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ATMOSPHERIC TRANSMISSIVITY UPDATE - 1988

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INTERIM REPORT
OCTOBER 1988

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16. Abstract

The Coast Guard uses atmospheric visibility data collected in 1958 and 1959 when calculating the effective luminous range of aids to navigation. Presently, Coast Guard aid designers question whether or not increases in population and industry have changed atmospheric visibility along our coasts. ~~We present~~ recent atmospheric visibility data in the form of transmissivity curves to answer this question.

National Weather Service (NWS) visibility records from the maritime zone form the basis for our study. Data from these records were sorted into 28 geographical zones. Curves were fit to frequency distributions within each zone, forming new atmospheric transmissivity curves, one for each zone.

The new and old transmissivity curves differ considerably in many regions. The old transmissivity curves should not be used to estimate atmospheric conditions.

Further study has shown that even the new transmissivity curves can be improved. Accurate, localized curves can be obtained by decreasing the area size to the limit that the NWS data will allow.

We recommend the Coast Guard accept small, localized regions for calculating transmissivity curves. In addition, ~~we recommend the Coast Guard develop~~ software which uses new localized curves and the aid design tables and calculations. This product would remove the need for look up tables and tedious computations presently used during aid design.

17. Key Words

transmissivity, aids to navigation, Allard's Law, luminous range, visibility

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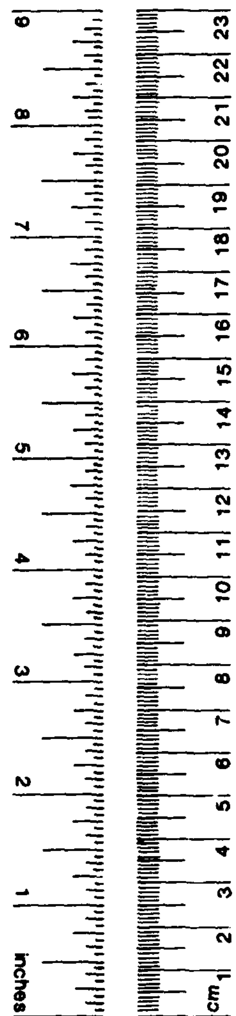
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

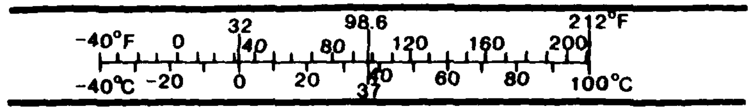
Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (WEIGHT)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (EXACT)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures. Price $2.25. SD Catalog No. C13.10.286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (WEIGHT)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	0.125	cups	c
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (EXACT)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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1.0 INTRODUCTION

The effective luminous range of a lighted aid to navigation is the distance between the light source and a point where the light just stimulates a visual response. This range is a function of effective beam candlepower, adaptation of the observer's eye, background luminance, and transmissivity. Here we are concerned only with transmissivity. Transmissivity is a measure of the clarity of the atmosphere. It is a dimensionless number representing the fraction of incident light successfully transmitted through the atmosphere per nautical mile. It depends on the concentration of aerosols, dust, and water vapor in the air and therefore varies from day to day, and even hour to hour. To account for this stochastic nature, calculations involving transmissivity involve frequency distribution curves. These curves are called transmissivity curves and are the subject of this study.

In 1923 the Coast Guard produced its first set of transmissivity curves using visual sightings made over an extended period. These data were used to produce 24 cumulative distribution functions describing the proportion of nights for which the transmissivity is less than a given value. These curves allow the aid designer to determine the effective intensity required to achieve an effective range some desired proportion of nights in each region. In the late 1950's, the Coast Guard again measured transmissivity around the country because of "geographic changes in industry and local changes in climate" [Ref. 1]. The Coast Guard published an updated set of 31 curves in 1961. This report again updates the curves and discusses differences between the new and old curves.

2.0 BACKGROUND

To create the 1961 transmissivity curves, lighthouse attendants and other Coast Guard Station personnel made subjective daily observations of lights in their respective regions. Researchers separated the data into 31 geographic areas to form cumulative frequency distributions. A curve was fit to the data by eye with dashed lines representing areas of insufficient data. These curves serve Coast Guard aid to navigation signal designers today as they did when first published in January of 1961.

For the present analysis, a collection of weather observations made in the coastal zone by mariners since 1854 were purchased from the National Weather Service (NWS). More than half of these 2.6 million observations were made in the last fifteen years.

3.0 DATA ANALYSIS

3.1 DATA

The NWS provided the coastal marine data in 1° latitude by 1° longitude blocks. These data represent all the visibility readings on record in each area. The NWS data fall into six visibility ranges: 0-0.5, 0.5-1.0, 1.0-2.0, 2.0-5.0, 5.0-10.0, and >10.0 nautical miles. The percentage of occurrences in each range is given, as is the total number of observations for the particular block (see Figure 1).

3.2 REDUCTION

3.2.1 Goals

The goal of this effort was to update transmissivity curves by objectively and accurately fitting curves to NWS data in various geographic regions. We sought a function that would fit all data sets with a minimum number of parameters. Such a function would allow explicit solutions rather than graphic interpretations. A second goal, established during the course of the investigation, was to simplify calculations needed to design aids to navigation.

3.2.2 Boundary Selection

The 1° square regions were combined into groups to represent various geographical areas. An attempt was made to define geographical regions similar to the 1961 regions, but the NWS data were not able to fit that description. Regional boundaries were confined to increments of 1° latitude and 1° longitude. For this reason, curves of small geographical areas such as Penobscot Bay, Maine and Green Bay, Wisconsin are included in larger areas. Similarly, large areas such as Alaska and the Gulf of Mexico are divided into a number of smaller areas. The 28 geographical areas are pictured in Appendix A.

3.2.3 Method

The data for each region were fit by least-squares method to various curves. The Weibull curve [Ref. 2] provides the best fit. This curve is of the form:

$$\text{PROBABILITY} = c * \text{EXP}^{-((V/a)^{b})} ,$$

Where V is the visibility,
- a is the placement of the 1/EXP point,
- b determines the slope near the center of the curve and
- c determines the probability of >0 nautical miles visibility (ideally this is 1.0, but field data seldom if ever exhibit ideal behavior).

U.S. Coastal Visibility Climatology (in miles)

Lat.	Lon.	% obs <.5	% obs .5<1	% obs 1<2	% obs 2<5	% obs 5<10	% obs >=10	Total percentage	Total no. of observations
32	117	.8	1.6	.8	8.1	40.3	48.4	100.0	124.
32	118	1.7	.7	1.1	5.7	37.4	53.4	100.0	44380.
33	118	1.9	1.8	4.4	8.3	42.4	41.3	100.0	25506.
33	119	2.1	.8	1.7	5.9	37.0	52.5	100.0	32490.
33	120	1.5	.8	1.6	4.3	31.7	60.2	100.0	15496.
33	121	1.7	.7	1.0	3.7	25.8	67.1	100.0	12662.
34	119	4.0	3.9	8.9	9.1	48.3	25.9	100.0	20835.
34	120	3.3	2.6	5.6	15.5	35.8	37.2	100.0	17707.
34	121	3.4	1.4	2.3	5.6	24.9	62.4	100.0	10221.
34	122	2.4	1.1	1.3	4.3	26.4	64.5	100.0	10676.
35	121	3.2	2.1	2.3	5.0	22.3	65.1	100.0	341.
35	122	3.2	1.2	1.7	4.6	26.1	63.2	100.0	11273.
35	123	2.6	1.2	1.5	5.0	28.2	61.5	100.0	7508.
36	122	3.5	1.6	1.7	5.2	28.5	59.6	100.0	1546.
36	123	3.2	1.6	1.5	4.7	28.0	61.0	100.0	12954.
37	123	4.7	3.0	2.2	7.1	30.3	52.7	100.0	13388.
37	124	4.6	2.7	2.2	4.8	27.4	58.3	100.0	16232.
38	123	2.2	3.4	7.3	12.3	49.7	25.2	100.0	5906.
38	124	6.0	1.9	2.0	5.9	25.5	58.7	100.0	13064.
38	125	3.5	1.8	1.7	4.9	24.9	63.2	100.0	7632.
39	124	5.4	1.3	2.1	5.8	22.4	63.1	100.0	872.
39	125	4.3	1.7	2.2	5.0	22.4	64.4	100.0	10259.
40	125	5.3	2.2	1.8	5.9	22.3	62.4	100.0	12819.
40	126	3.0	1.4	1.9	4.6	21.0	68.2	100.0	5214.
41	125	4.7	1.6	1.8	5.4	19.8	66.6	100.0	8687.
41	126	3.8	1.5	1.7	4.2	22.5	66.3	100.0	4043.
42	125	5.1	1.4	2.0	5.8	20.8	64.8	100.0	6906.
42	126	5.1	1.5	1.7	4.2	21.3	66.3	100.0	4154.
43	125	4.9	1.1	2.0	5.5	19.4	67.1	100.0	11098.
43	126	3.1	.9	1.6	5.4	21.3	67.6	100.0	4844.
44	124	3.5	1.2	2.4	10.6	18.8	63.5	100.0	85.
44	125	3.7	1.0	1.6	6.0	20.6	67.0	100.0	15171.
44	126	2.4	1.2	1.6	4.9	22.1	67.7	100.0	5553.
45	124	3.8	.0	1.9	7.7	23.1	63.5	100.0	52.
45	125	1.9	1.1	1.6	6.0	21.5	67.9	100.0	8443.

Figure 1. Representative listing of National Weather Service Data

A computer routine calculated the three parameters (a, b and c) for each region and plotted the best fit curve along with the data points used to create it.

4.0 RESULTS

4.1 TRANSMISSIVITY CURVES

Figures in Appendix B display the best fit Weibull curves for each of the 28 areas. The Weibull parameters used to construct the curves are also found in Appendix B.

4.2 COMPARISON

Figures 2 through 5 are examples of the new and old curves. Note the scattering of data used to create the 1961 curves on figures 4 and 5. It is not clear why the 1961 data are so variable, but given this variability, one cannot expect to represent such data with a single curve. It is not a surprise that the results of the subjective 1961 curve fitting efforts differ substantially from curves objectively derived here.

The new curves closely represent the data points from which they were created. It is interesting to plot the new curves directly on the 1961 curves (See Figures 4 and 5). At the low transmissivity end of the graphs the curves are very nearly the same. In many cases, such as those shown in Figures 4 and 5, the old data points straddle the new curve. For this reason, differences between the old and new curves are not attributed to atmospheric fluctuations. Instead, these differences appear to be the result of curve fitting methods used in 1961.

Transmissivity values corresponding to frequently used proportions, 0.75 and 0.90, provide a global comparison of new and old curves. These values are shown in Appendix C.

4.3 AUTOMATION OF CALCULATIONS

The quantitative curve fitting procedures used for the new transmissivity curves enable one to automate aid design. Previously aid designers had to read transmissivities and frequencies off plotted curves. It is now possible to compute either transmissivity or frequency for any area by using the equation for the Weibull function along with the fitting parameters of Table B-1.

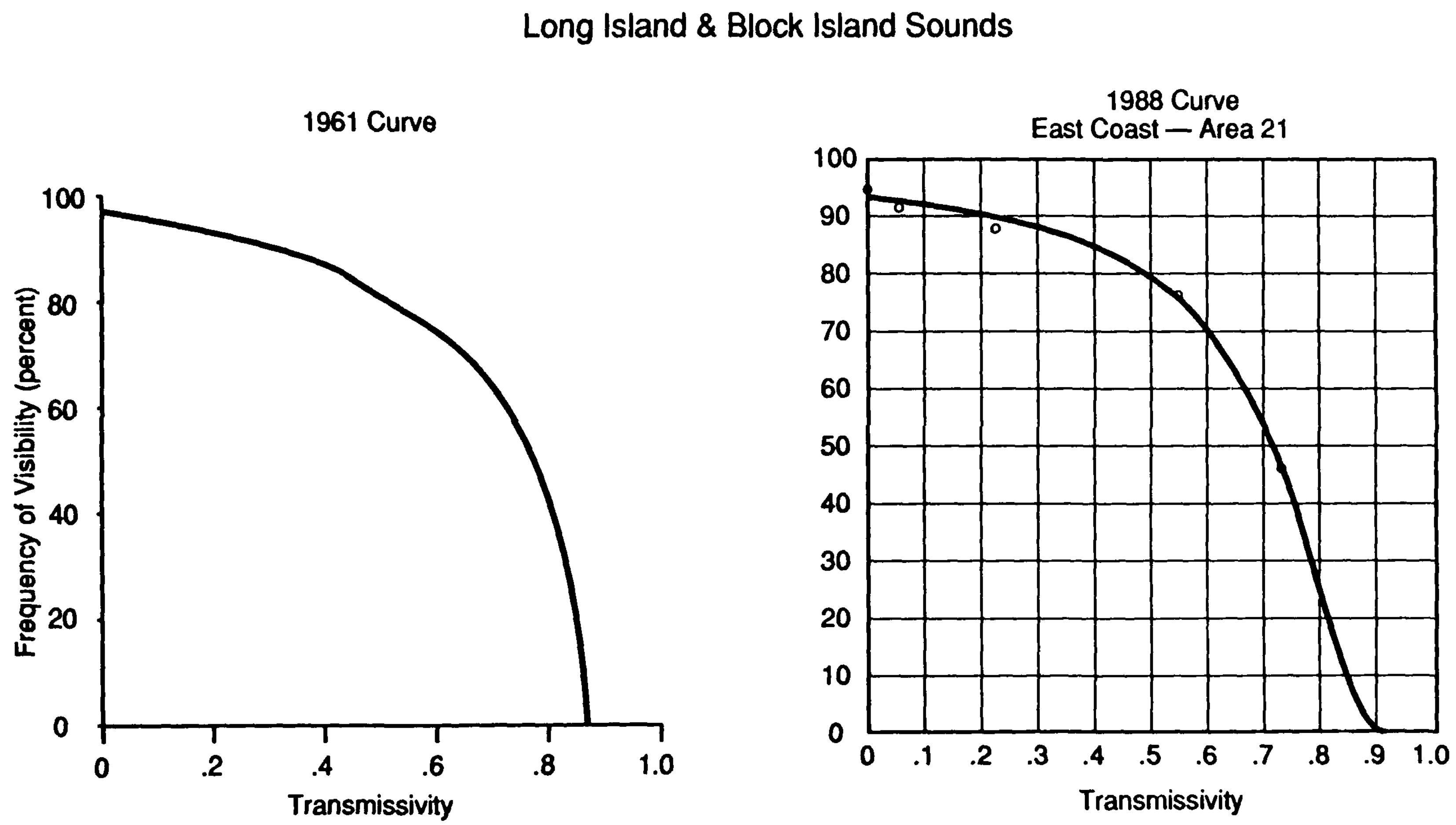

Figure 2. Side by side comparison of 1961 curve and 1988 transmissivity curve for Long Island Sound

Chesapeake Bay

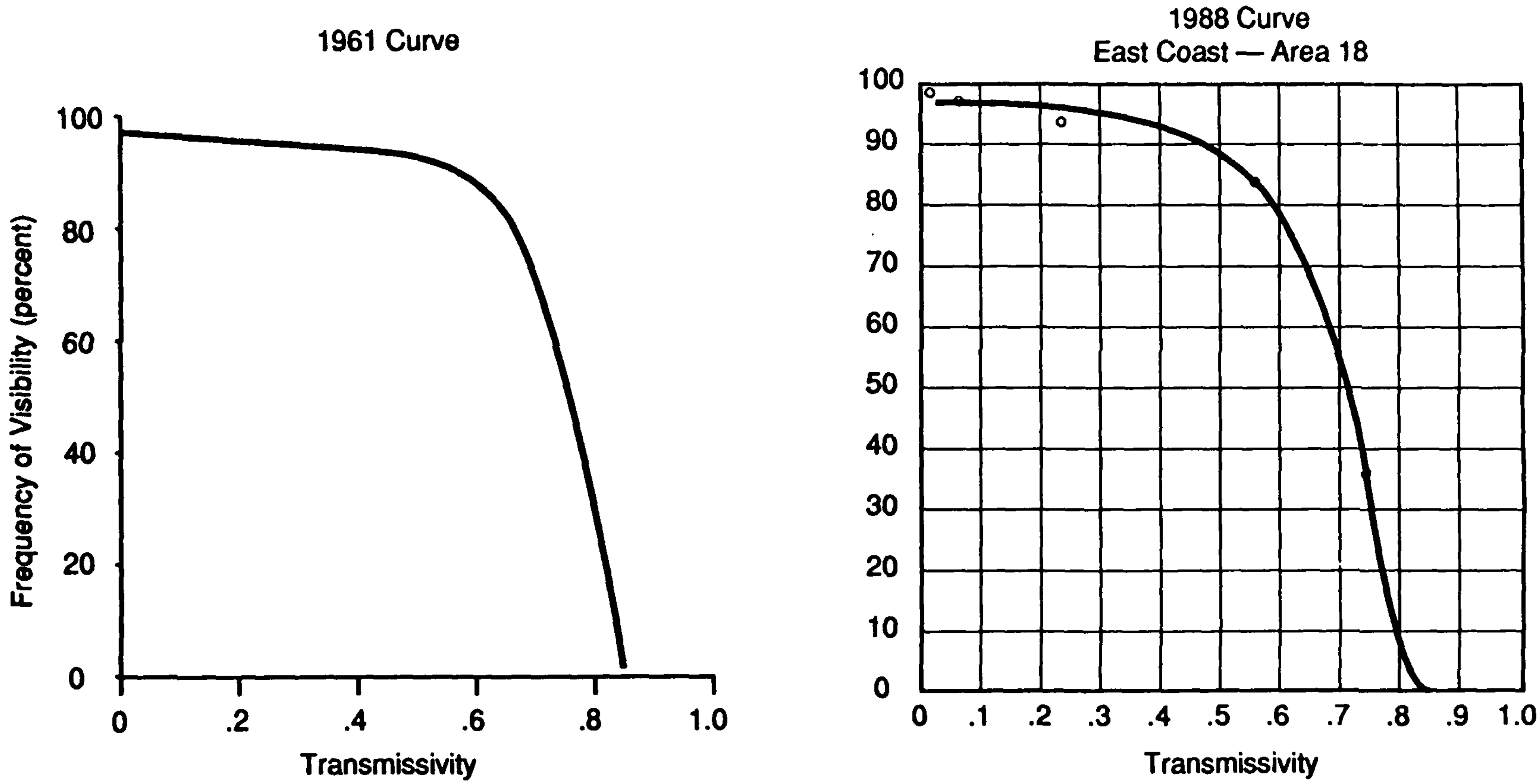

Figure 3. Side by side comparison of 1961 curve and 1988 transmissivity curve for Chesapeake Bay

