APPENDIX B

Behavioral Analysis Support Documentation

Hurricane Evacuation Behavior in the Middle Atlantic and Northeast States

Analysis of Response in Gloria, Intended Responses, and Applicability of Generalizations from other Regions

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Background and Approach: Behavioral Science and Hurricane Evacuation Planning

Evacuation outcomes depend upon many factors, including how the public responds to the event, and in hurricane evacuation planning, one must make assumptions about those factors. If one makes unreasonable assumptions, an actual evacuation is unlikely to proceed as anticipated. The public responses having the greatest impact upon an evacuation are

1. The number of people who evacuate.
2. The number of vehicles used in the evacuation.
3. How promptly evacuees leave.
4. The number of evacuees who leave or attempt to leave the local area and where they go.
5. The number of evacuees who seek refuge in public shelters.

Deriving Correct Assumptions

Regardless of how detailed, formal, or quantitative an evacuation plan appears, it contains assumptions about behaviors such as those discussed above. Even if the assumptions are not deliberately and explicitly addressed, there are implicit or implied values for them. For example, planners who say they make no assumptions at all regarding whether people outside the recommended evacuation zone will evacuate are in fact assuming that none of those people will leave. Any time an evacuation plan is "tested" to ascertain the length of time required to complete an evacuation under the plan, the test includes quantitative assumptions

regarding behavioral factors. The issue is not whether such assumptions should be made, because they must; the issue is what the assumptions should be.

There are at least three basic ways to derive behavioral assumptions:

1. Conduct interviews with people in a large number of locations asking what they did in multiple hurricane threats, documenting patterns of behavior under various conditions (general response model).
2. Conduct interviews asking people what they did in one particular evacuation (single event survey).
3. Conduct interviews asking people what they would do during a hurricane threat (hypothetical survey).

An Integrated Approach

Building a Quantitative General Response Model

A response model can be constructed to indicate quantitative values of specific responses, given a particular set of circumstances which the planner specifies. The extent of shadow evacuation in hurricanes, for example, can be forecast by specifying the severity of the storm, hazardousness of the neighborhood, and actions taken by public officials.

This is the heart of HMG's approach to formulating behavioral assumptions for hurricane evacuation planning. We are fortunate to have amassed actual response data from many hurricane evacuations spanning a wide geographical area and a variety of hurricane threat circumstances over a period of roughly three decades. Figure 1 shows locations where post-hurricane sample surveys have been administered. Multiple markers at a location indicates that more than one survey has been conducted.

