Survey-Lake Erie Unit in Sandusky may be able to assist you in determining this number for the specific property in which you are interested. The address and phone number is:

ODNR, Division of Geological Survey; P.O. Box 650;
Sandusky, Ohio 44870; 419/626-4296.

DEVICE is the estimated useful lifetime of an erosion control device. This is estimated to be 8 years for a simple rip-rap device and 20 years for more substantial bulkheads and concrete modular breakwalls.

As an example, consider a property which has a **SETBACK** of 25 feet. (There are 97 years from 1876 to 1973.) It has lost 100 feet due to erosion from 1876 to 1973. There is no protection device.

$$\begin{aligned} \text{GEOTIME} &= \{ 25 * \{ (97) / 100 \} \} + 0 \\ &= \{ 25 * \{ .97 \} \} + 0 \\ &= \{ 24.25 \} + 0 \\ &= 24.25 \end{aligned}$$

There are 24.25 years of **GEOTIME** remaining--the time when the distance from the home to the edge of the bluff is zero. If a rip-rap device is constructed then **GEOTIME** is increased by eight years, the number of years that the protection is estimated to last. A bulkhead that is expected to last 20 years would increase **GEOTIME** to 44.25.

B. Next calculate **PRICE**. This calculation requires a knowledge of high school level mathematics and a calculator that can handle exponents and natural logarithms. An example of an exponent is $2^3=8$ or $4^2=0.0625$. An example of a natural logarithm is $\ln(65)=4.174$. The base for the exponents and logarithms is the natural number e which is equal to 2.718.

Property specific characteristics that were found to have a significant impact on the purchase price of coastal property include the following:

DIST is the mileage from the property to Cleveland's Public Square.

LOT is the square footage of the property lot.

FIREP is the number of fireplaces in the home.

GARAGE is the presence of a garage on the property.

HAREA is the square footage of the house.

AGE is the age of the house.

ROOM is the number of rooms on the home's first floor.

BATH is the number of bathrooms.

AC is the presence of air conditioning in the house.

STONE is the presence of stone or brick exterior finish.

MINCOME is the average income of survey respondents within a coastal township or city.

Consider a house which has the following characteristics:

DIST = 30 miles

LOT = 35,000 square feet

FIREP = 1

So **FIREP** = 2

GARAGE = yes

So **GARAGE** = 1

HAREA = 2,200 square feet

AGE = 25 years

ROOMS = 6 on the first floor

BATH = 2.5

So **AC** = 0

AC = No

So **STONE** = 1

STONE = Yes

MINCOME = \$70,000 for the respondents in the township

GEOTIME = 24.25 years (from first calculation)

There are some peculiarities in the calculation. First, for mathematical reasons, the **FIREP** variable is scaled up by one, so in this example the house actually has one (1) fireplace, but it is entered as having two (2). The second peculiarity concerns the variables that are one (1) when a characteristic is present, or zero (0) when the characteristic is absent. These variables are **GARAGE**, **AC** and **STONE**. In this example the house has some type of garage, so **GARAGE** equals one. There is no air conditioning, so **AC** equals zero. Since our example home has a brick facing, **STONE** equals one. Please note that the estimated price will be in 1987 dollars. You can adjust this estimate up to current dollars.

The table below is a spreadsheet for calculating the price. Also, the result of calculating the **INTERCEPT** variable is a constant value. This same value should be used when calculating the price of property you are interested in.

Table 1: A spreadsheet for calculating price

Variable	Value	Coefficient	Calculation	Result
DIST	30	-0.086	$30^{-0.086}$	0.746
LOT	35,000	0.105	$35000^{0.105}$	3.000
FIREP	2	0.005	$2^{0.005}$	1.003
GARAGE	1	0.348	$2.718^{1 * 0.348}$	1.416
HAREA	2,200	0.308	$2200^{0.308}$	10.702
AGE	25	-0.043	$25^{-0.043}$	0.871
ROOMS	6	0.156	$6^{0.156}$	1.323
BATH	2.5	0.116	$2.5^{0.116}$	1.112
AC	0	0.153	$2.718^{0 * 0.153}$	1.000
STONE	1	0.088	$2.718^{1 * 0.088}$	1.008
MINCOME	70,000	0.657	$70000^{0.657}$	1524.858
INTERCEPT	na	-0.386	$2.718^{-0.386}$	0.680

Multiply all "Result" terms together and you have the following: $0.746 * 3 * 1.003 * 1.416 * 10.702 * 0.871 * 1.323 * 1.112 * 1 * 1.008 * 1524.858 * 0.680 = \$45,558.65$ for the price of the house. This does not include the effect of **GEOTIME** on the price of the house. This will be calculated in the next step.