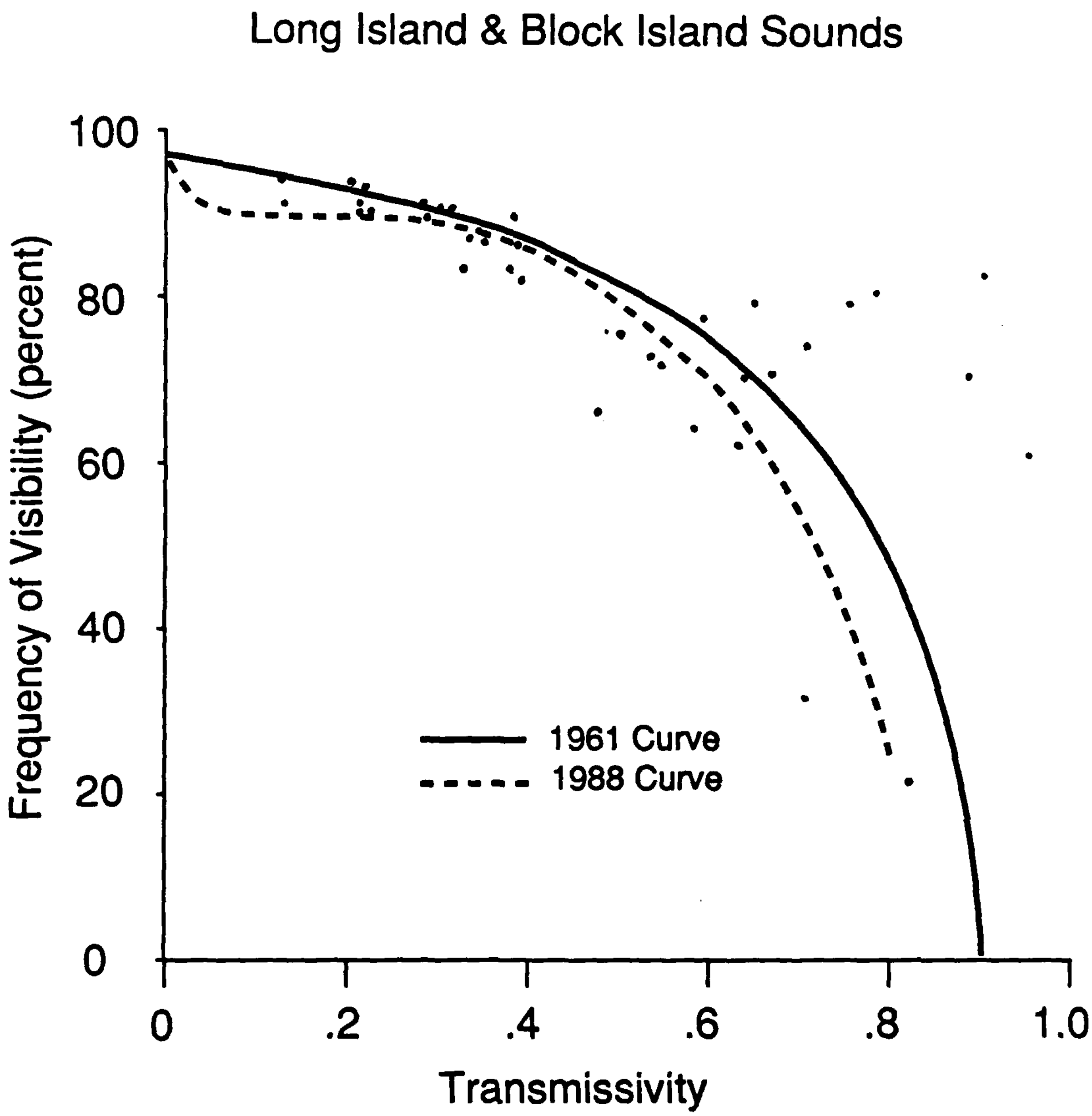

Figure 4. Overlay of 1961 curve and 1988 curve for Long Island Sound

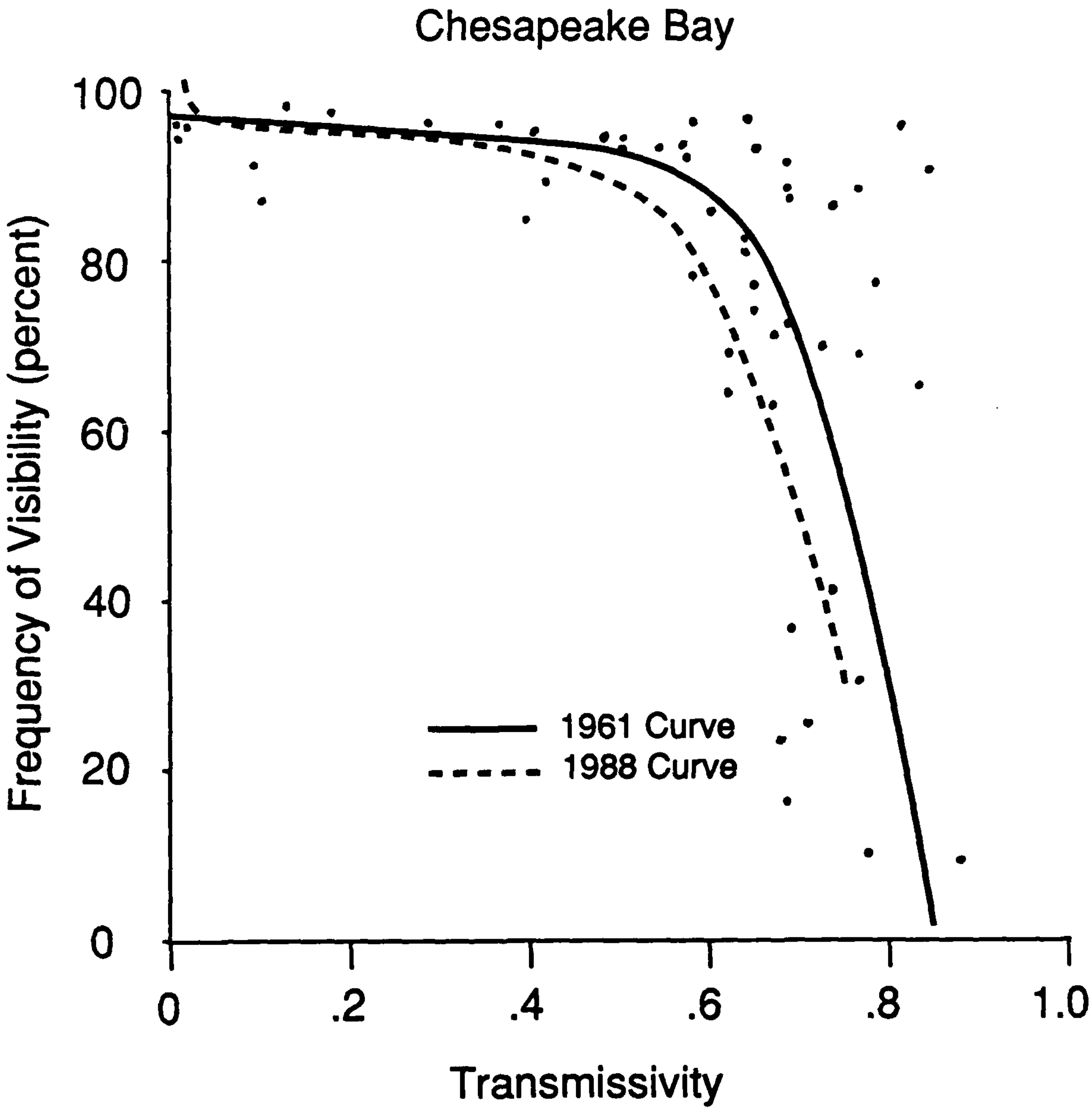

Figure 5. Overlay of 1961 curve and 1988 curve for Chesapeake Bay

A PASCAL computer program was written for the Coast Guard Standard Terminal to demonstrate how aid design can now be automated. The program combines the new transmissivity curves with Allard's law to solve for luminous range or luminous intensity. Figure 6 shows the screen layout for this program with the input and output of CASE 1 below used as an example.

To use this program one first specifies the geographic area of concern from the areas shown in Appendix A. As an alternative to specifying area, the software will determine the appropriate area given a latitude and longitude. Next, the aid designer has the option of specifying a transmissivity, frequency of visibility or atmospheric visibility. Once one of these values is specified, the software computes the other two. Finally, the aid designer provides a range or an effective intensity. Computations of required effective intensity or range, depending upon which is entered, are then made for the various background lighting conditions (See Figure 6).

This program, called C-FAR, is available through the Coast Guard Research and Development Center in Groton, CT.

4.4 DISCUSSION

The objective transmissivity curves resulting from this work make it necessary to review the luminous ranges of all aids to navigation. The following examples serve to illustrate this point.[1]

Case 1

Location - Southern California (minor background lighting)
New Area 10
Aid Type - Lighted Buoy
Effective Luminous Range Required - 1.5 Nautical Miles
Proportion of Nights to be Visible - 0.9 (90%)

Old	New
0.9 Transmissivity Point = 0.29	0.9 Transmissivity Point = 0.48
Effective Intensity Req'd = 100	Effective Intensity Req'd = 45

[1] Case 1 is Example 7 from CG-250-37.

```
Transmissivity and Allard's Law Computations

Remarks : Enter either an area or a latitude and longitude
          (LAT and LONG in DD.MM) DD = degrees, MM = minutes
---------------------------------------------------------------
AREA NO# 10            LAT North              LONG West
---------------------------------------------------------------
                              Percentage of
     Transmissivity           Nights visible      Visibility
        0.48                    90.00      %         4.10      n. mi
---------------------------------------------------------------
    RANGE  1.50       n.mi    EFF. INTENSITY                  cdls

                        Background Lighting

             None                    5. Candelas
             Moderate               45. Candelas
             Considerable          451. Candelas

      HIT [F1] TO SAVE AND RESTART - [HELP] FOR INSTRUCTIONS
```

Figure 6. Standard Terminal Screen Layout of the Transmissivity and Allard's Law Program C-FAR

Case 2

Location - Key West, Florida (minor background lighting)
New Area 14
Aid Type - Primary Seacoast
Effective Luminous Range Required - 15 Nautical Miles
Proportion of Nights to be Visible - 0.9 (90%)

Old	New
0.9 Transmissivity Point = .83	0.9 Transmissivity Point = 0.73
Effective Intensity Rq'd = 25,000	Effective Intensity Rq'd = 170,000

These two examples show that effective intensities necessary to maintain advertised ranges may increase or decrease depending on area, application, etc. Aid designers will have to review operational characteristics of each aid on a case by case basis.

4.5 FURTHER ANALYSIS

The curves of Appendix B are created by combining a collection of NWS data for 1° blocks of latitude and longitude. For example, the curve for Area 10, Southern California, was created from fifteen 1° blocks. Figure 7 shows all fifteen transmissivity curves from these blocks plotted on one graph. It is interesting to note that the curves differ. Three of the fifteen curves fall well below the band which contains the twelve remaining curves. For these three blocks, which happen to be the coastal area near Los Angeles, the Area 10 curve overestimates transmissivity. Hence, more accurate predictions of transmissivity can be obtained with smaller areas.

The 1961 transmissivity curves represented large geographic areas as data from only a limited number of locations were collected. The NWS data are not so limited. It is possible to provide more accurate, localized transmissivity information with the NWS data. As stated previously, the NWS data are restricted to a smallest possible region of 1° increments of latitude and longitude. Curves representing each 1° block of latitude and longitude can be developed.

While improvements in transmissivity information would be achieved with smaller regions, the number of curves needed would increase dramatically. Approximately 450 curves would be created using the 1° increments of latitude and longitude. A computer program, such as C-FAR, would be necessary to effectively use this collection of curves.

Work is underway to produce the localized transmissivity curves. The software which shall use the localized curves is under development. In addition, the software shall be expanded to include the tables and calculations from COMDTINST M16510.2. The final product of this effort will be a software package capable of performing many of the aspects of aid design and hardware selection.

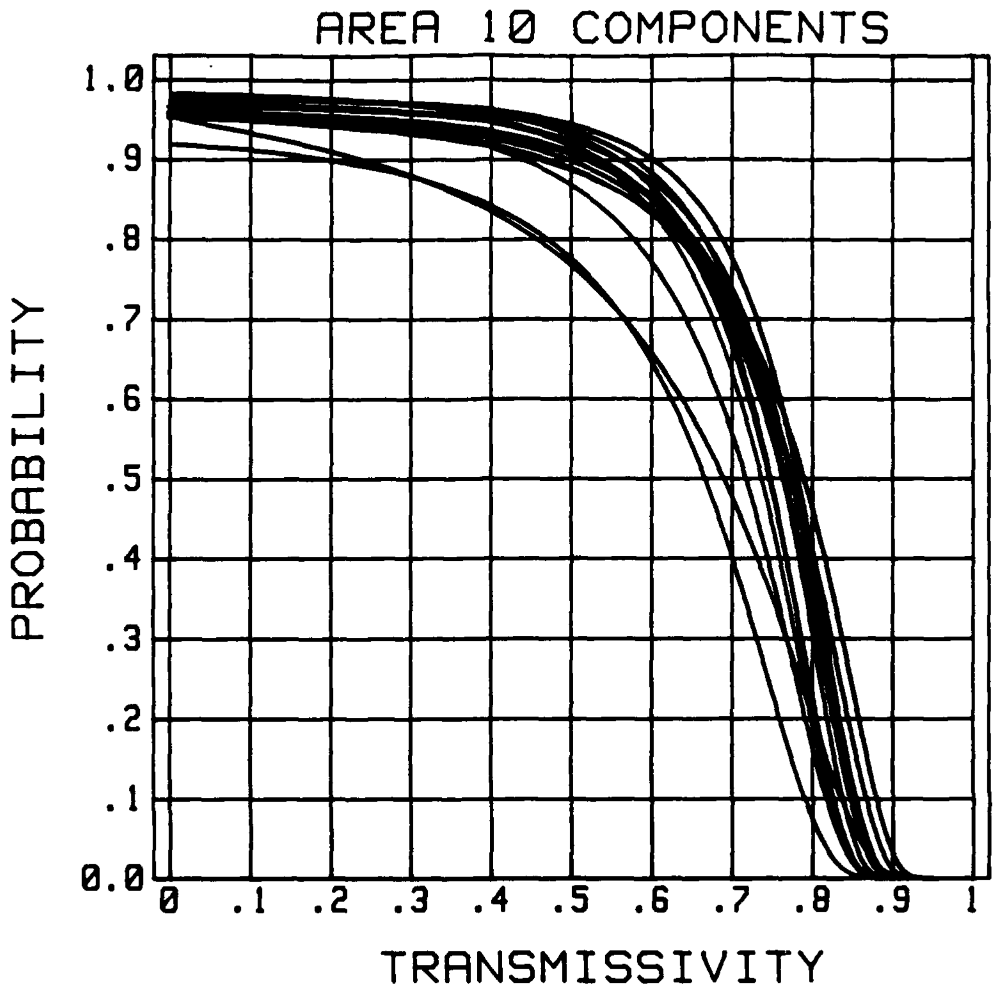

Figure 7. Overlay of the 15 component Curves for Transmissivity Area 10 (Southern California)

5.0 CONCLUSIONS

The National Weather Service Climatic Database provided sufficient marine visibility information to objectively update transmissivity frequency distribution curves. The updated curves are significantly different from those presently used by Coast Guard aid designers. In most regions, the transmissivity is actually lower than old curves indicate. It follows that effective luminous ranges of aids to navigation lights in many locations are not what they are thought to be.

Transmissivity estimates can be further improved by creating localized curves from the NWS data. The transmissivity computer program will provide a means to keep track of the new localized curves. In addition, the program will allow aid designers to efficiently review the luminous range of every lighted aid to navigation.

Work shall continue to create curves for as small a geographic region as possible. The computer program will be extended to include new localized transmissivity curves.

6.0 RECOMMENDATIONS

We recommend the Coast Guard:

- o proceed with the development of localized transmissivity curves
- o extent the C-FAR Program to include the new localized transmissivity curves
- o extend the C-FAR Program to include tables from COMDTINST M16510.2.

7.0 REFERENCES

1. U.S. Coast Guard (G-ECV), Distribution Curves of Atmospheric Transmissivity for United States Coasts, Civil Engineering Report CG-250-4A, January 1961.

2. Weibull, W., "A Statistical Distribution Function of Wide Applicability", Journal of Applied Mechanics, 18, pp. 292-297.

3. U.S. Coast Guard (G-EOE), Visual Signalling Manual, Ocean Engineering Report CG-250-37, June 1970.

APPENDIX A

GEOGRAPHICAL BOUNDS OF THE NEW CURVE AREAS

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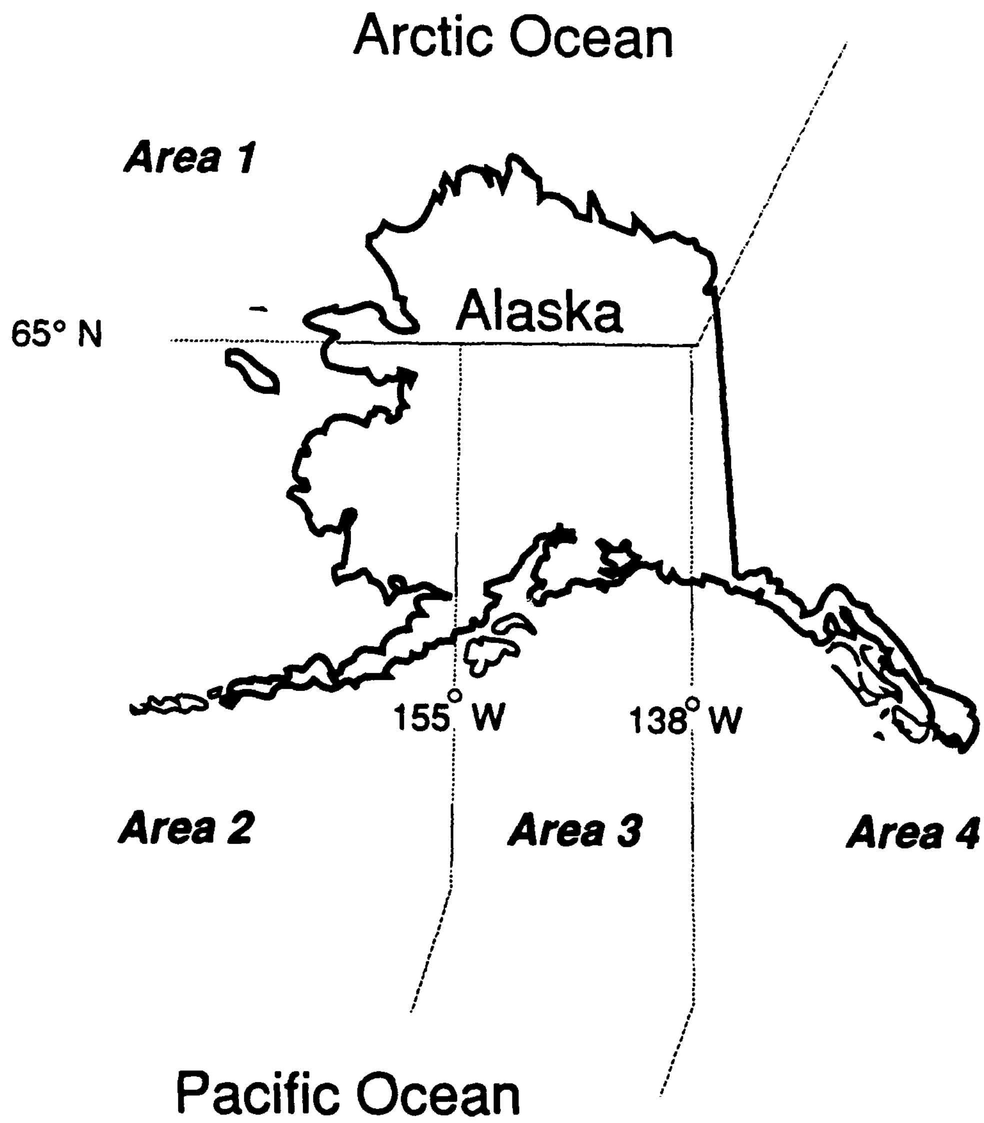