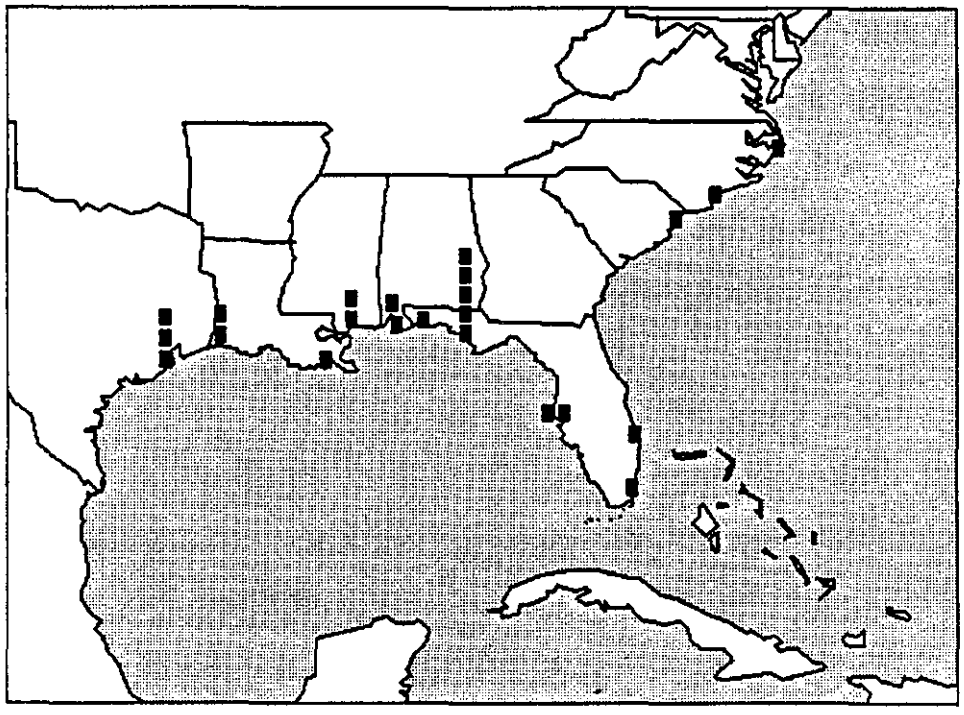

FIG. 1

HMG's general response model has been used successfully in evacuation plans along the Gulf and Atlantic coasts. Thus, for each of the behaviors to be anticipated, the model predicts a quantitative value, depending upon specific situations and circumstances specified. The structure of the general response model, including the variables affecting the principal behaviors, appears in Figure 2.

A common concern expressed about the general response model is that it is based upon responses of people in "other places" and that "our people are different." Actually the strength of the general model is that it accounts for differences in responses as they vary because of demographic characteristics of the population, actions by emergency management personnel, physical hazardousness of the study area, and so forth. Evidence of the model's validity lies in its history of accurately explaining and forecasting actual response behavior observed in a variety of places.

Single Event Actual Response Data

It is tempting to overgeneralize from a single evacuation in a particular location. Even the same people will respond differently in different sets of circumstances. Single event data can be very useful if not overused, however. If an evacuation occurs late at night, for example, and the evacuation is urgent, those circumstances tend to lead to fewer people leaving the local area than other circumstances. Thus, if the single event was a late night, urgent evacuation, it should provide an indication of the "worst case" to expect in that location for certain types of behaviors.

Single events also provide opportunities to validate the use of the general response model for forecasting in a specific location. Actual behavior in a single event can be documented and compared to that which would have been predicted

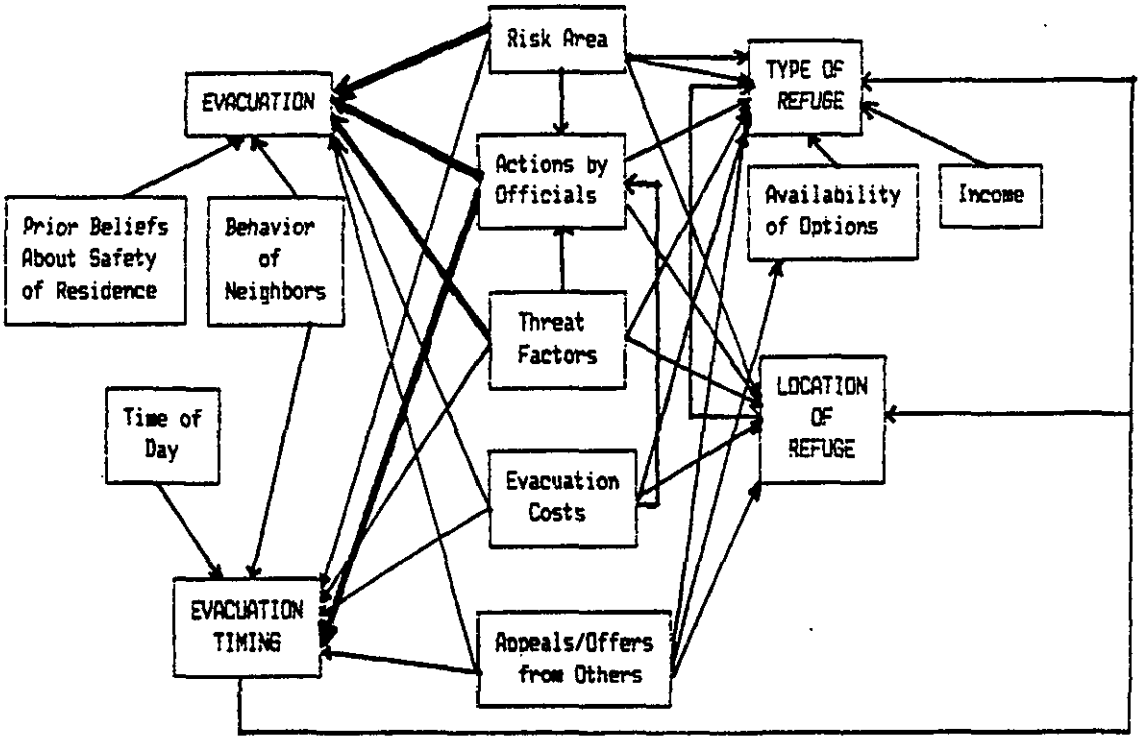
Risk Area
EVACUATION
TYPE OF REFUGE
Actions by Officials
Availability of Options
Income
Prior Beliefs About Safety of Residence
Behavior of Neighbors
Threat Factors
LOCATION OF REFUGE
Time of Day
Evacuation Costs
EVACUATION TIMING
Appeals/Offers from Others