Calculate the price of the property you are interested in. Fill in the data for the variables and make the calculations.

Variable	Value	Coefficient	Calculation	Result
DIST	_____	-0.086	VALUE ^{-0.086}	_____
LOT	_____	0.105	VALUE ^{0.105}	_____
FIREP	_____	0.005	VALUE ^{0.005}	_____
GARAGE	_____	0.348	2.718 ^{VALUE^{0.348}}	_____
HAREA	_____	0.308	VALUE ^{0.308}	_____
AGE	_____	-0.043	VALUE ^{-0.043}	_____
ROOMS	_____	0.156	VALUE ^{0.156}	_____
BATH	_____	0.116	VALUE ^{0.116}	_____
AC	_____	0.153	2.718 ^{VALUE^{0.153}}	_____
STONE	_____	0.088	2.718 ^{VALUE^{0.088}}	_____
MINCOME	_____	0.657	VALUE ^{0.657}	_____
INTERCEPT	na	-0.386	2.718 ^{-0.386}	0.680

Multiply all "Result" terms together.

You should be able to get most of the information for the home you are interested in from a visual inspection of the property. Measure the distance from the house to the bluff edge. Your real estate agent may also be able to assist you. The value for the MINCOME can be obtained from Table 2 below.

Table 2: Average income of lake shore residents who responded to the 1988 coastal homeowners survey

County	City/Twp	Income
Ashtabula	Conneaut	\$41,000
	Kingsville	\$45,000
	Ashtabula	\$55,000
	Geneva	\$46,000
	Geneva-On-The-Lake	\$45,500
Lake	Madison	\$60,000
	Mentor	\$57,500
	Willoughby	\$47,000
	Eastlake	\$65,000
	Lakeline	\$59,000
	Willowick	\$50,000
Cuyahoga	Euclid	\$88,000
	Bratenahl	\$126,000
	Lakewood	\$107,000
	Rocky River	\$138,000
	Bay Village	\$88,000
Lorain	Avon Lake	\$78,000
	Sheffield Lake	\$68,000
	Lorain	\$63,000
	Vermilion	\$67,000
Erie	Vermilion	\$71,000
	Huron	\$110,000
	Sandusky	\$77,500

Note: In some townships there were no responses to the income question. These townships are omitted. An approximate MINCOME in these cases would be the average of its two neighbors. For example, a township between Madison and Mentor would be \$58,750.

C. You can calculate how **DEVICE** increases **PRICE**. The spreadsheet includes two calculations. The first is the base house value, i.e. what it would sell for today, in 1987 dollars. The second is the property value for a change in one erosion characteristic. In this case, it is adding a protection device that

is expected to last twenty years. The difference between these two property values is the increased property value that can be expected from building the erosion protection. Calculating the property value attributable to GEOTIME is complicated. This is because it enters the **PRICE** equation twice: as a first and second order polynomial. This is done to obtain the shape of the price curve in Figures 1 and 2.

You will have to take the natural log of GEOTIME, for example $\ln(24.25)=3.19$, and put it in as the exponent or coefficient as shown in the calculation column. In this example, the increased GEOTIME increases the property value by \$9,622. Applying the calculation to any property on the lake is easy. You just substitute the property's characteristics into the value column and perform the calculations with the same coefficients.

Base GEOTIME calculation:

Variable	Value	Coefficient	Calculation	Result
GEOTIME	24.2	0.298	24.2 ^{0.298}	2.584
	$\ln(24.2)=-3.18$	-0.020	24.2 ^{-0.020^{-3.18}}	0.816

Multiply the "Result" terms by the property value determined from the example above to get the base property value.

Base property value = 45,558.65 * 2.584 * 0.816 = \$96,062

GEOTIME calculation for an erosion device added which will last twenty years follows. Remember, in the original GEOTIME calculation, you simply add to the formula the number of years an erosion control device will last.