Figure A-1. Geographic Boundaries of Areas 1 through 4

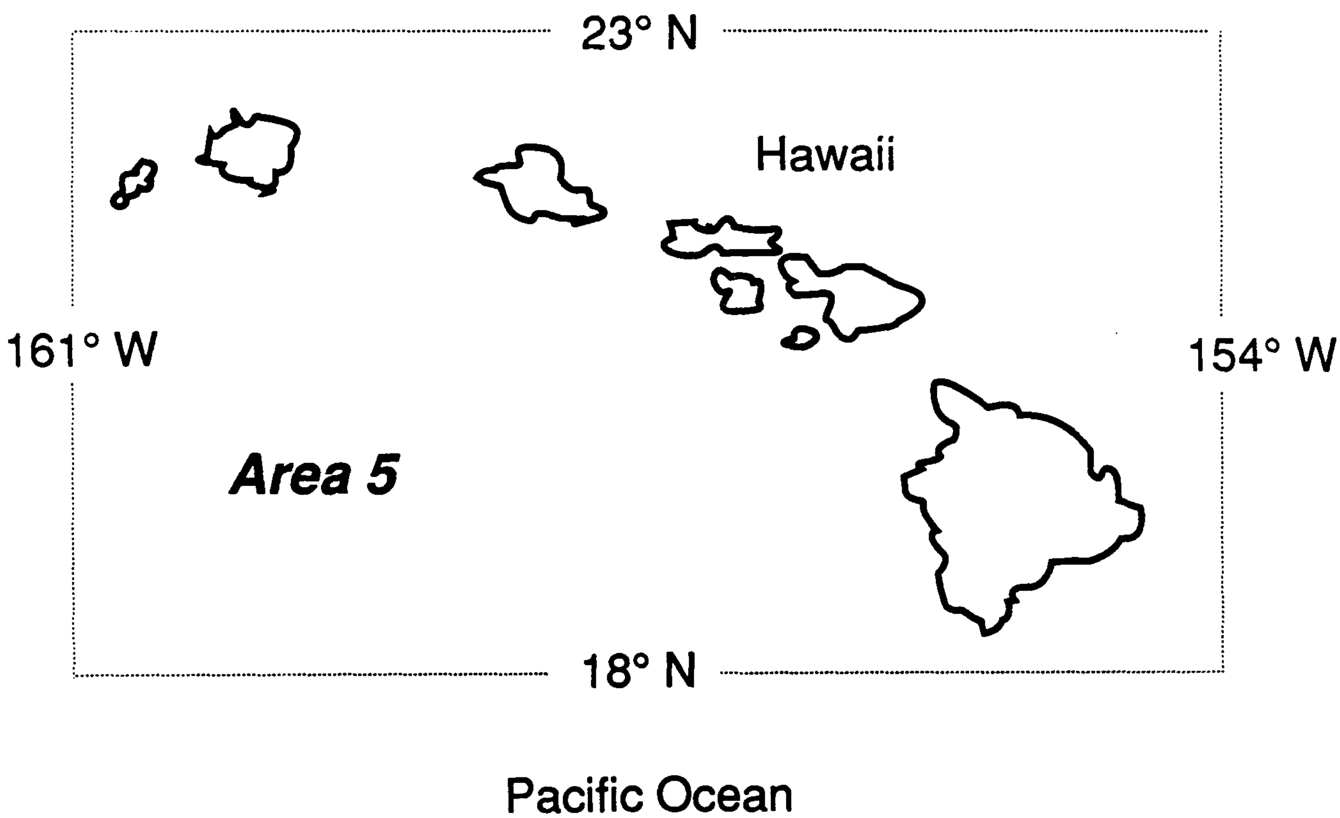

Figure A-2. Geographic Boundaries of Area 5

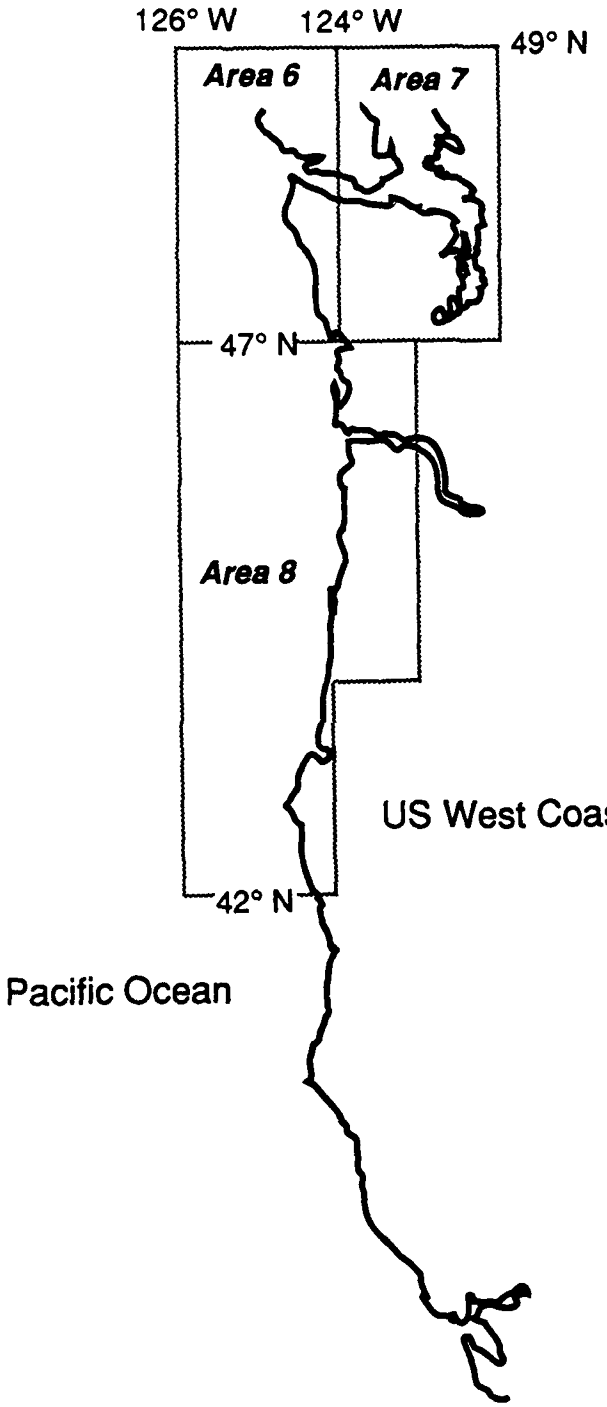

Figure A-3. Geographic Boundaries of Areas 6 through 8

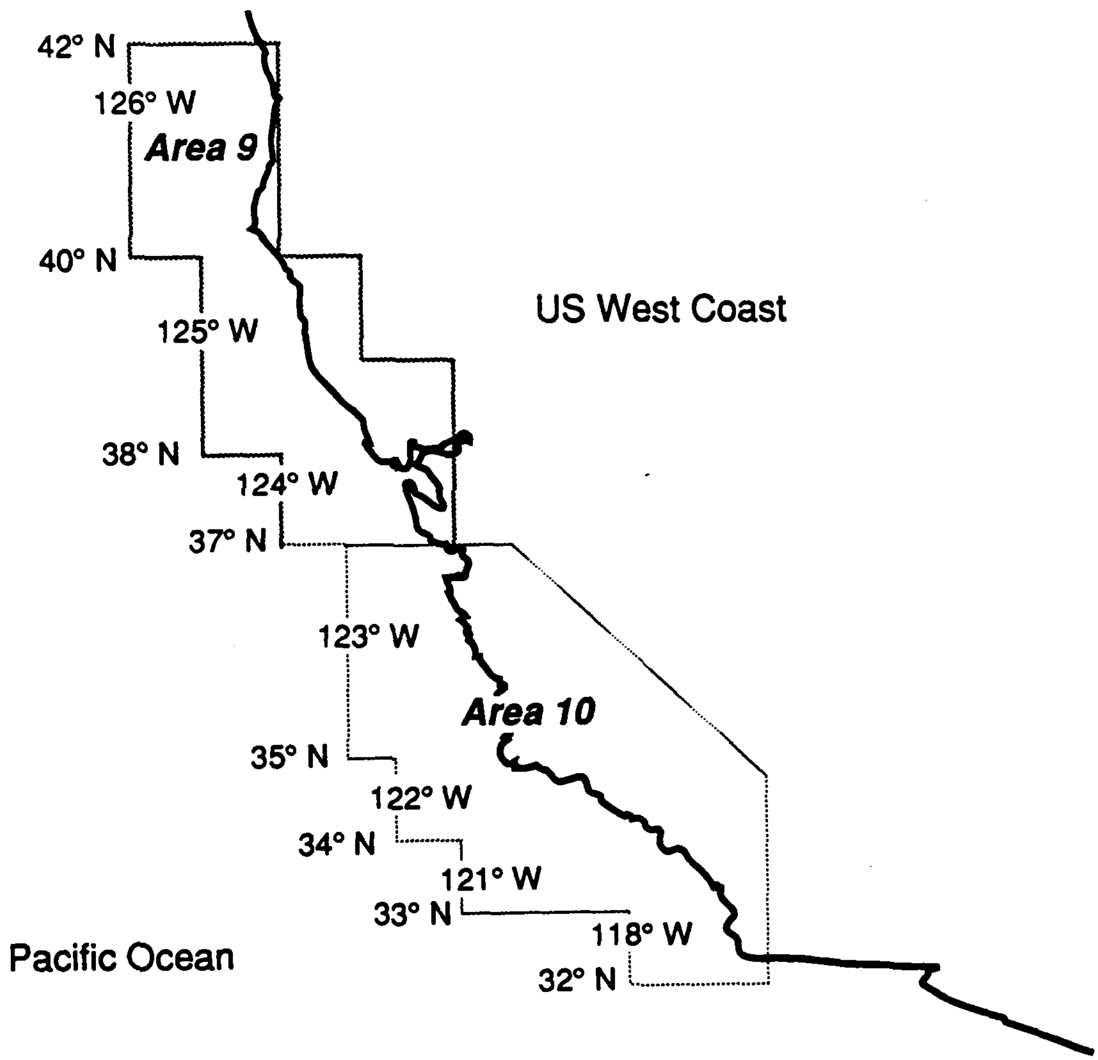

Figure A-4. Geographic Boundaries of Areas 9 and 10

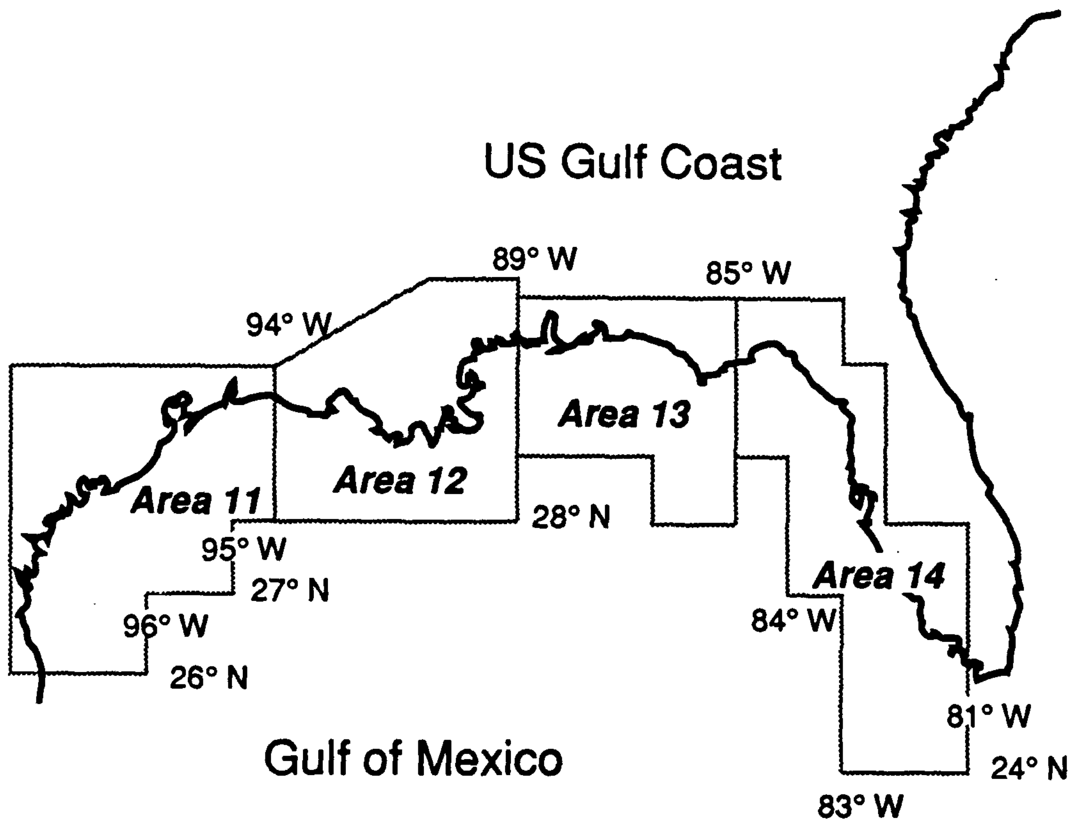

Figure A-5. Geographic Boundaries of Areas 11 through 14

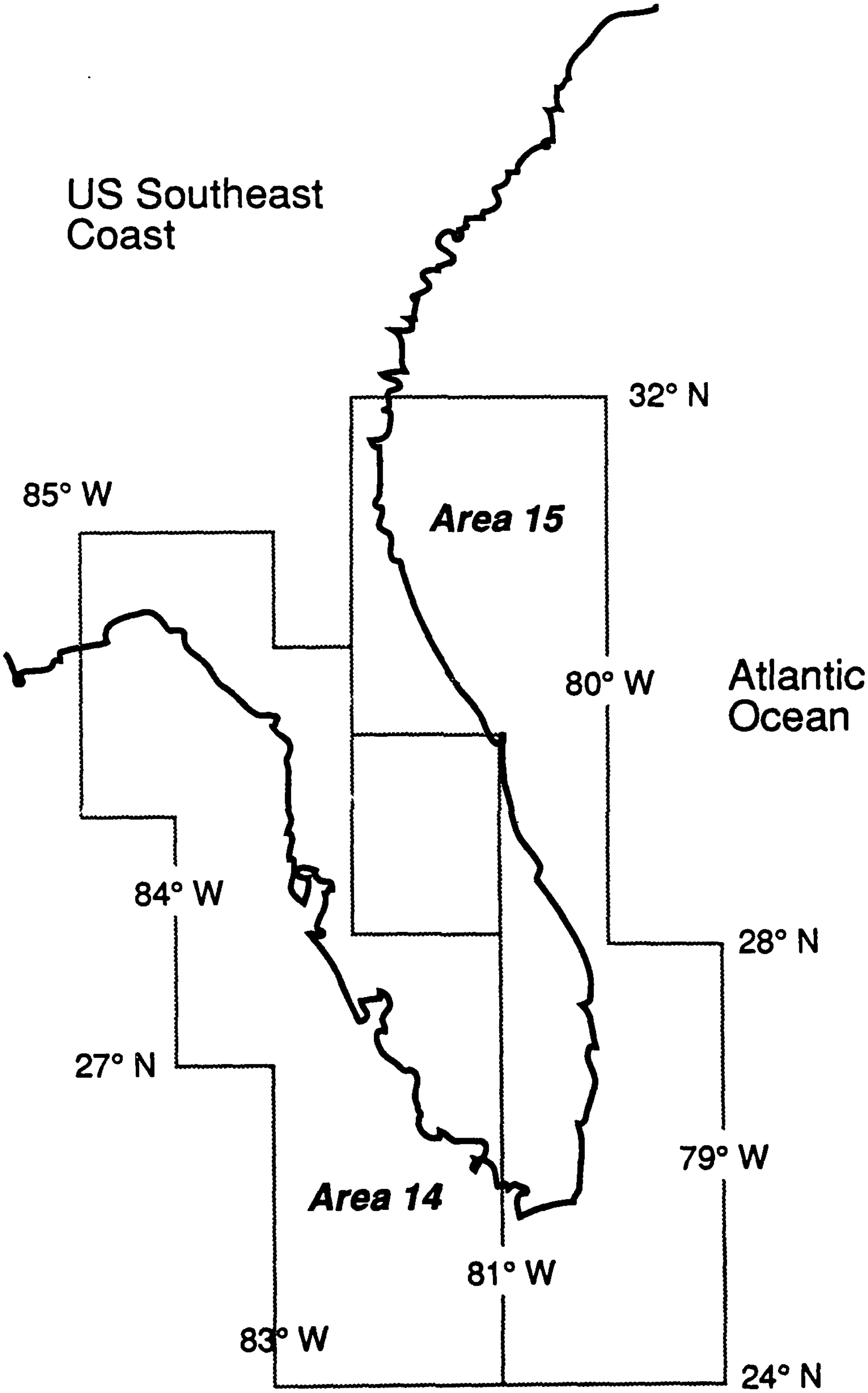

Figure A-6. Geographic Boundaries of Areas 14 and 15

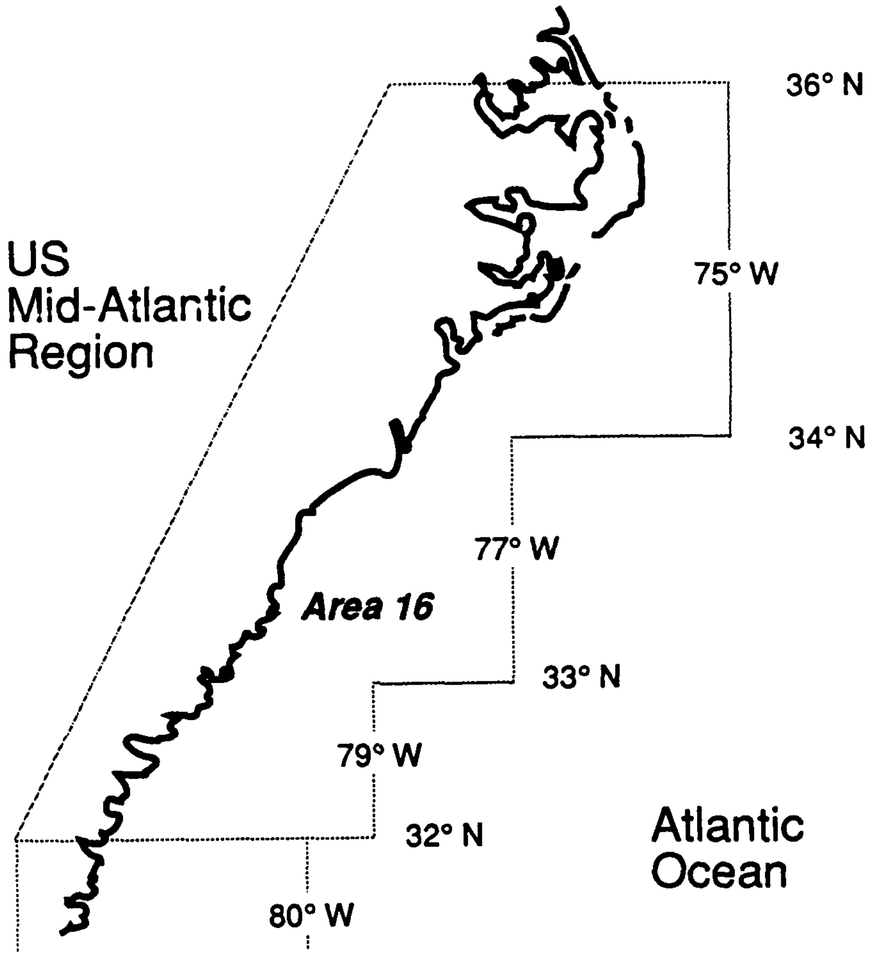

Figure A-7. Geographic Boundaries of Area 16

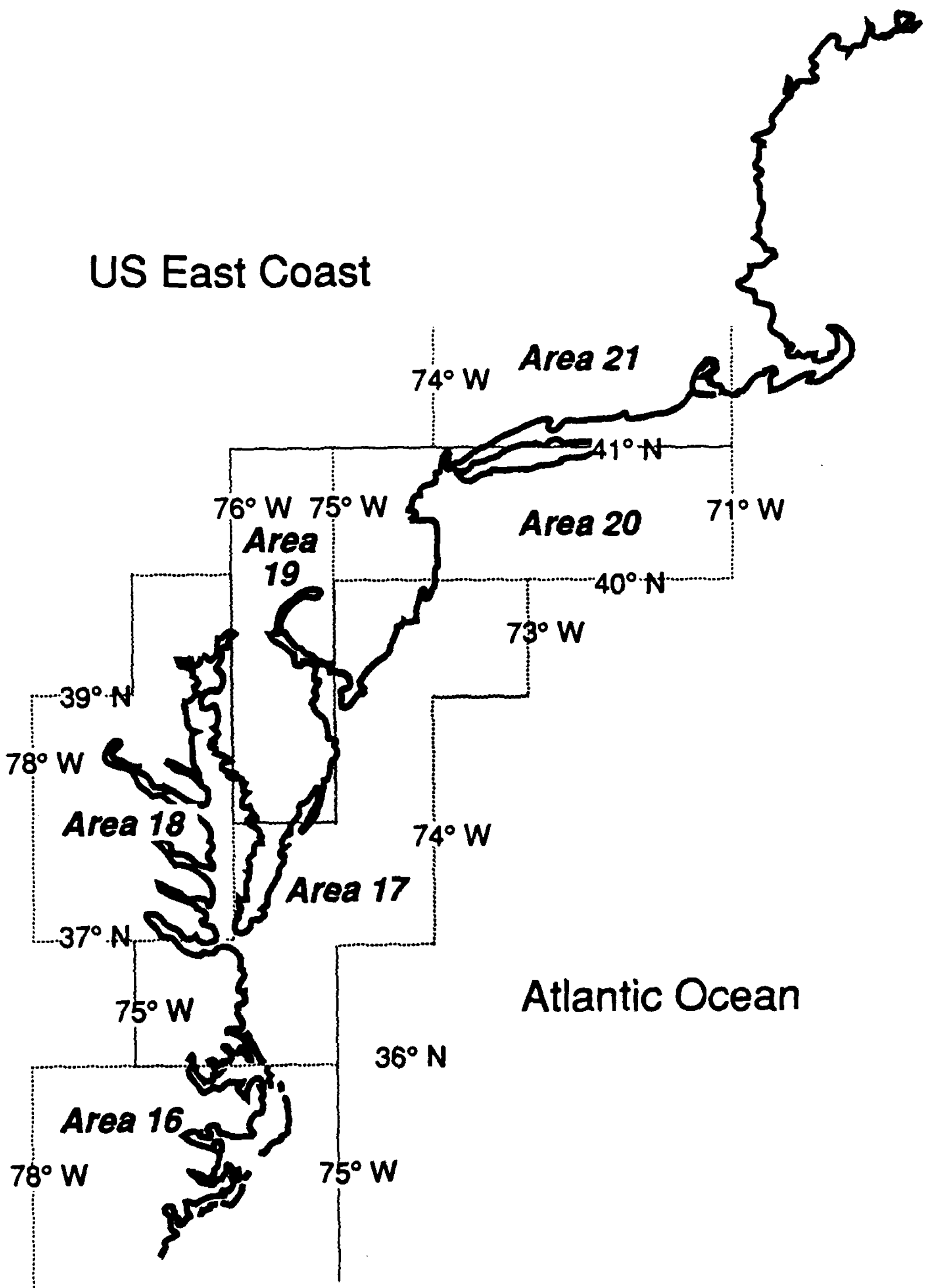

Figure A-8. Geographic Boundaries of Areas 17 through 20

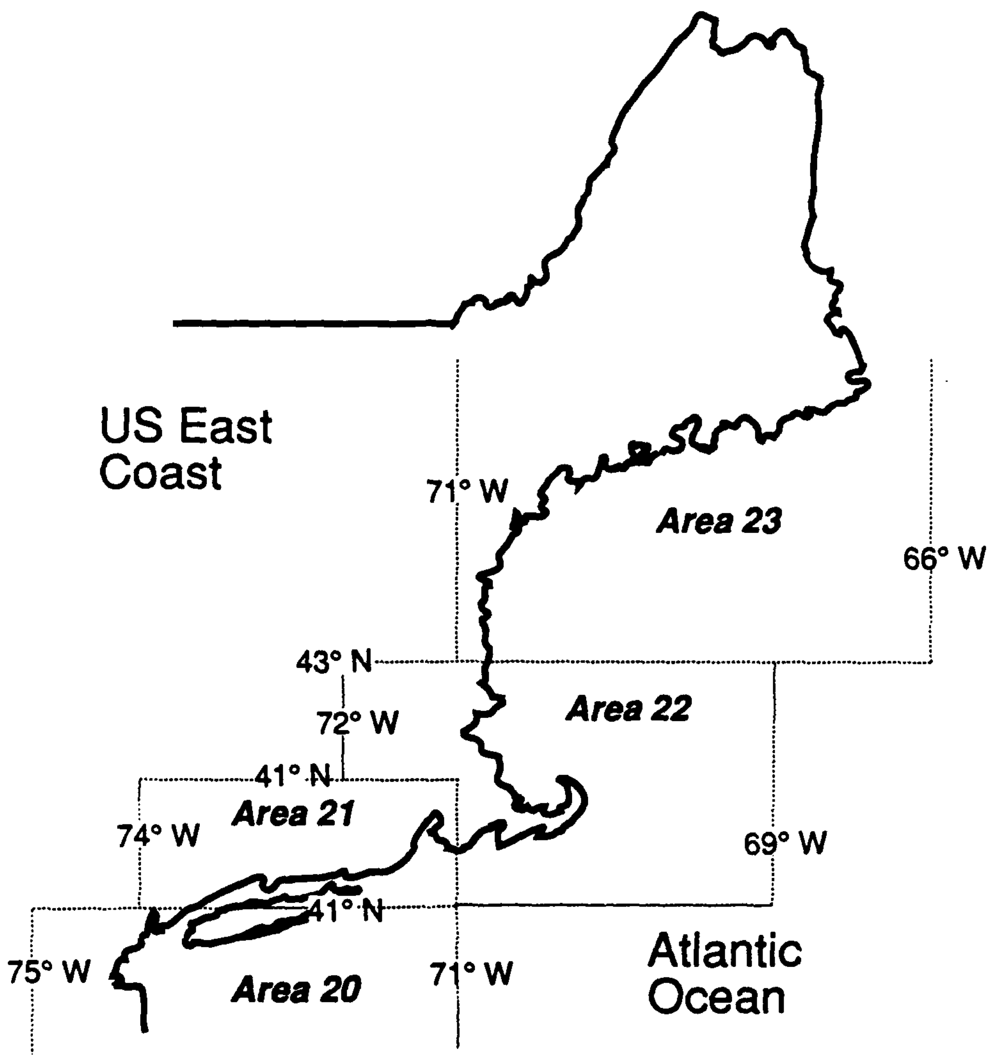

Figure A-9. Geographic Boundaries of Areas 21 through 23

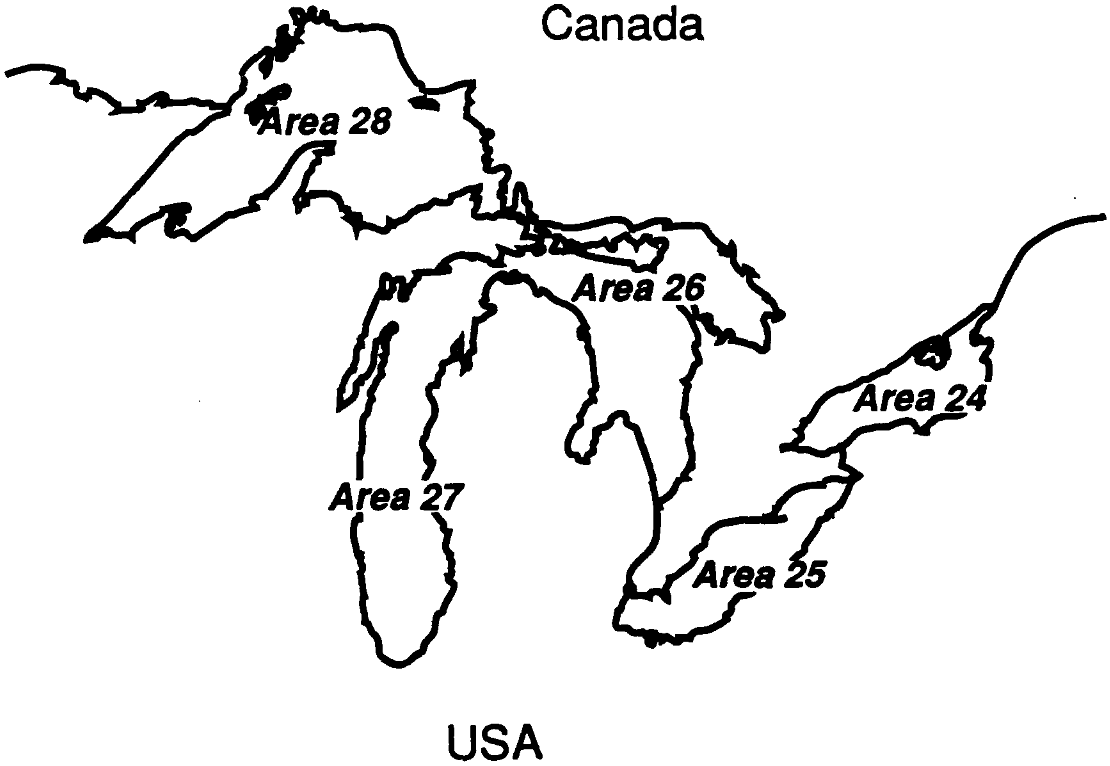

Figure A-10. Geographic Boundaries of Areas 24 through 28

APPENDIX B

AREA PARAMETERS AND TRANSMISSIVITY CURVES

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Table B-I

WEIBULL FUNCTION PARAMETERS

Area	Parameters		
	a	b	c
ALASKA - AREA 1	11.566	2.452	0.929
ALASKA - AREA 2	12.757	1.699	0.930
ALASKA - AREA 3	16.716	1.710	0.977
ALASKA - AREA 4	13.764	1.871	0.956
HAWAII - AREA 5	15.632	4.029	0.998
WEST COAST - AREA 6	13.313	2.227	0.934
WEST COAST - AREA 7	9.454	3.144	0.907
WEST COAST - AREA 8	16.146	2.066	0.959
WEST COAST - AREA 9	14.301	2.125	0.939
WEST COAST - AREA 10	12.077	2.497	0.962
GULF COAST - AREA 11	15.812	2.878	0.987
GULF COAST - AREA 12	17.380	2.943	0.993
GULF COAST - AREA 13	13.948	3.261	0.988
GULF COAST - AREA 14	18.107	3.536	0.997
EAST COAST - AREA 15	15.962	3.692	0.997
EAST COAST - AREA 16	14.117	3.089	0.991
EAST COAST - AREA 17	12.330	2.743	0.970
EAST COAST - AREA 18	10.060	2.774	0.967
EAST COAST - AREA 19	11.256	2.612	0.956
EAST COAST - AREA 20	12.366	2.246	0.945
EAST COAST - AREA 21	12.044	1.867	0.930
EAST COAST - AREA 22	13.079	2.107	0.917
EAST COAST - AREA 23	16.549	1.436	0.877
LAKE ONTARIO - AREA 24	14.609	1.634	0.960
LAKE ERIE - AREA 25	14.327	1.704	0.981
LAKE HURON - AREA 26	17.683	1.665	0.960
LAKE MICHIGAN - AREA 27	19.226	1.643	0.957
LAKE SUPERIOR - AREA 28	23.379	1.595	0.934