FIG. 2

by the general response model. Its "fit" gives a clue to how much the model would have to be adjusted to work for the specific location and hazard.

Single event data was collected in this study documenting how residents responded during hurricane Gloria in 1985. This marks the first time actual response data has been collected systematically in the study area. The Gloria results will be compared to patterns predicted by the general response model to assess the model's applicability to the region. It is tempting to overgeneralize from any single evacuation, and response to future hurricane threats could vary substantially from the Gloria findings.

Hypothetical Responses

Although hypothetical response data can hardly ever be used literally for quantitative forecasts, HMG has collected much data of this nature, and it does have utility in experienced, knowledgeable hands. There are certain consistent biases in hypothetical response data, for example. People are more likely to say they would evacuate in "low risk" situations than they usually do, more likely to say they would leave early than they usually do, and more likely to say they would use public shelters than they usually do. Hypothetical response data can be adjusted to account for those sorts of known biases. Hypothetical data in one location can be compared with that collected elsewhere for an indication of relative variation between the samples. If more people in one location say they would refuse to leave than in another, they probably really are more likely to refuse. At least more effort will be required to have them move. So, although the magnitude of people saying they wouldn't leave might not be quantitatively valid, it at least gives a relative indication. This can be particularly useful when actual response data is also available in the second location.

Many respondents to the Gloria survey did not evacuate in response to the threat. That information is useful in assessing evacuation rates forecast by the general response model, but provides no information concerning other behaviors such as shelter use by those respondents. Therefore residents not evacuating in Gloria were asked hypothetical questions about what they believe they would do in future hurricane threats or what they would have done if they had evacuated in Gloria. The hypothetical responses will be compared to intended response data collected elsewhere and to actual response by other respondents in Gloria.

Vacationers

Unfortunately, the general response model is well developed only for residents. Actual response data is virtually nonexistent concerning how tourists, including RV operators, respond during hurricane threats.

HMG collected hypothetical response data with many vacationers in both North and South Carolina, but that data has most of the same weaknesses as hypothetical response data from residents. In addressing vacationer response we base most of our conclusions upon interviews conducted with tourism officials, hotel/motel managers, and campground operators following hurricane threats elsewhere.

Purpose of This Report

Methodology and results of the post-Gloria survey will be presented in the following sections of this report. Findings for all 19 survey sites will be included, with consistencies and differences noted among sites. The results will be compared to results normally observed in other hurricane prone areas to assess the

applicability of the general response model to the study area. The survey data will be used in supplementary reports for each state to refine the general response model if necessary for use in deriving planning assumptions for each state.

Survey Methodology

Sampling

Corps of Engineers representatives from Norfolk, Baltimore, Philadelphia, New York, and New England districts worked with HMG and state and local emergency management officials to select survey sites and sample sizes in each state from Virginia through Massachusetts. Criteria for selection varied from state to state, but in most instances the locations were important in and of themselves because of evacuation concerns at those sites or because the places were representative of other areas to which generalizations could be extended. The sample sites are displayed in Figure 3.

Virginia Beach, Virginia

Approximately 100 telephone interviews were completed with households having telephone prefixes 420, 427, and 428. Phone numbers were selected from the local telephone directory.

Norfolk, Virginia

Approximately 100 telephone interviews were completed with households having telephone prefixes 480, 489, 583, 587, and 588. Phone numbers were selected from the local telephone directory.