Variable	Value	Coefficient	Calculation	Result
GEOTIME	44.2	0.298	44.2 ^{0.298}	3.093
	$\ln(44.2)=-3.79$	-0.020	44.2 ^{-0.020^{-3.79}}	0.750
SETBACK	25	na		
ERODE	100	na		
DEVICE	20	na		

New property value = 45,558.65 * 3.093 * 0.750 = \$105,684

Change in property value by constructing an erosion control expected to last twenty years:

$$\begin{aligned} \text{New property value} &= \$105,684 \\ \text{Base property value} &= \$96,062 \\ \text{Increased property value} &= \$9,622 \end{aligned}$$

Disclaimer: The information and suggestions in this publication are intended to provide guidelines. The Ohio Sea Grant College Program assumes no liability.

listed above, both of which cost money.

Erosion factors of property also influence price. The more erosion prone a property is, the lower its selling price should be. Looking at a sample of lake shore properties, there should be price differences (called price variation) that are related to these. Similar logic can be applied to other property features. For example, a house with no fireplace yields fewer benefits from ownership than a comparable house with a fireplace. Across a sample of properties there will be measurable price variation attributed to fireplaces.

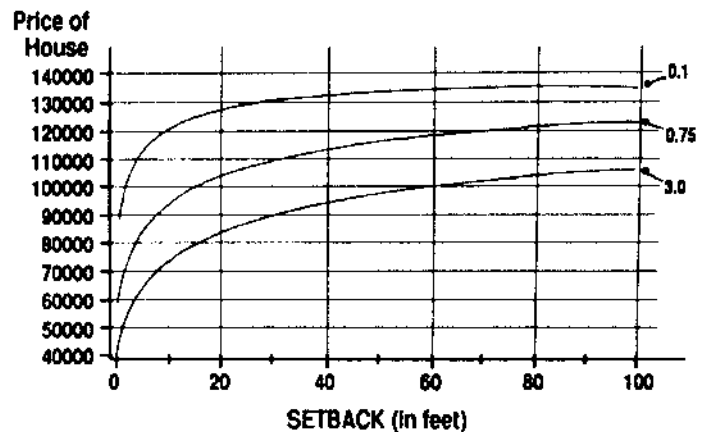
Price variation can be analyzed by statistical techniques. In this case, the model says that property sales price is a mathematical function of the features given in Table 2. For each of the 228 properties, sales price and each of the features were entered into a computer. A computer program estimated numerical coefficients for the function. The coefficients are the net effect of each feature on the price. With these coefficients and data that describe any property, a predicted price can be calculated. (See the appendix).

The model was used to identify the features that are a reliably significant predictor of sales price. We conclude that buyers of lake shore property are willing to pay more for erosion protection. This protection may be in the form of the setback distance, the erosion rate, or the presence of a protection device. The other significant characteristics are (in declining order of importance): GEOTIME, MIN-COME, HAREA, GARAGE, LOT, DIST, AC, ROOMS and STONE.

If a homeowner were wondering how he/she could improve the value of a house, this analysis indicates that the most important improvement would be increasing GEOTIME by constructing a protection device, followed by adding additional living area (HAREA), and adding on a garage (GARAGE). Of course, to determine whether an improvement project would pay, the increase in property value must be compared with the project's cost.

An example of a benefit-cost analysis for erosion control is the construction of a bulkhead that would last twenty years. This example is presented in the appendix. This would increase GEOTIME from 24.2 to 44.2. This raises the property's value by about \$9,600. This estimate can be compared with a contractor's cost estimate to decide whether the project is worthwhile. An alternative to constructing a bulkhead is rip-rap erosion control. On average, rip-rap gives eight years of protection but it is relatively cheap to install. For this example, rip-rap protection would increase GEOTIME from 24.2 to 32.2. This would increase the property value to \$99,260, for a gain of \$4,730. The increased property value from rip-rap is only half of the gain from the bulkhead but rip-rap's lower construction cost may mean that the net gain from a rip-rap device is greater than the bulkhead. If there are annual maintenance costs, their present value should be added to the initial construction cost.

Figure 1. Effect of setback on price of average house for 0.1, 0.75 & 3.0 feet eroded per year



If the erosion protection device fails to perform up to the estimated useful life span then the benefits of installing the device will be over estimated.

Using a calculation procedure, it is possible to plot out a graph of how price responds to changes in a characteristic while holding all the other characteristics at their average.