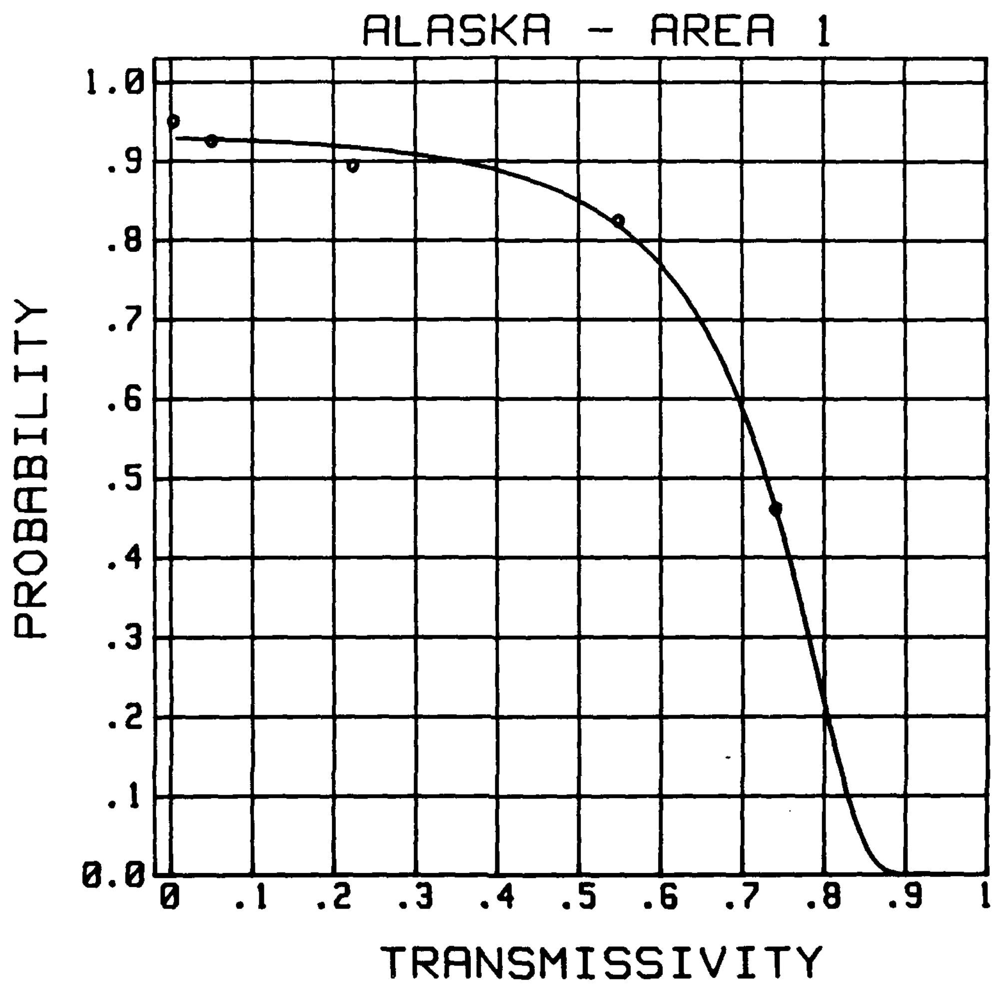

Figure B-1. Transmissivity Curve for ALASKA - AREA 1

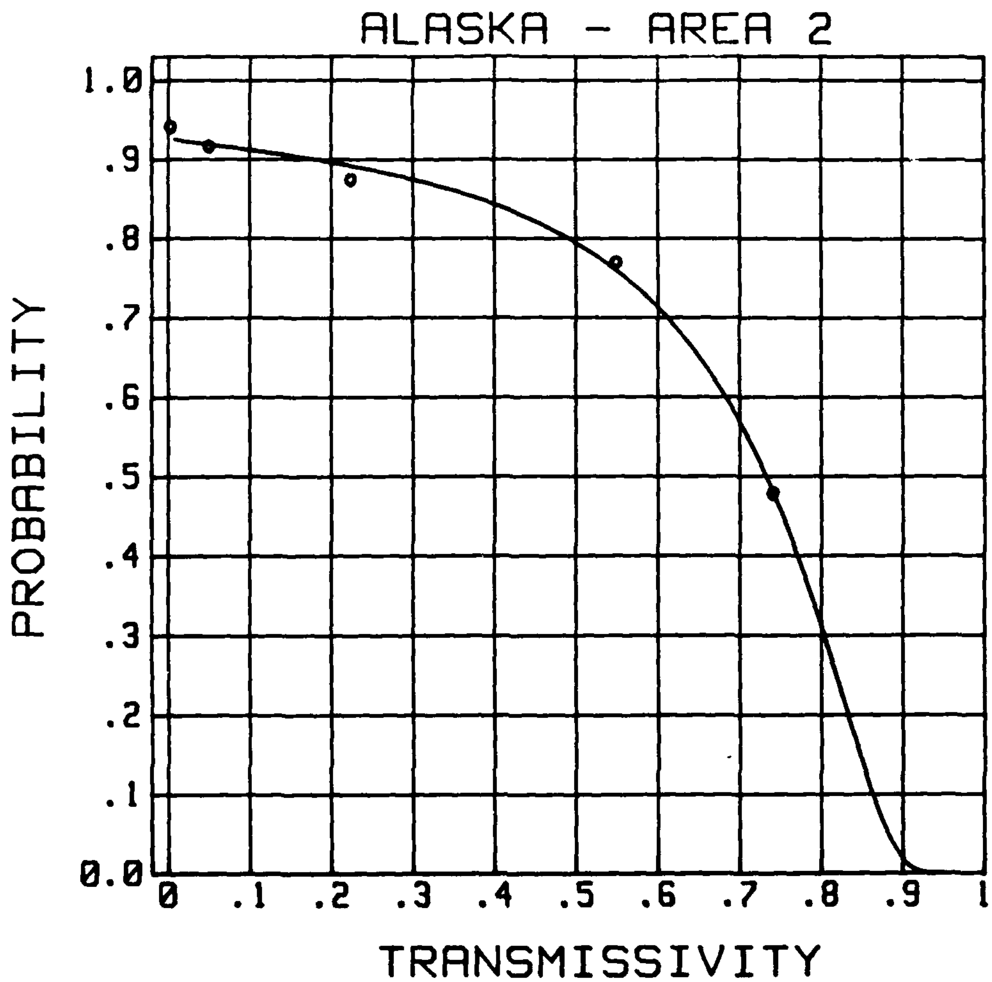

Figure B-2. Transmissivity Curve for ALASKA - AREA 2

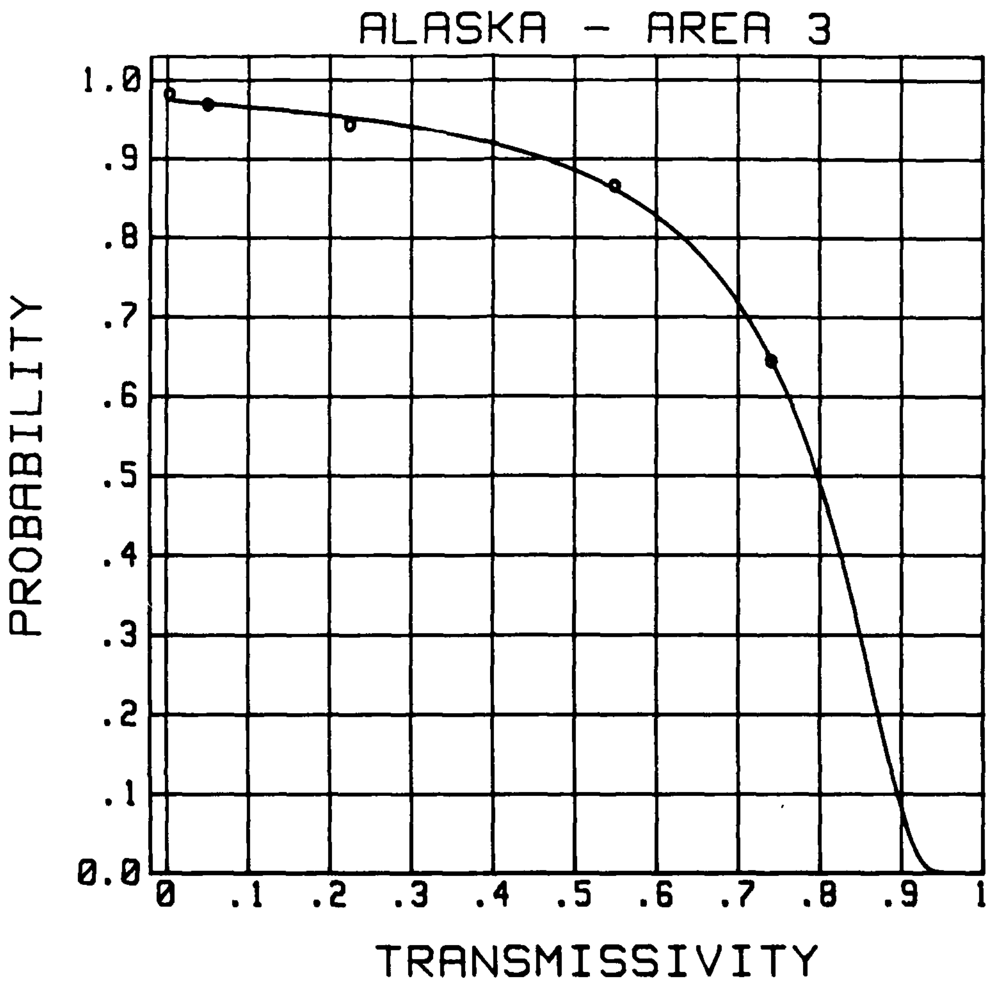

Figure B-3. Transmissivity Curve for ALASKA - AREA 3

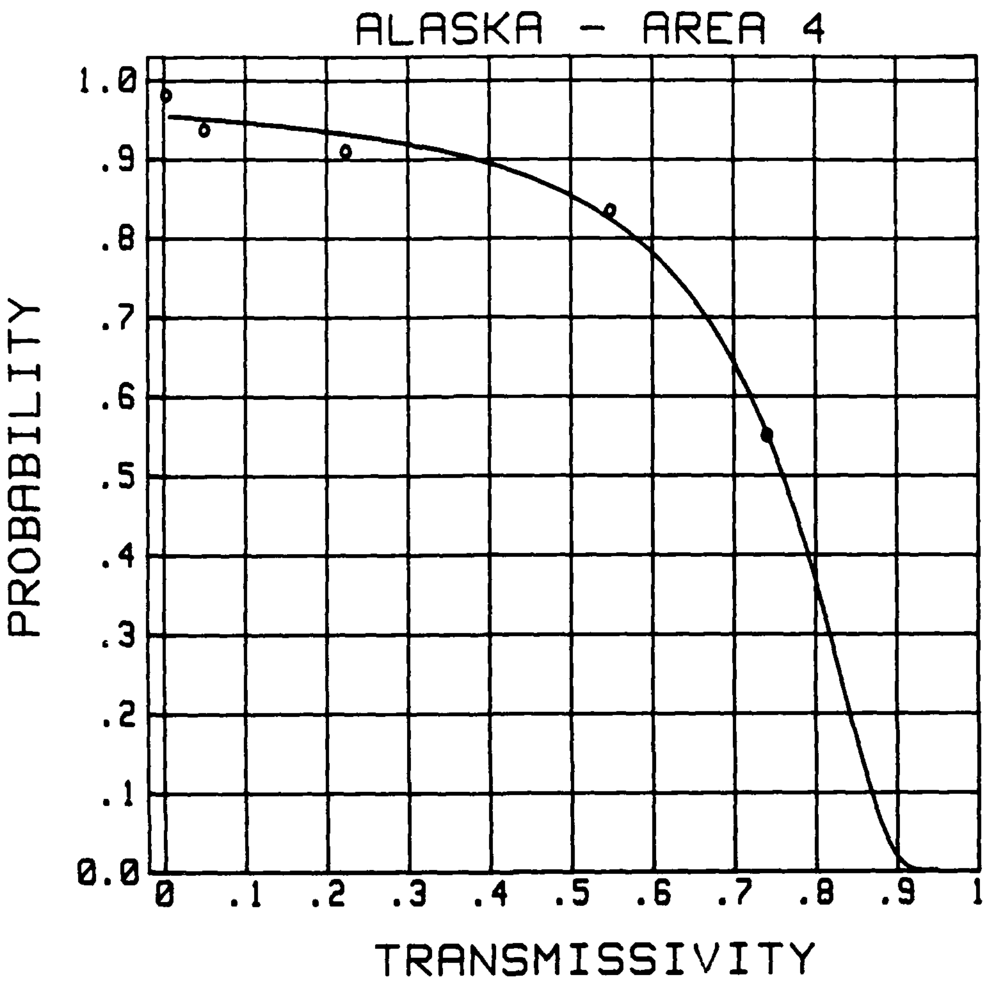

Figure B-4. Transmissivity Curve for ALASKA - AREA 4

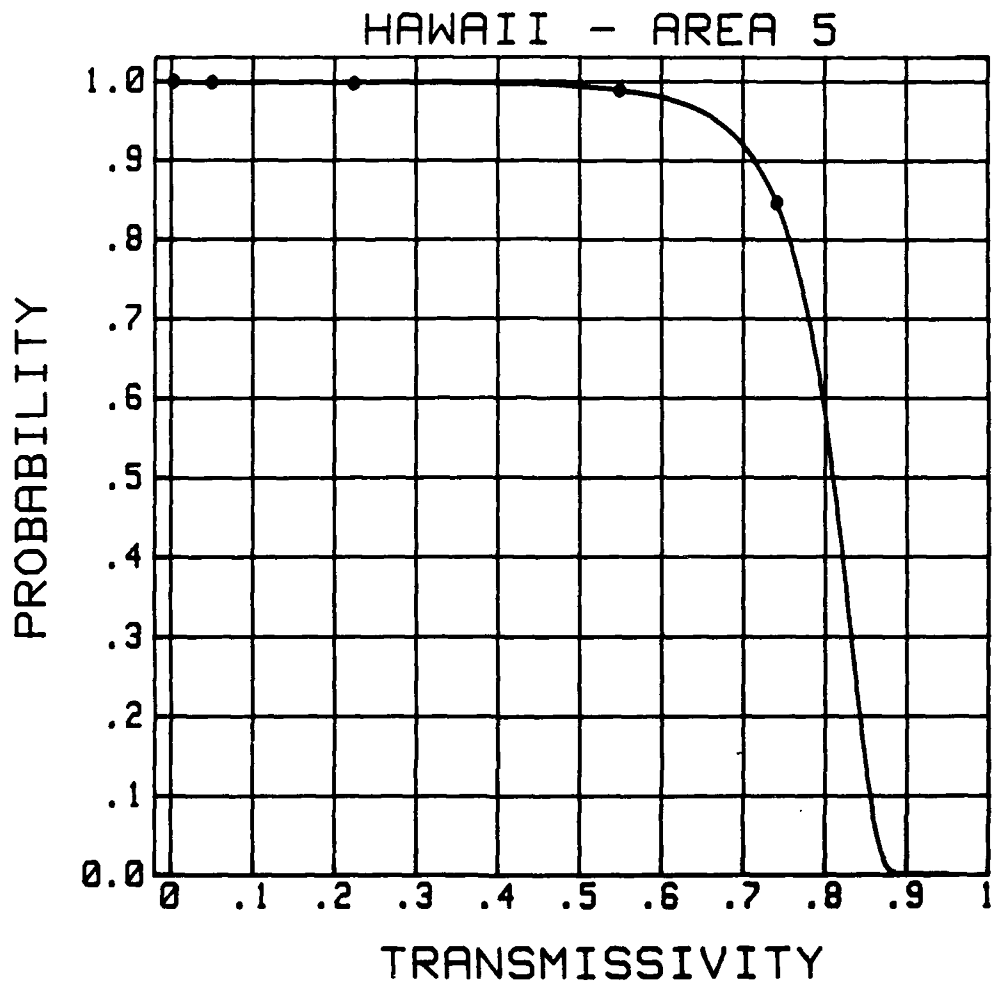

Figure B-5. Transmissivity Curve for HAWAII - AREA 5

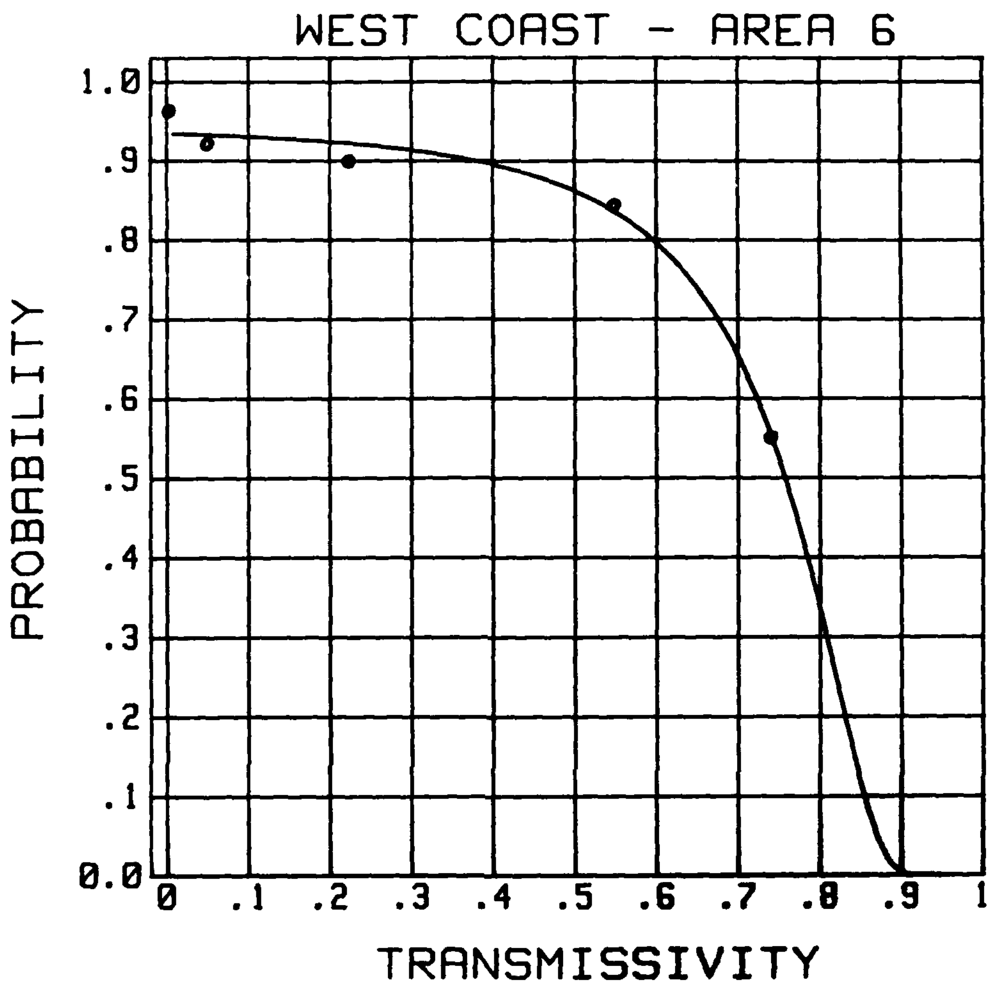

Figure B-6. Transmissivity Curve for WEST COAST - AREA 6

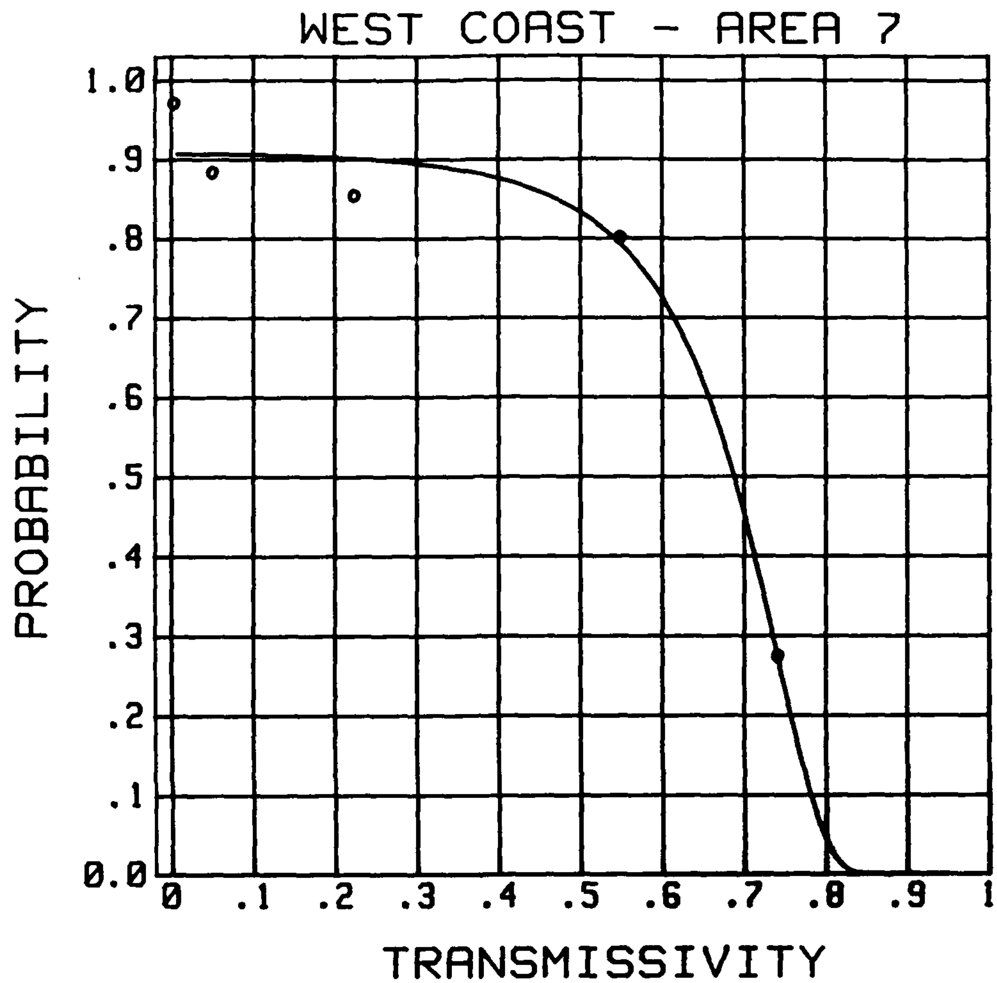

Figure B-7. Transmissivity Curve for WEST COAST - AREA 7

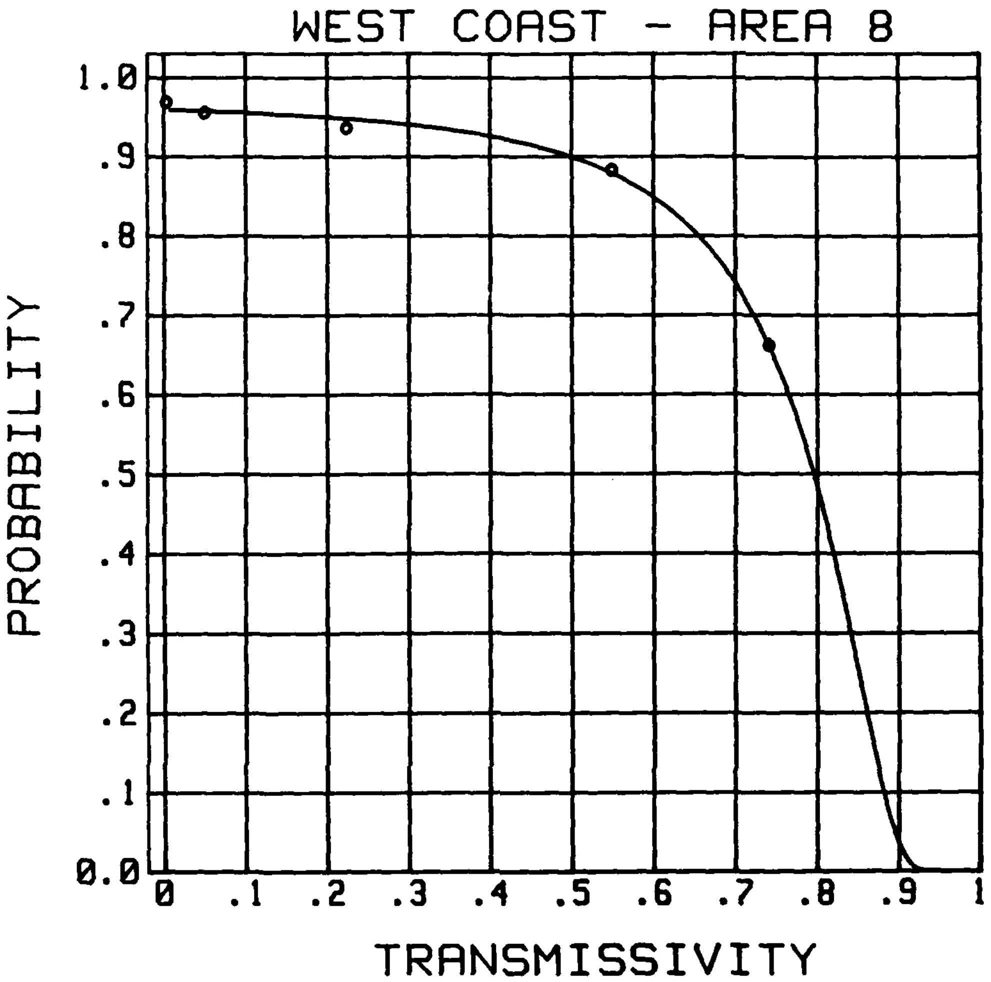

Figure B-8. Transmissivity Curve for WEST COAST - AREA 8

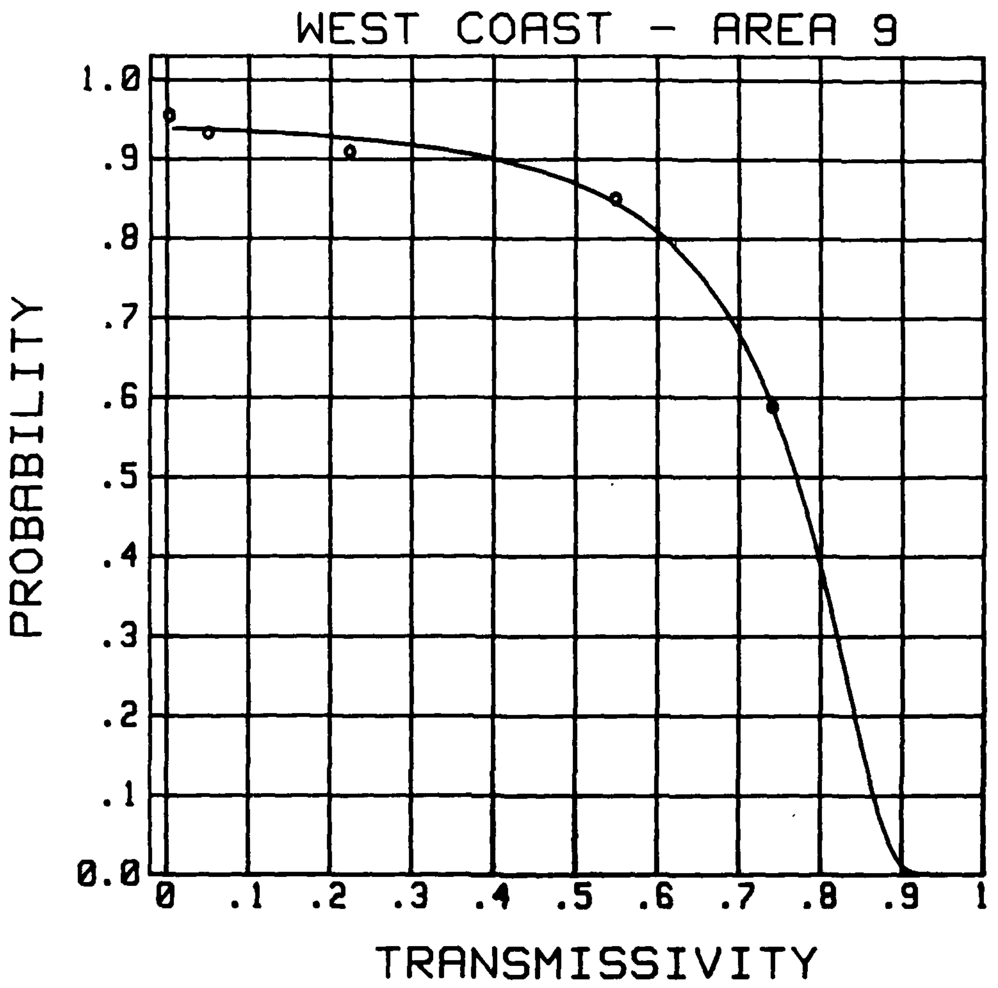

Figure B-9. Transmissivity Curve for WEST COAST - AREA 9

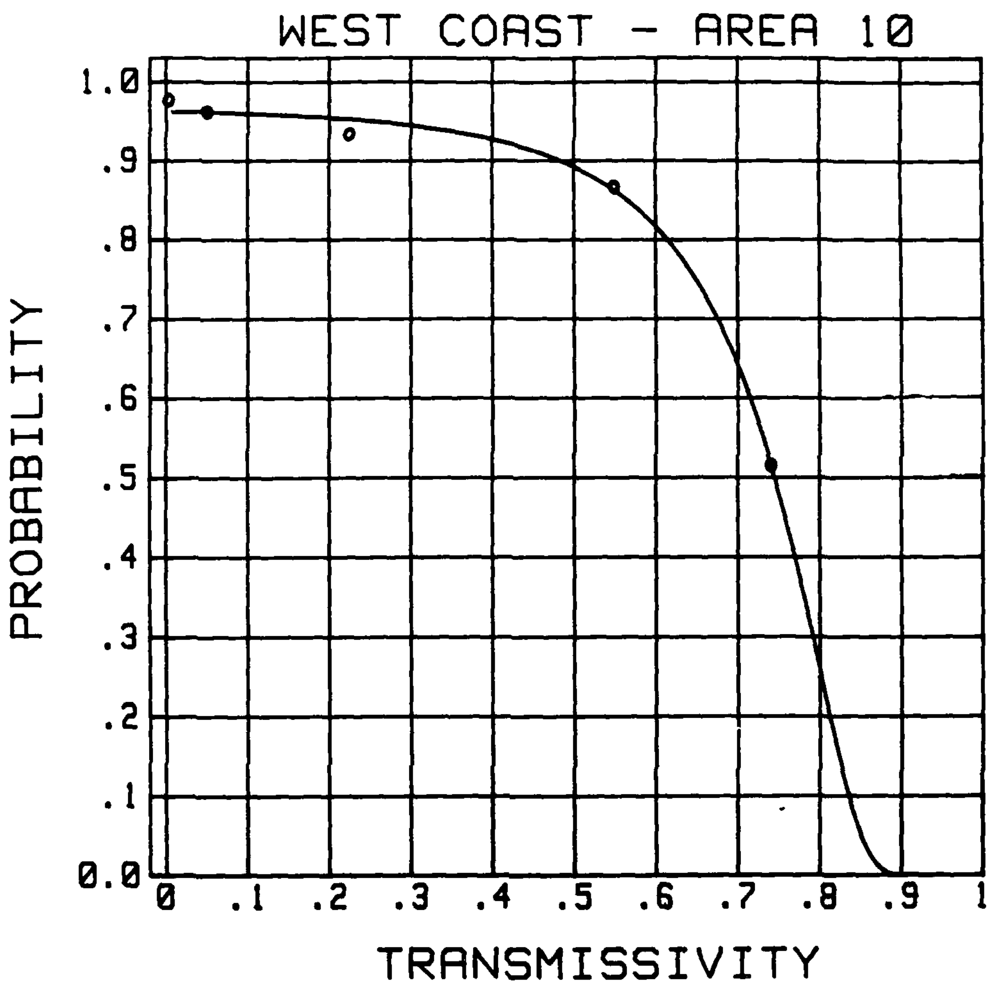

Figure B-10. Transmissivity Curve for WEST COAST - AREA 10

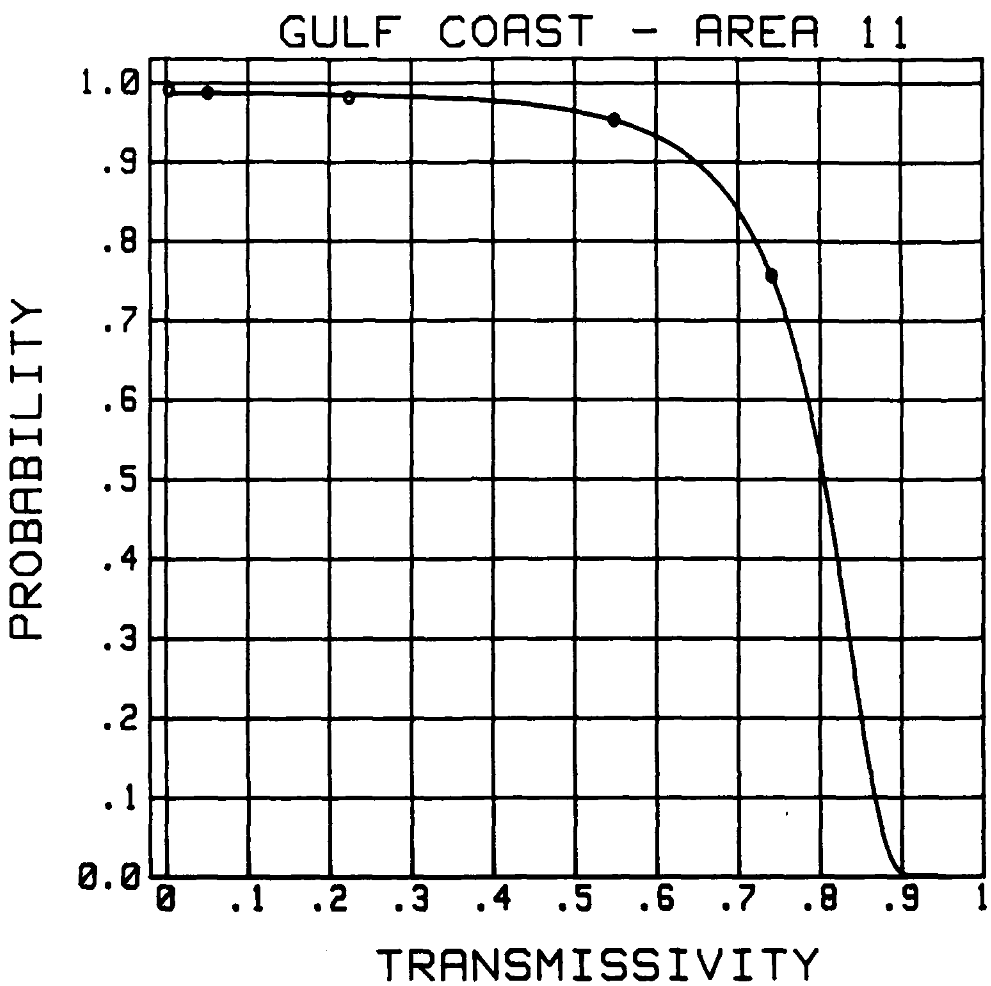

Figure B-11. Transmissivity Curve for GULF COAST - AREA 11

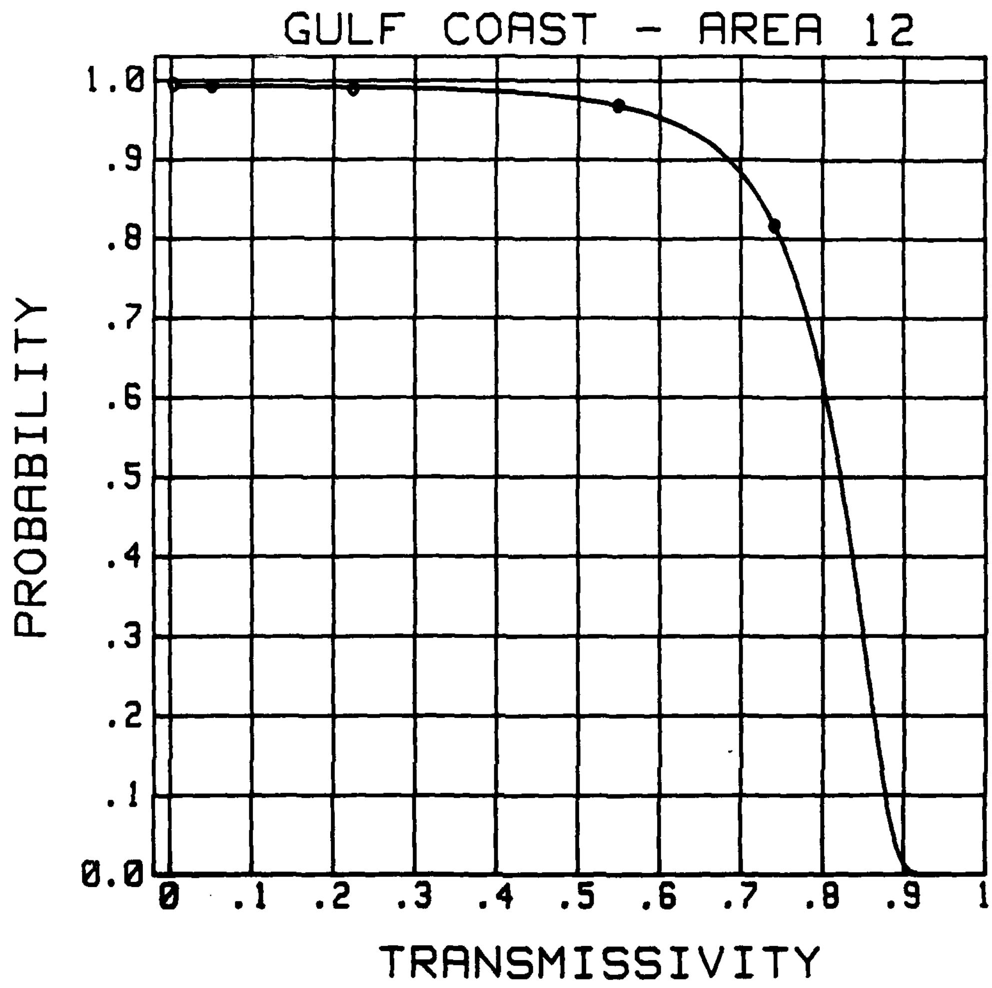

Figure B-12. Transmissivity Curve for GULF COAST - AREA 12

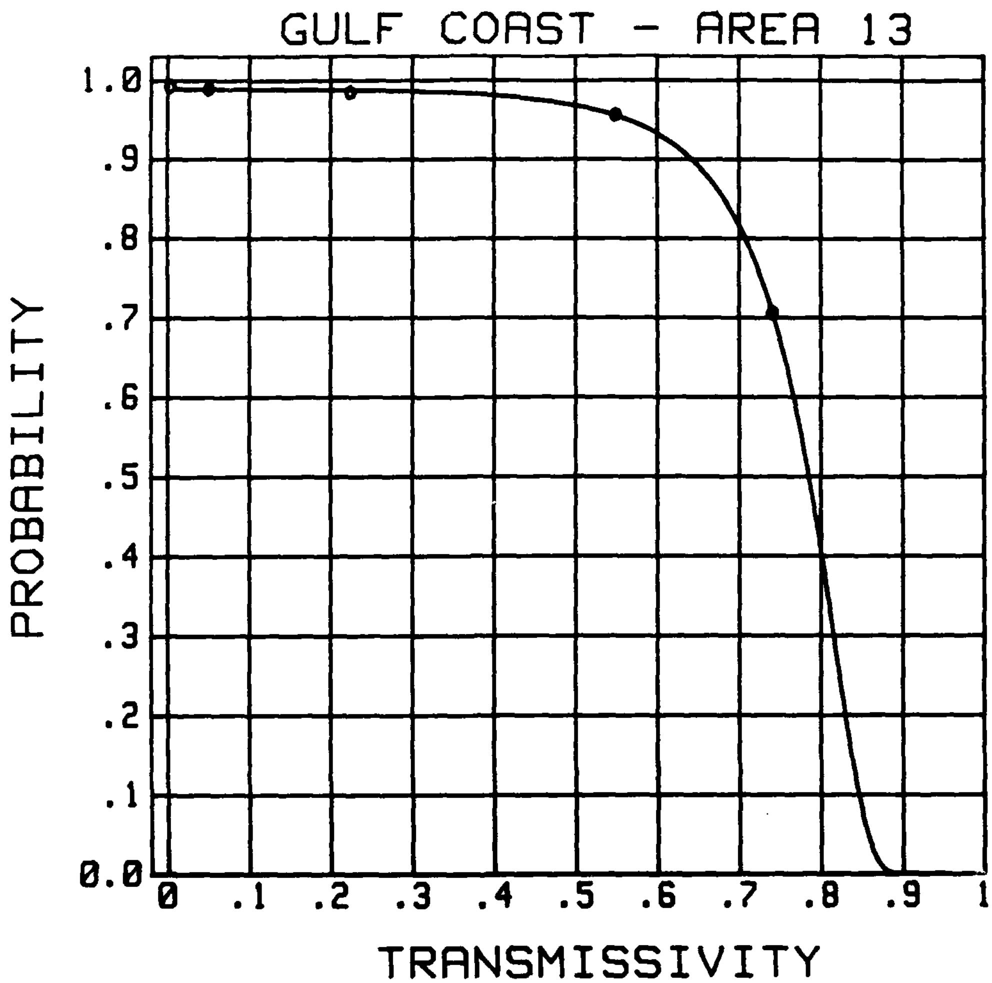

Figure B-13. Transmissivity Curve for GULF COAST - AREA 13

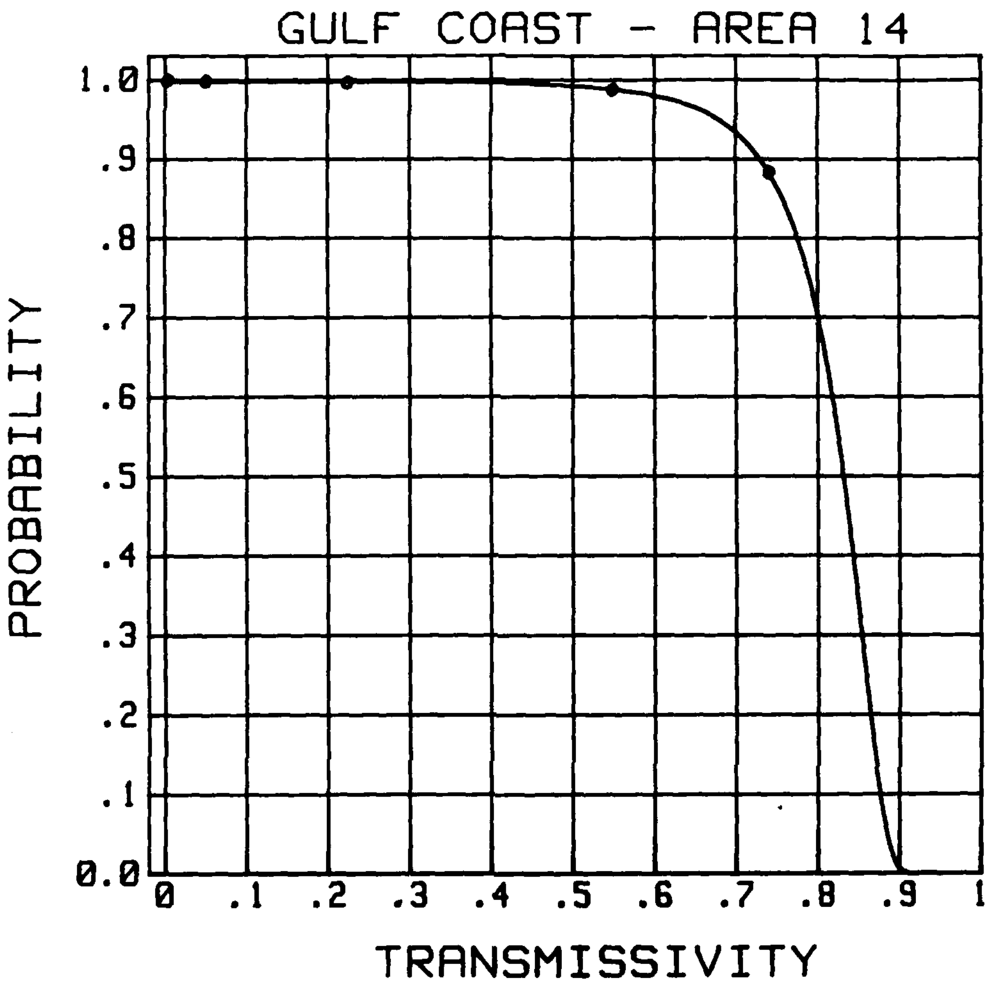