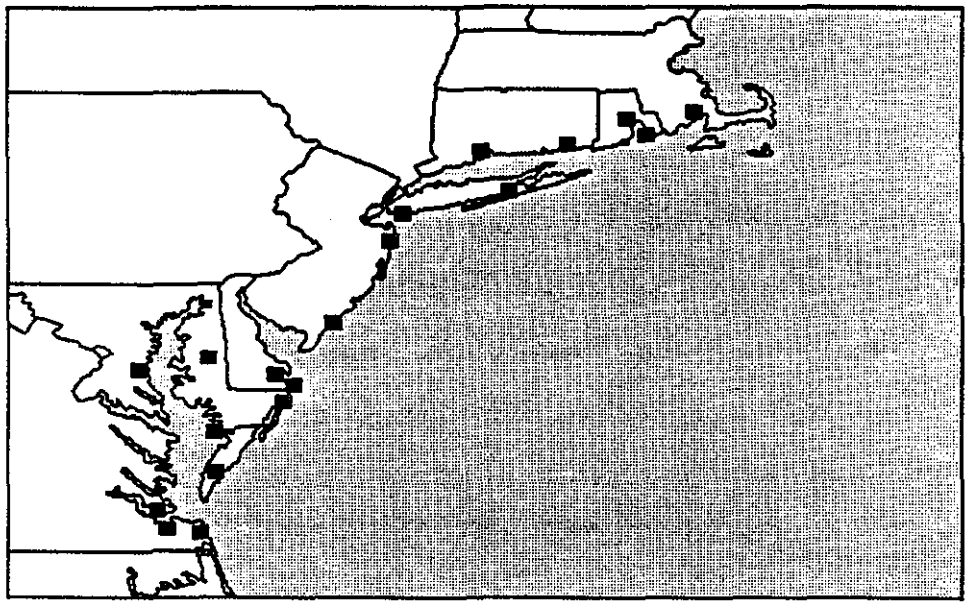

FIG. 3

Newport News, Virginia

Approximately 100 telephone interviews were completed with households having telephone prefixes 245 at addresses south of 39th street and east of Jefferson Avenue. Phone numbers were selected from the local telephone directory.

Virginia Eastern Shore

Approximately 100 telephone interviews were completed with households in a number of Northampton and Accomack County towns suggested by local emergency management officials. Phone numbers were selected from the local telephone directory after cross referencing the addresses with elevation maps of the area. Predominant prefixes were 331, 787, 442, 336, 824, and 891.

Chrisfield, Maryland

Approximately 100 telephone interviews were completed with households having telephone prefix 968 and having a Chrisfield address. Phone numbers were selected from the local telephone directory.

Anne Arundel County, Maryland

Approximately 100 telephone interviews were completed with households having telephone prefixes 741, 798, 867 and having an address in one of several specific towns on or near Chesapeake Bay south of Annapolis (including Deale, Avalon Shores, Rose Haven). Phone numbers were selected from the local telephone directory.

Denton, Maryland

Approximately 100 telephone interviews were completed with households having telephone prefix 479 and having an address in Denton or West Denton. Phone numbers were selected from the local telephone directory.

Ocean City, Maryland

Approximately 100 telephone interviews were completed with households having telephone prefixes 250, 289, 524, 723 and having an address in Ocean City. Phone numbers were selected from the local telephone directory.

Delaware "Beach"

Approximately 100 telephone interviews were completed with households having telephone prefix 539 and having an address in Bethany Beach or South Bethany. Phone numbers were selected from the local telephone directory.

Delaware "Mainland"

Approximately 100 telephone interviews were completed with households having telephone prefix 945, which included Millsboro and nearby towns. Phone numbers were selected from the local telephone directory.

"Southern" New Jersey

Approximately 100 telephone interviews were completed with households in Ocean City having telephone prefixes 390, 391, 398, and 399. Phone numbers were selected from the local telephone directory.

"Northern" New Jersey

Approximately 100 telephone interviews were completed with households in Ocean Grove, Bradley Beach, and Avon having telephone prefixes 774, 775, 776, 918, 922, and 988. Phone numbers were selected from the local telephone directory.

"Rockaway" New York

Approximately 200 telephone interviews were completed with households in the Far Rockaway, Belle Harbor, Edgemere areas of Queens. The area is referred to as Zone 13 in the NYNEX directory and includes several prefixes (318, 327, 337, 471, 474, 634, and 945). Phone numbers were selected from the local telephone directory.

"Suffolk" New York

Approximately 200 telephone interviews were completed with households in Quoge and Westhampton Beach in Suffolk County on Long Island (with prefixes 635 and 288). Phone numbers were selected from the local telephone directory.