Figure 1 shows how the price of the "average" house is affected by changes in the SETBACK distance, from 1 to 100 feet. The plotting process has been run three times for three different ERODE rates. The lower curve is for a high ERODE rate of 3.0 feet per year (or about 300 feet lost between 1876 and 1973). The middle is an average rate of 0.75 feet per year. The highest curve is for a very slow erosion rate of 0.1 feet per year. This graph is useful to anyone who faces the problem of appraising property value. The house price declines rapidly as the setback distance approaches zero for all three erosion rates. However, for the low erosion rate, the price curve levels off at about 30 feet. Additional setback does not increase the price. Under the high erosion rate (the bottom curve), additional setback increases the price up to 100 feet. Note that a house built on less erodible land is always more valuable than a house on erodible land if the houses are similar in other features.

FIGURE 2. Effect of Geotime on house price for the average house in five counties

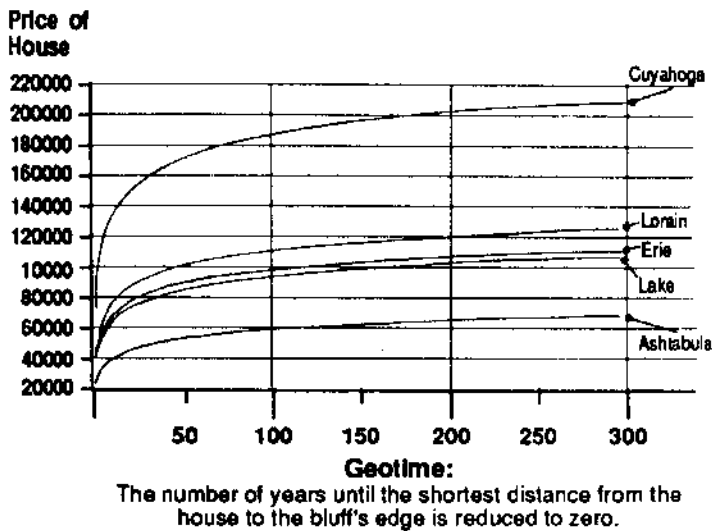
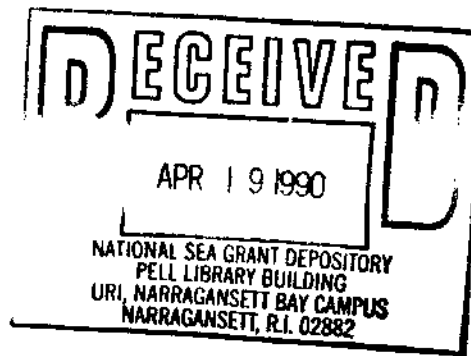


Figure 2 is a graph that is of interest to anyone who is deciding whether the monetary benefits of constructing an erosion protection device are greater than the costs. Here the plotting process has been run five times. Each of the

curves represents the "average" house in each of the five counties. The height difference between curves reflects differing county average prices (from Table 2). It shows, for example, that in Lake County, increasing the average houses's GEOTIME from near zero to 20 will increase property value by about \$37,000. If the same house initially has 20 years of GEOTIME, an increase to 40 years will add only \$8,000. Therefore, constructing erosion control has the biggest impact on property value when GEOTIME is small. That occurs when the house is visibly threatened by erosion. Another important feature of Figure 2 is that increases in GEOTIME impact highly valued property more than a similar change impacts lower valued property. In Cuyahoga County, the increase in GEOTIME from 20 to 40 increases property value by \$18,000. The same increase in Ashtabula County changes property value by only \$5,000. The economic reason for this is that there are greater gains in preventing capital losses on valuable property. The same principle works for different properties within any county. Please bear in mind that Figure 2 yields approximate prices. To obtain more precise numbers, you should follow the calculation procedure explained in the appendix.



Disclaimer: The information and suggestions in this publication are intended to provide guidelines. The Ohio Sea Grant College Program assumes no liability.

This publication is a result of work sponsored by the Ohio Sea Grant College Program (projects R/ME-5 and A/EP-1 under grant NAB9AA-D-SG132) of the National Sea Grant College Program, National Oceanic and Atmospheric Administration. Support is also provided by the Ohio Board of Regents, The Ohio State University, participating universities, industries and associations.