Figure B-14. Transmissivity Curve for GULF COAST - AREA 14

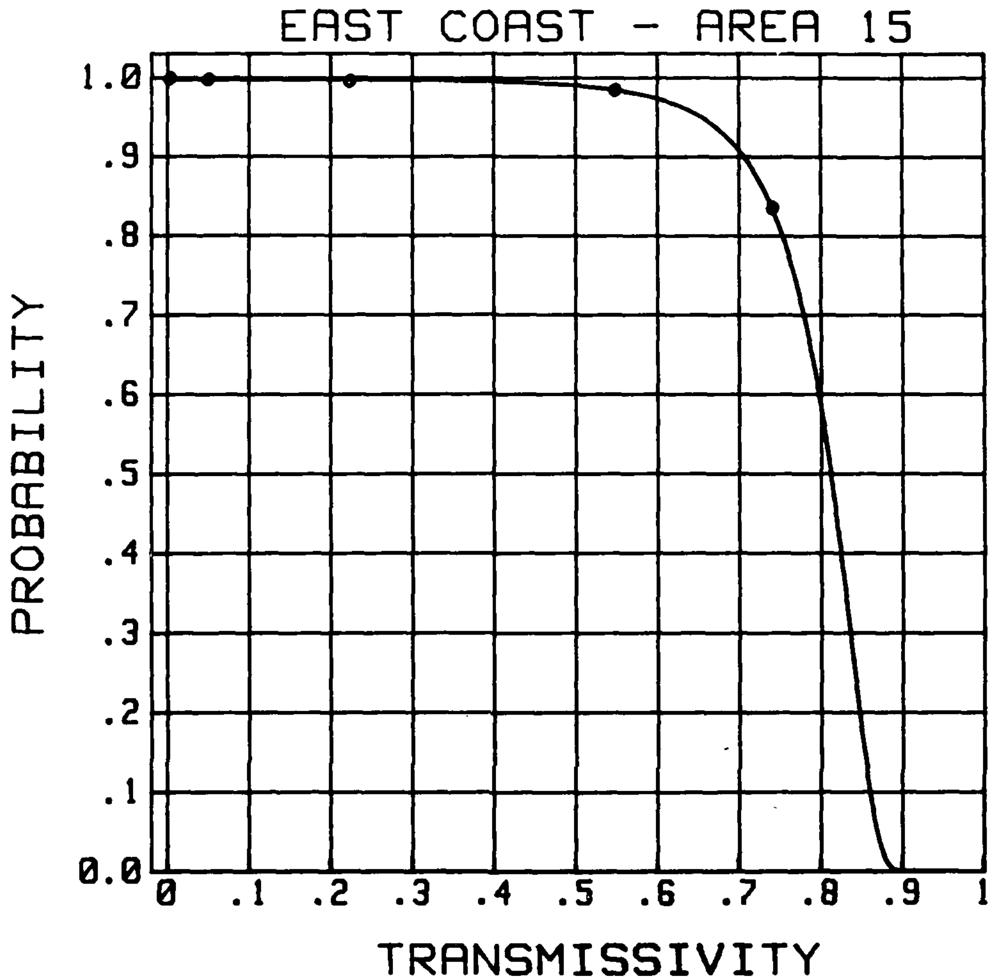

Figure B-15. Transmissivity Curve for EAST COAST - AREA 15

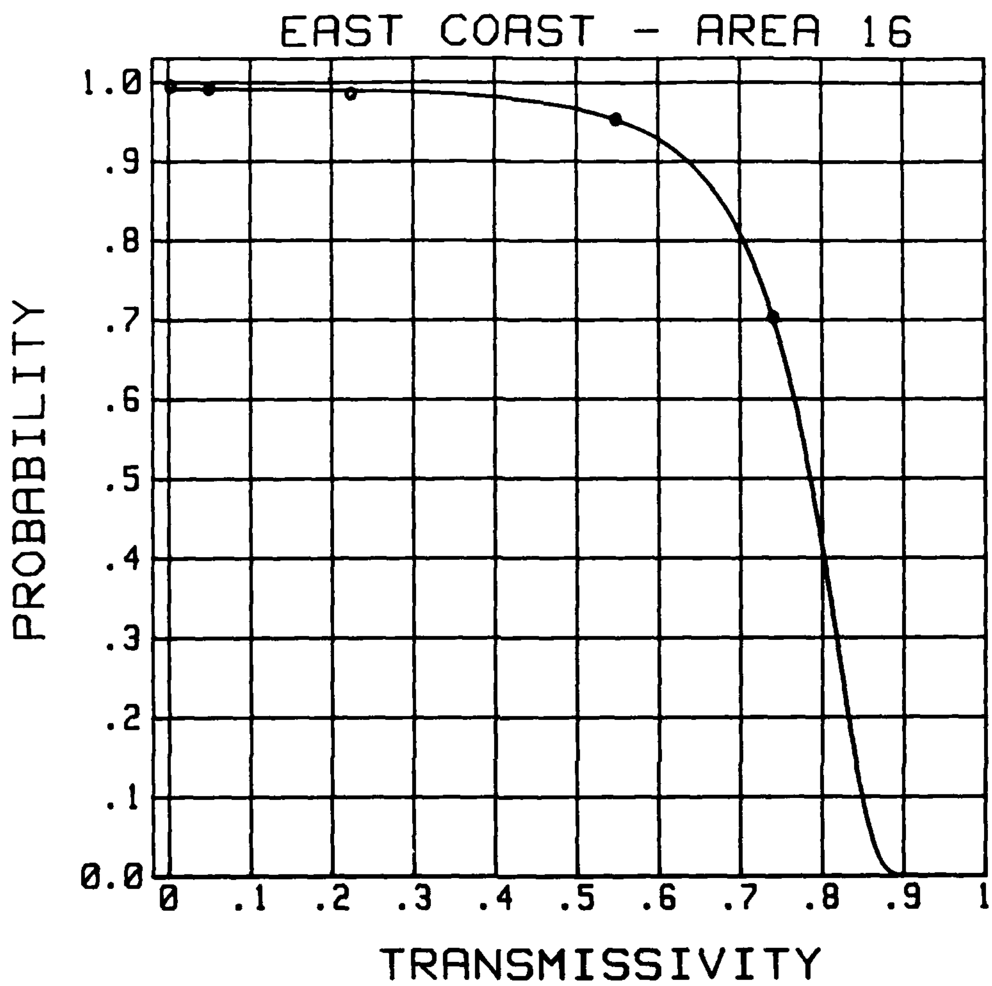

Figure B-16. Transmissivity Curve for EAST COAST - AREA 16

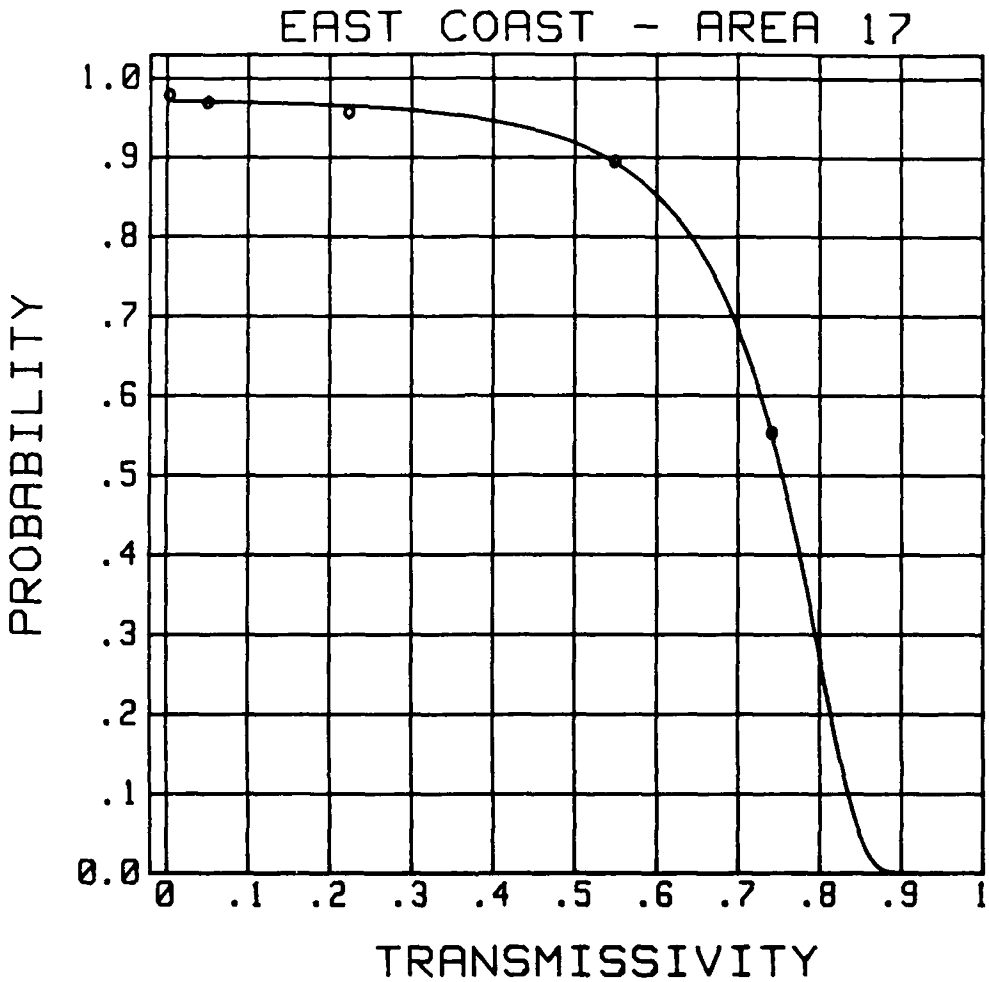

Figure B-17. Transmissivity Curve for EAST COAST - AREA 17

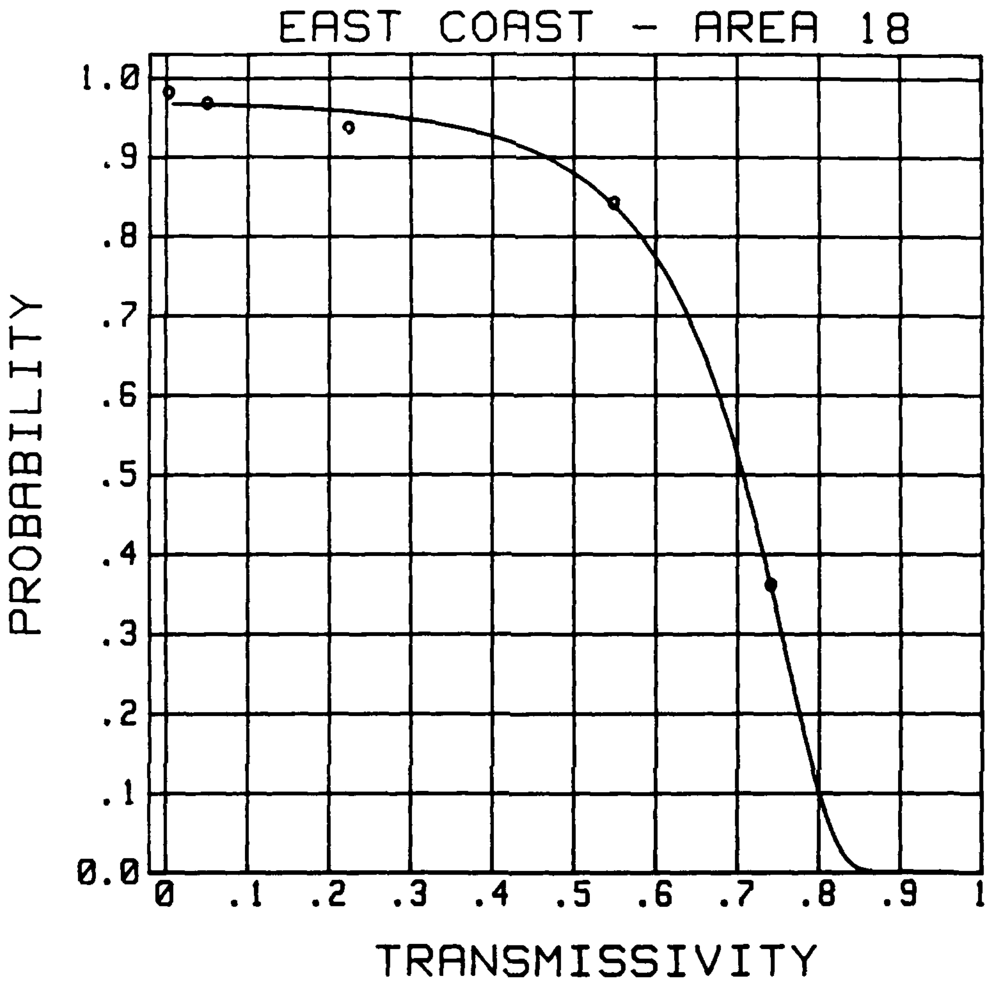

Figure B-18. Transmissivity Curve for EAST COAST - AREA 18

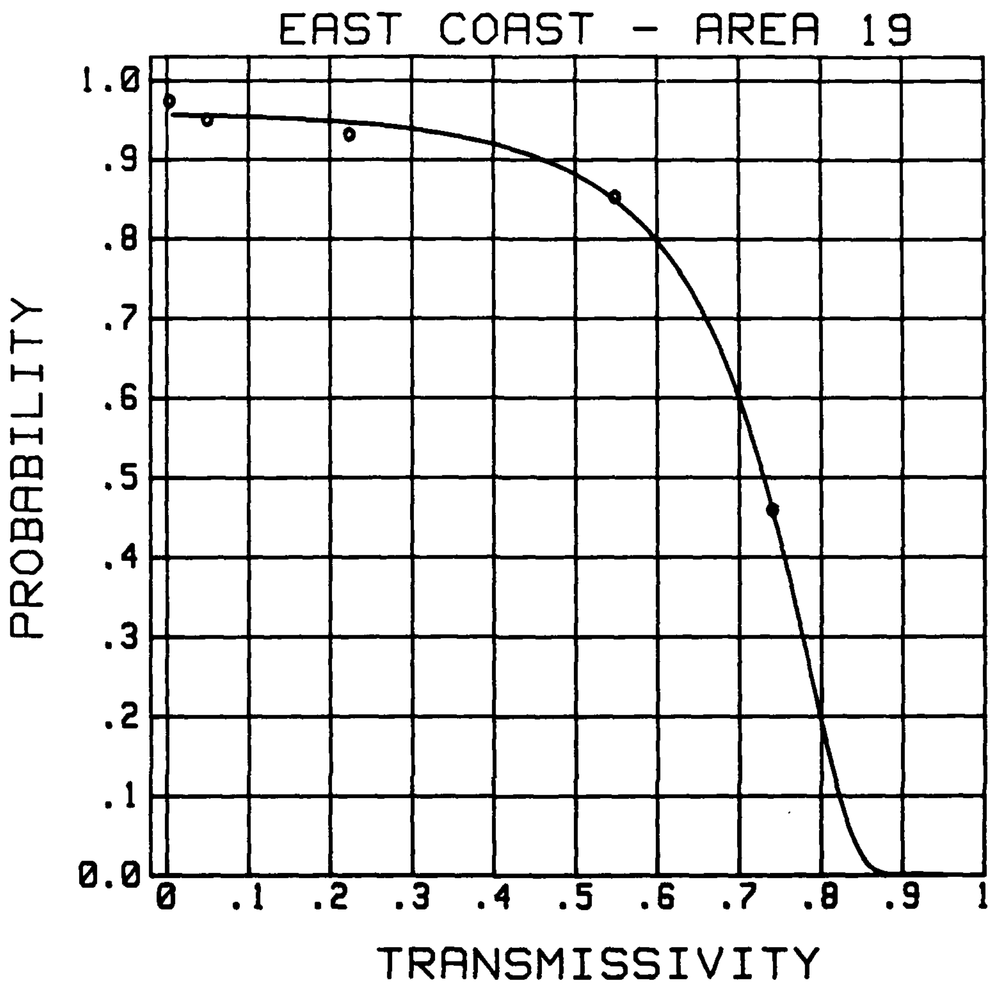

Figure B-19. Transmissivity Curve for EAST COAST - AREA 19

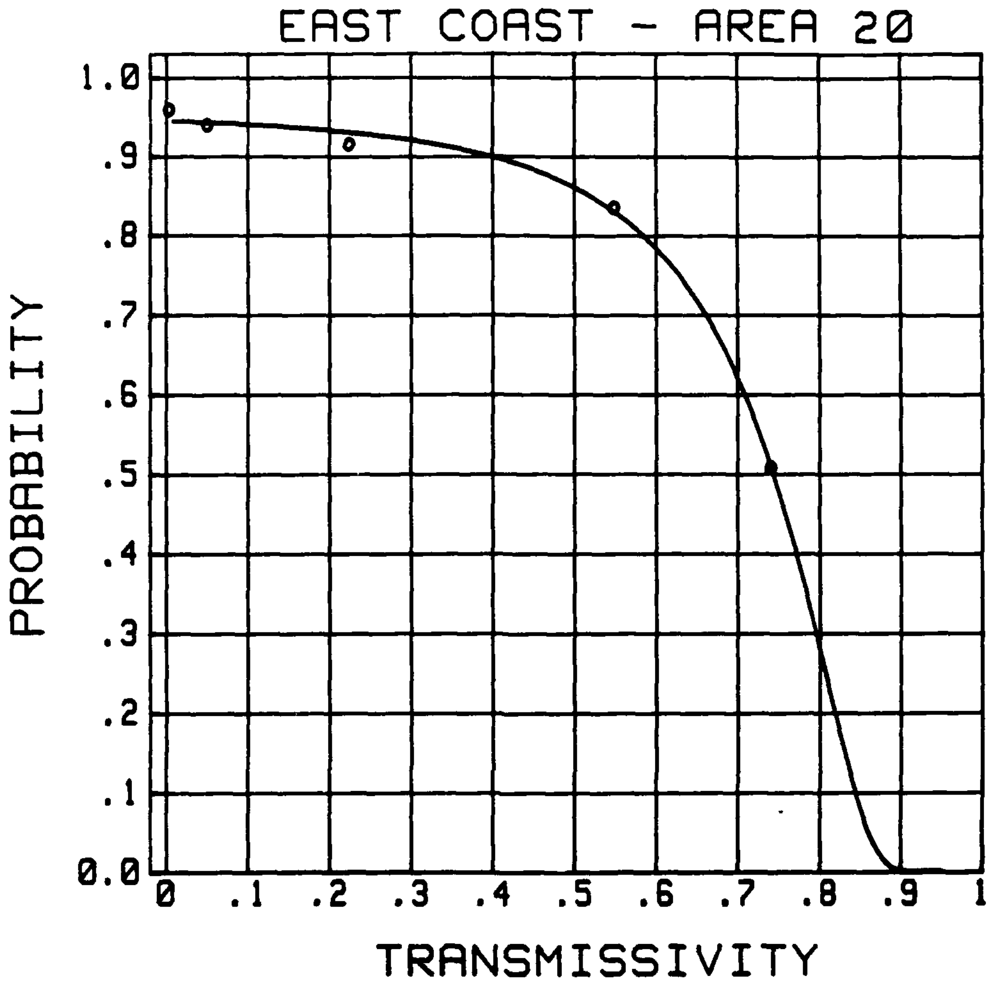

Figure B-20. Transmissivity Curve for EAST COAST - AREA 20

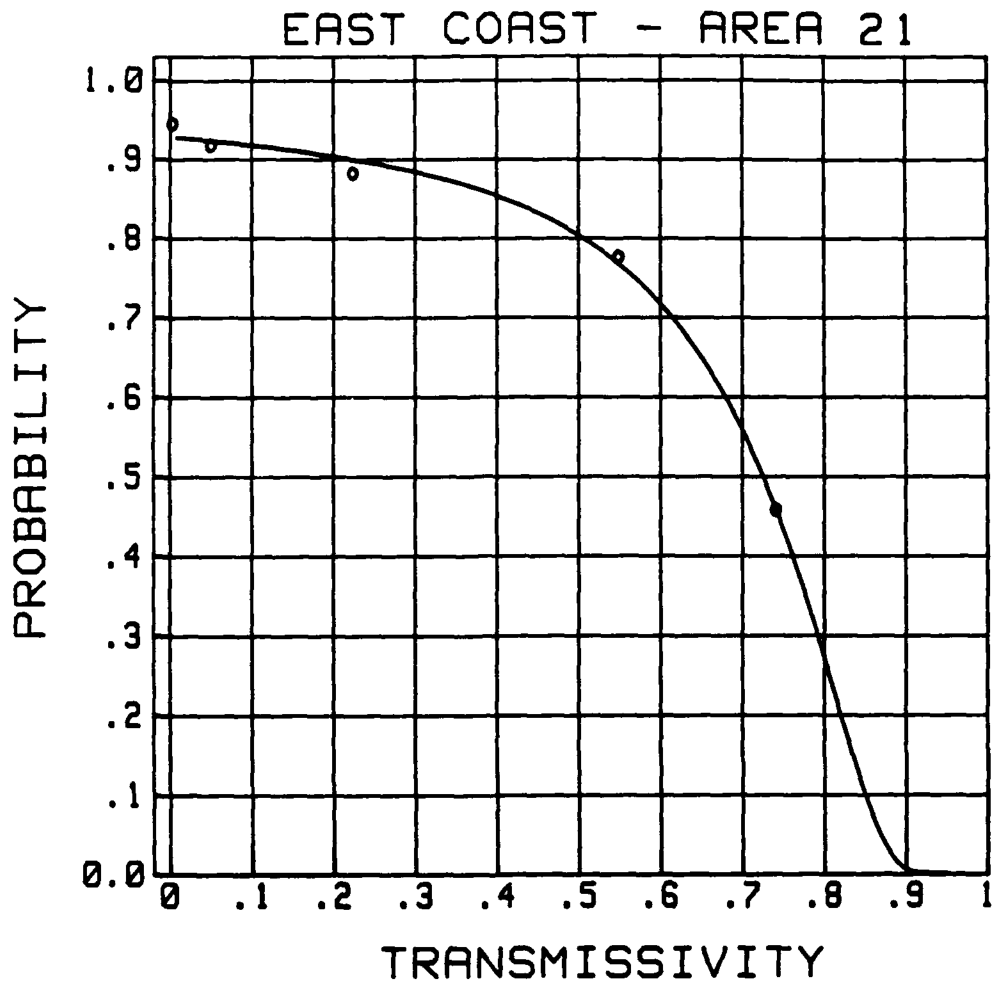

Figure B-21. Transmissivity Curve for EAST COAST - AREA 21

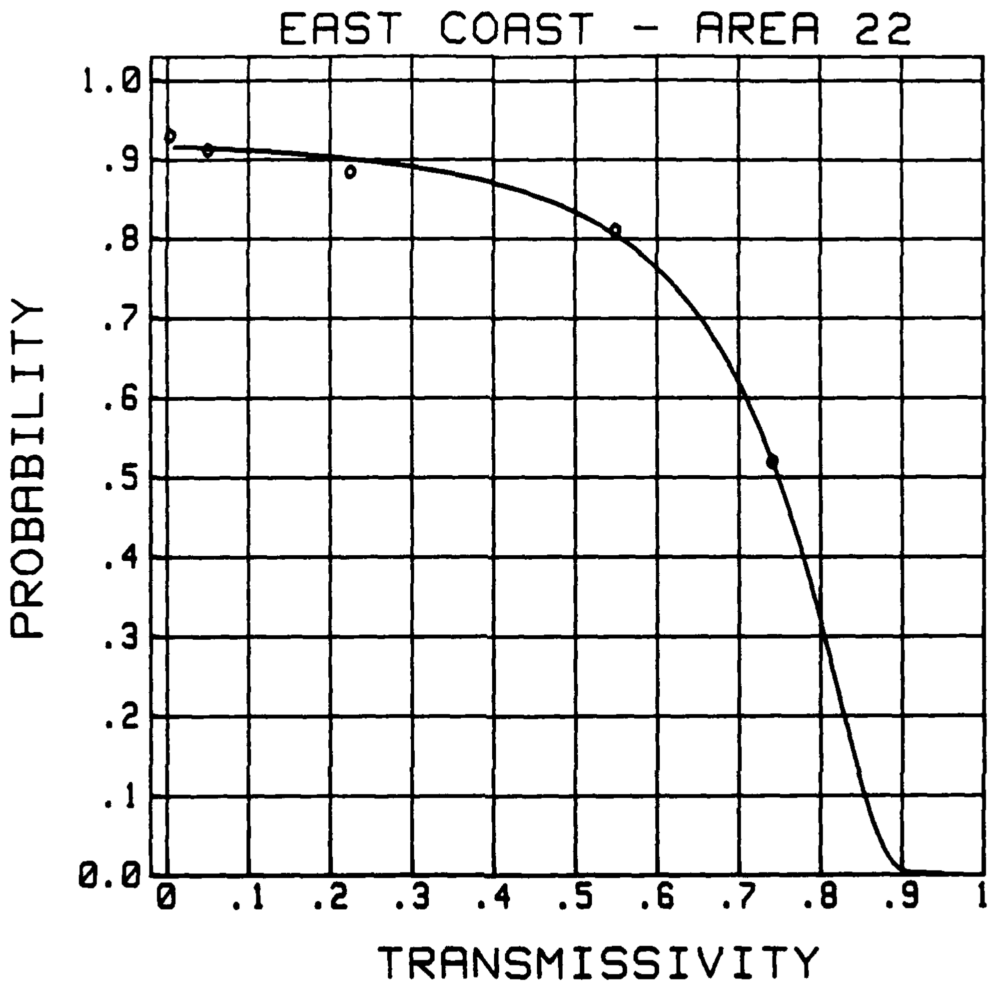

Figure B-22. Transmissivity Curve for EAST COAST - AREA 22

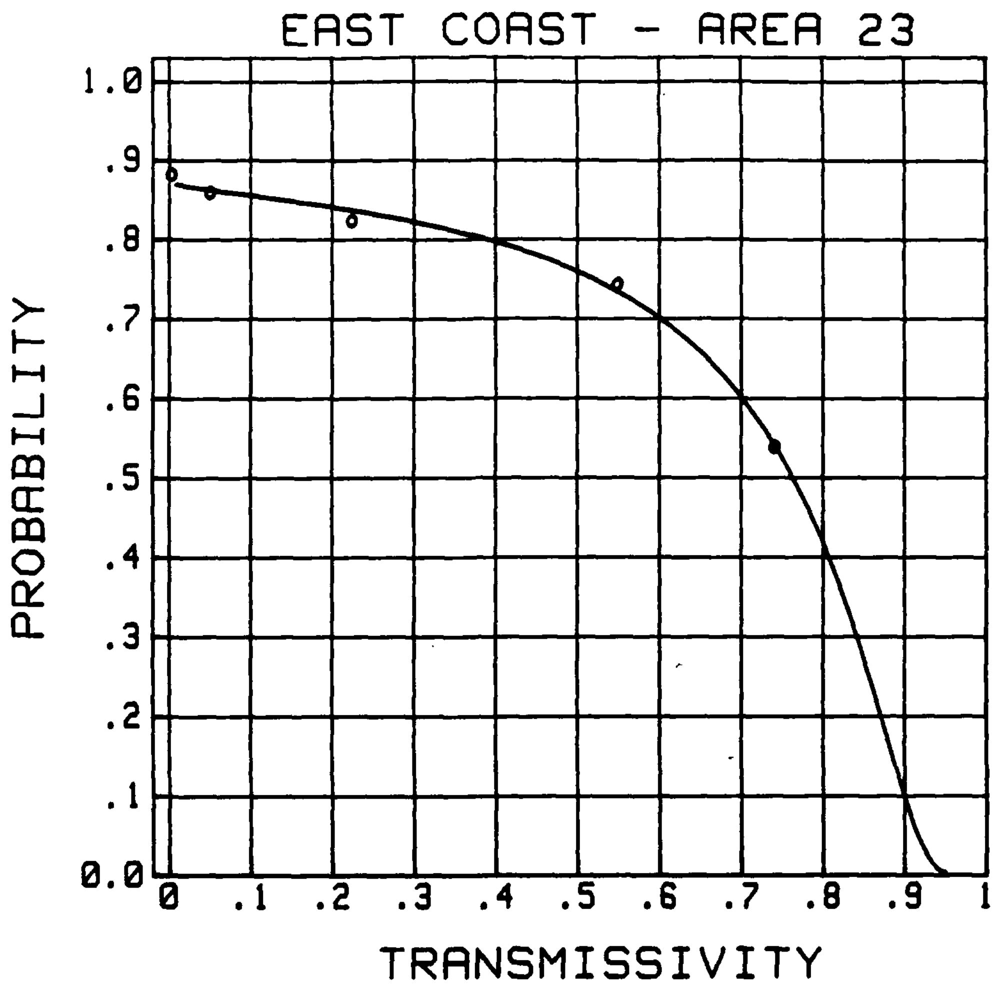

Figure B-23. Transmissivity Curve for EAST COAST - AREA 23

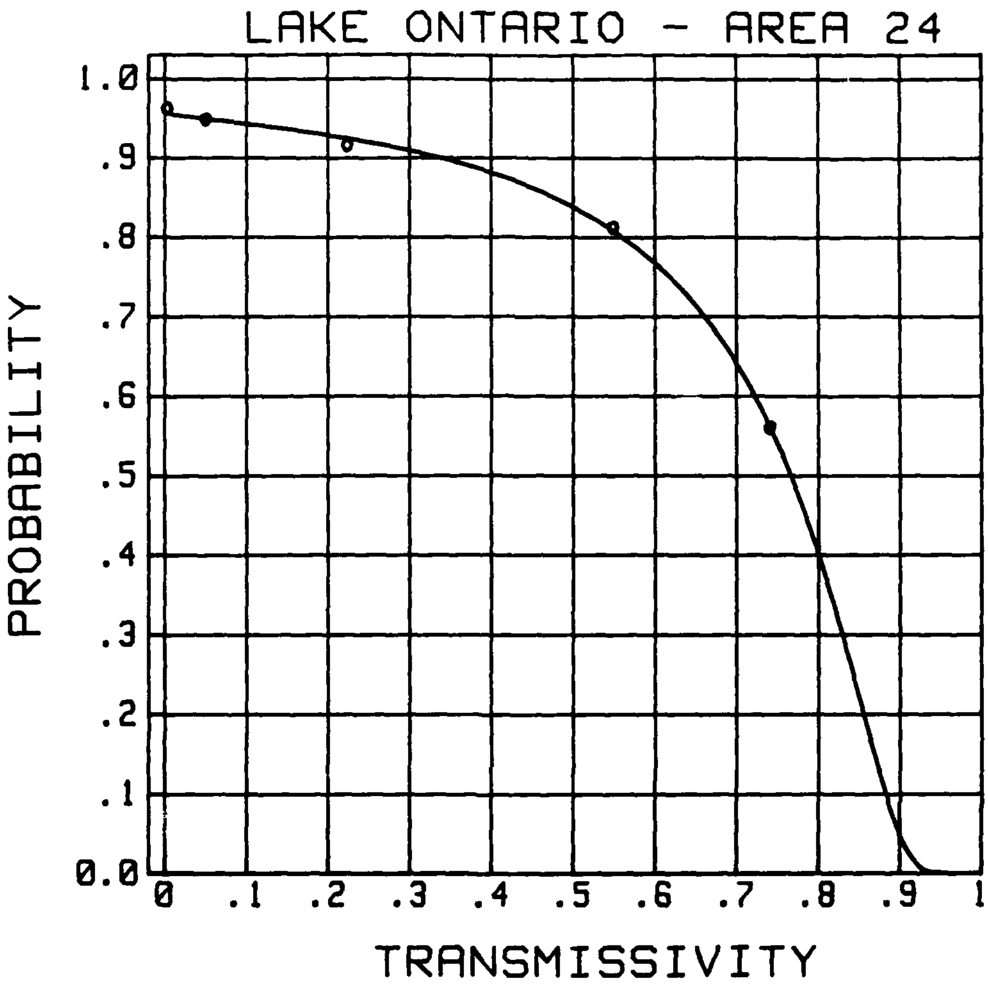

Figure B-24. Transmissivity Curve for LAKE ONTARIO - AREA 24

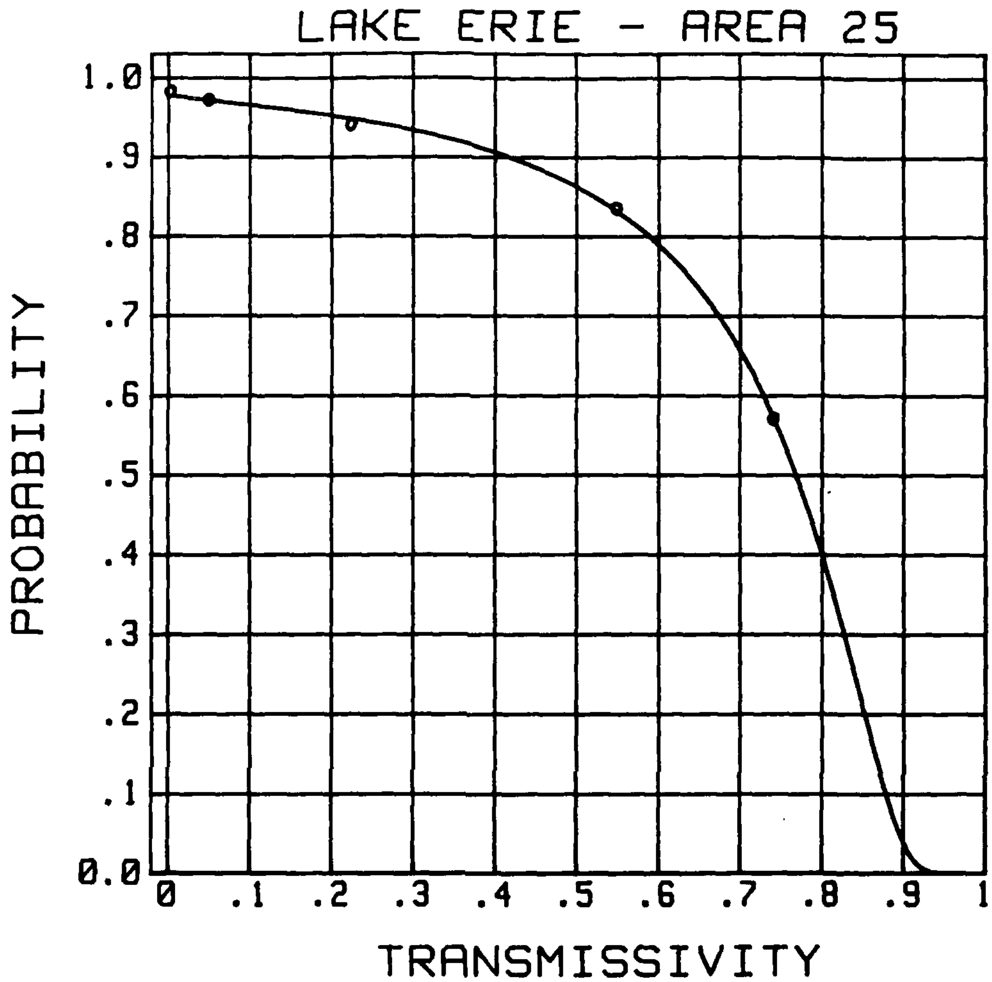

Figure B-25. Transmissivity Curve for LAKE ERIE - AREA 25

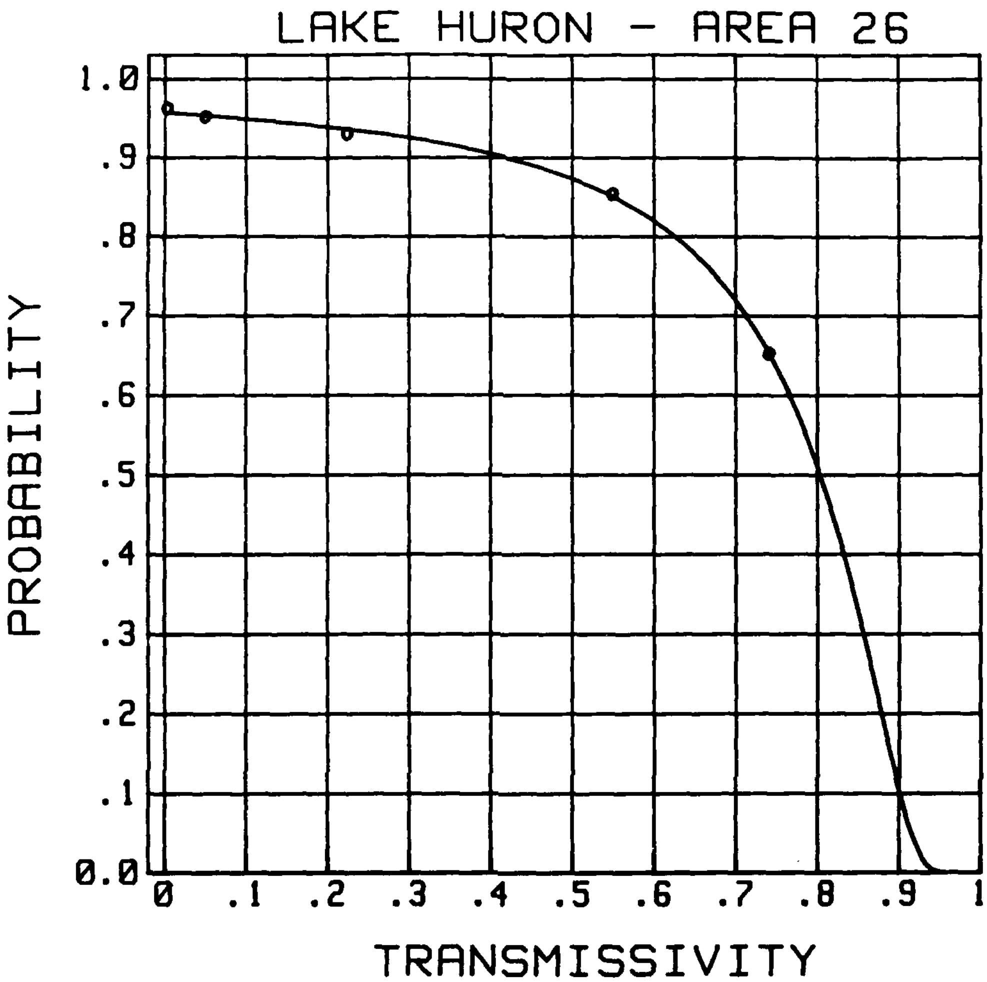

Figure B-26. Transmissivity Curve for LAKE HURON - AREA 26

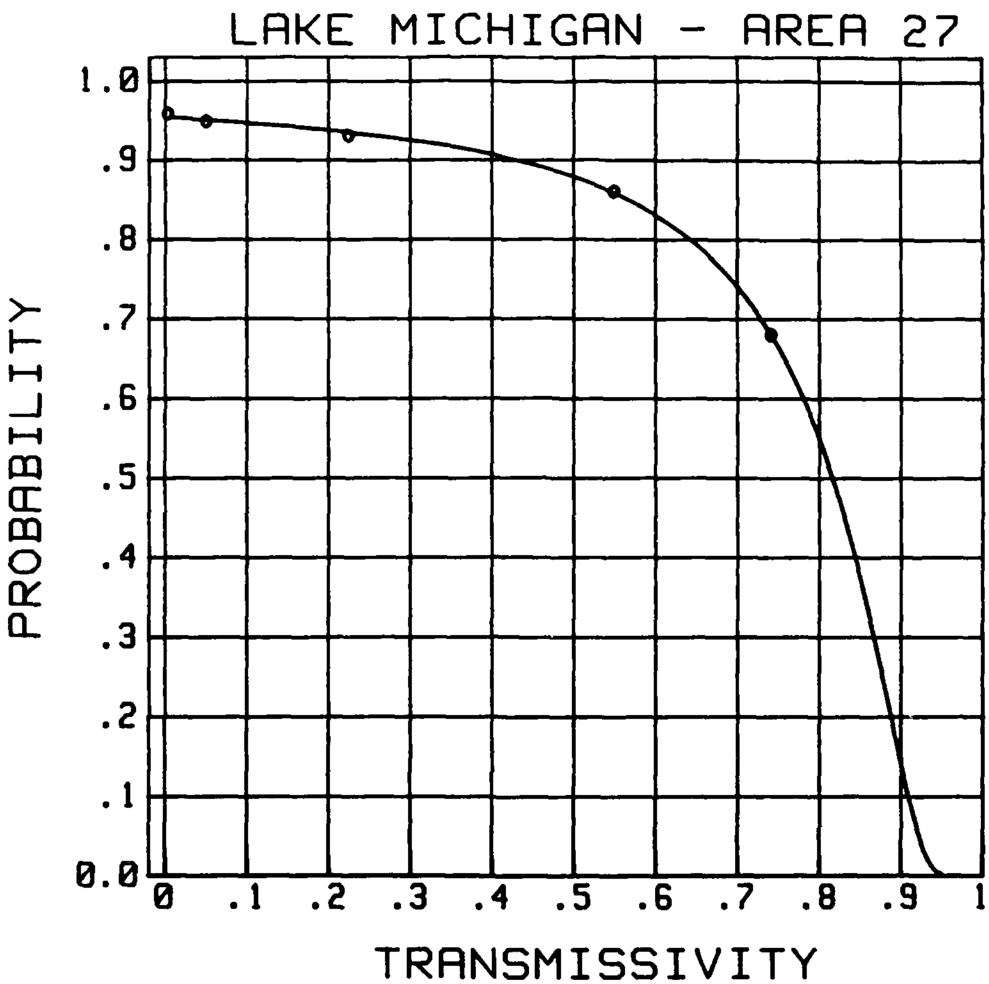

Figure B-27. Transmissivity Curve for LAKE MICHIGAN - AREA 27

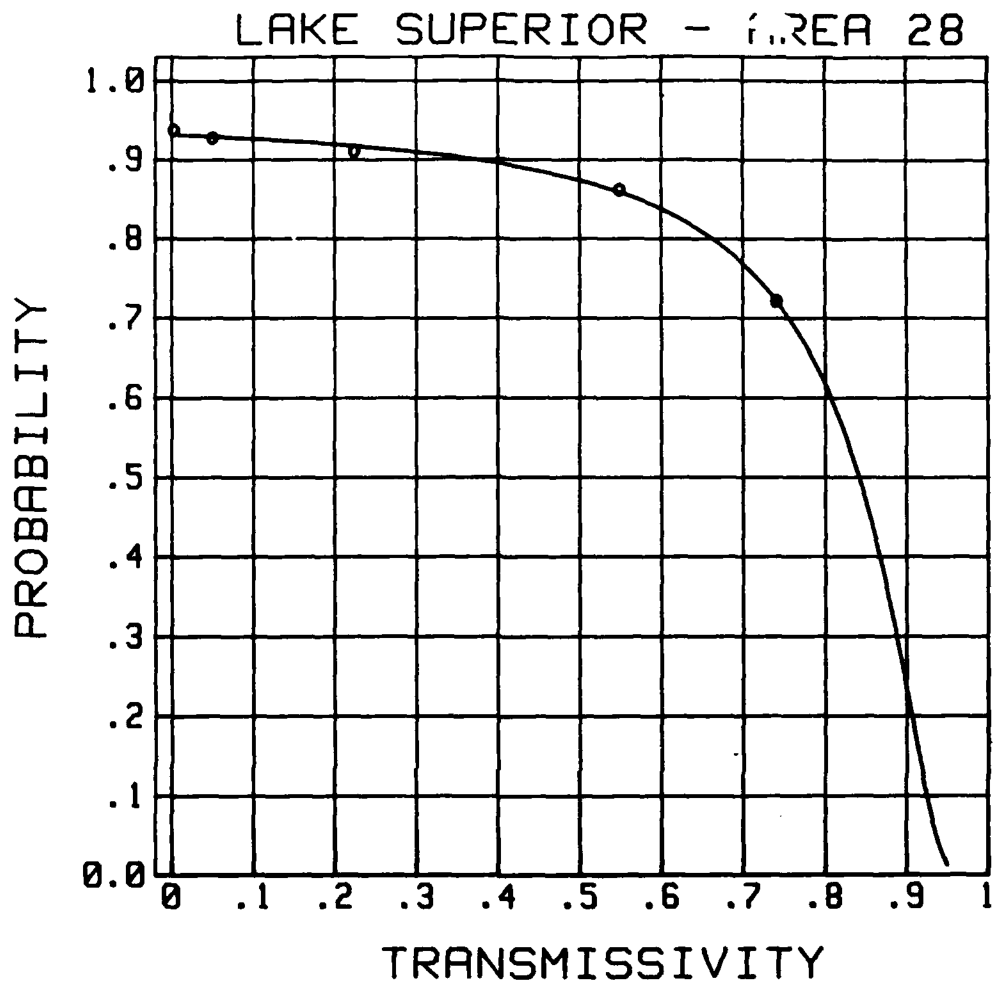

Figure B-28. Transmissivity Curve for LAKE SUPERIOR - AREA 28

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APPENDIX C

CURVE COMPARISONS

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Table C-I

NEW CURVE / OLD CURVE COMPARISON

Areas	Transmissivities	
NEW AREAS	Probabilities	
Old Areas	0.75	0.90
ALASKA - AREA 1	0.6155	0.3484
ALASKA - AREA 2	0.5604	0.1758
ALASKA - AREA 3	0.6771	0.4621
ALASKA - AREA 4	0.6295	0.3801
Southeastern Alaska	0.90	0.72
HAWAII - AREA 5	0.7699	0.7143
Hawaiian Islands	0.88	0.82
WEST COAST - AREA 6	0.6417	0.3768
Coasts of Oregon and Washington	0.84	0.63
WEST COAST - AREA 7	0.5845	0.2288
Straits of Juan de Fuca & Georgia	0.72	0.36
Puget Sound, Washington	0.78	0.54
Admiralty Inlet, Washington	0.69	0.53
WEST COAST - AREA 8	0.6941	0.4971
Coasts of Oregon and Washington	0.84	0.63
Columbia River Entrance	0.88	0.56
WEST COAST - AREA 9	0.6557	0.3997
California Coast	0.55	0.00
San Francisco Bay and Entrance	0.59	0.28
WEST COAST - AREA 10	0.6490	0.4815
Southern California Coast	0.67	0.29
GULF COAST - AREA 11	0.7433	0.6486
Gulf of Mexico	0.88	0.59
GULF COAST - AREA 12	0.7669	0.6845
Gulf of Mexico	0.88	0.59
GULF COAST - AREA 13	0.7272	0.6420
Gulf of Mexico	0.88	0.59
GULF COAST - AREA 14	0.7899	0.7302
West Coast of Florida	0.83	0.72
EAST COAST - AREA 15	0.7683	0.7066
Atl. Coast - S. Car. to Key West	0.86	0.78

Table C-I (cont'd)

Areas	Transmissivities	
NEW AREAS	Probabilities	
Old Areas	0.75	0.90
EAST COAST - AREA 16	0.7256	0.6365
Atl. Coast - Cape Henry to S. Car.	0.84	0.71
EAST COAST - AREA 17	0.6716	0.5368
Atl. Coast - N. J. to Cape Charles	0.67	0.27
EAST COAST - AREA 18	0.6143	0.4647
Chesapeake Bay	0.72	0.57
Chesapeake Bay Entrance	0.70	0.52
EAST COAST - AREA 19	0.6330	0.4598
Delaware Bay and Entrance	0.75	0.49
EAST COAST - AREA 20	0.6284	0.3966
Lower New York Bay	0.72	0.15
EAST COAST - AREA 21	0.5685	0.2176
Long Island & Block Island Sounds	0.62	0.28
EAST COAST - AREA 22	0.6126	0.2229
Massachusetts Bay	0.76	0.17
Nantucket and Vineyard Sounds	0.44	0.08
EAST COAST - AREA 23	0.5177	0.0000
Coast of Maine (ex. Penobscot Bay)	0.61	0.16
Penobscot Bay, Maine	0.50	0.05
LAKE ONTARIO - AREA 24	0.6174	0.3351
Lake Ontario	0.71	0.48
LAKE ERIE - AREA 25	0.6366	0.4158
Lake Erie	0.64	0.31
Detroit Riv., Lk St. Clair & Riv.	0.79	0.68
LAKE HURON - AREA 26	0.6757	0.4167
Lake Huron and Straits of Mackinac	0.64	0.38
LAKE MICHIGAN - AREA 27	0.6924	0.4282
Lake Michigan	0.73	0.34
Green Bay and Entrance, Michigan	0.82	0.51
LAKE SUPERIOR - AREA 28	0.7181	0.3662
Lake Superior	0.86	0.66

Table C-I shows that differences exist between the new and old curves. In 28 of 34 comparisons or 82% of the time, the 0.75 transmissivity point on the new curves has decreased an average of 0.15. In the remaining six cases, the 0.75 point increased an average of 0.08. For the 0.90 transmissivity point, there are 20 of 34 curves or 59%, which have decreased an average of 0.16. The average increase in the other 14 curves is 0.18.

The largest increase in the 0.90 transmissivity point, 0.40, is found on the curve for Area 9, the California coast. The largest increase of the 0.75 transmissivity point, 0.17, is found on the curve for Area 22, the coast of Massachusetts. The largest decreases in transmissivity are both found on the curve for Area 4, Alaska, with a decrease of 0.34 for the 0.90 point and a decrease of 0.27 for the 0.75 point.

The largest discrepancy between the new and old transmissivities is found in the comparison of the 1961 curve for Alaska and the new Area 4 curve. For this area the old curve shows a 0.90 point of 0.72 (9 nmi.) and a 0.75 point of 0.90 (28.4 nmi.). The new curve for Area 4 has a 0.90 point of 0.38 (3.1 nmi.) and a 0.75 point of about 0.63 (6.5 nmi.). While this decrease is quite significant, it seems unreasonable to expect a visibility of 28 nautical miles or greater in Alaska 75% of the time. The new curves seem to be more in line with what would be expected.