"Fairfield" Connecticut

Approximately 100 telephone interviews were completed with households in Fairfield, Bridgeport, Stratford, and Milford. Phone numbers were selected from Hill-Donnelly directories after identifying streets from maps provided by the New England District showing Category 2 surge inundation areas.

"Groton" Connecticut

Approximately 100 telephone interviews were completed with households in Groton, Stonington, and Mystic. Phone numbers were selected from Hill-Donnelly

directories after identifying streets from maps provided by the New England District showing Category 2 surge inundation areas.

Warwick, Rhode Island

Approximately 100 telephone interviews were completed with households in Warwick. Phone numbers were selected from the Polk directory after identifying streets from Flood Insurance maps provided by the New England District.

Newport, Rhode Island

Approximately 100 telephone interviews were completed with households in Newport. Phone numbers were selected from the Cole directory after identifying streets from Flood Insurance maps provided by the New England District.

Wareham, Massachusetts

Approximately 100 telephone interviews were completed with households in Wareham. Phone numbers were selected from the New Bedford and vicinity Cole directory after identifying streets from Flood Insurance maps provided by the New England District.

Sample Size Considerations

There is always some probability of error when generalizing from a sample to the larger population from which it was drawn. If 100 residents of the surge prone area of Warwick, Rhode Island are selected randomly and interviewed, those 100 people are referred to as a sample. All people living within the Warwick surge zone from which the sample was selected constitute the population to which we attempt to generalize from information gained only from the sample.

A sample of 100 provides figures which, 90% of the time, will be within 5 to 8 percentage points of the actual population values. A sample of 200 will be within 3 to 5 percentage points of the true population value 90% of the time. This is true even if the population includes millions of people. For some purposes such small samples are not adequately reliable. In this case, however, the survey data is but one component in a broader, more important methodology and provides sufficient precision for the comparative purposes intended for it. The responses obtained in this survey are compared to response patterns observed under the general response model to assess whether the two are generally consistent. Small differences are not of consequence.

One should be especially cautious when generalizing from subsets of the samples of 100. For example, in many locations only about a third of the respondents evacuated. Therefore, in those sites only about 35 people were asked what sort of shelter they used. Answers based on interviews with 35 people are usually reliable within only 11 percentage points, which is a substantial margin of uncertainty.

One point to keep in mind, therefore, is that sample differences are not necessarily indicative of differences within the population. For example, if 70% of 100 respondents in one site left the local area when evacuating in Gloria, and only 60% of 100 respondents in a second site left the local area, that would probably not be sufficient evidence to conclude that people in the former location were more likely overall to leave the local area than people in the latter location. Figures of 70% and 50%, however, would usually indicate population differences in that example.

At times it is useful to ascertain whether, for example, wealthy evacuees were any less likely to use public shelters than low income evacuees. To answer those sorts of questions reliably, samples must sometimes be fairly large.

Therefore, to analyze those kinds of crosstabulations, the individual site samples will be aggregated in this report. Samples from Virginia through New Jersey are lumped into a single group which will be referred to as the southern sample, and New York through Massachusetts are grouped into a northern sample.

In all the tables presenting survey results, sample sizes are included. The reader is advised to always note the sample size before deciding how much confidence to place in a particular result.

Interview Questions

The questions asked of respondents are included as Appendix I. Questions 8a, 14a, 16a, 17a, and 17b were asked in the northern area only. Question 17 was asked in both areas, but in the northern area the response categories were made more specific.

Sample Characteristics

Age

Four questions were asked which could provide background information useful in explaining variations in response to Gloria and to the hypothetical questions. Figure 4 shows the age distribution of respondents across the 19 sites. From a behavioral perspective the most meaningful age group is probably people over 65. At a few of the sites a third of the sample is over 65. Warwick has the smallest percentage (10%) over 65.

Income

Respondents were asked to indicate which of five categories described their annual family income. Income categories were used to make the information less specific and therefore to increase the willingness to provide the information. Nevertheless roughly 15% of the respondents refused to reveal their income. Moreover, there is no way of knowing whether other respondents were candid and accurate in their responses.

Based upon answers provided, Figure 5 indicates incomes at the 19 sites. Chrisfield, MD and Newport News, VA had the greatest incidence of low income interviewees. More than a third in those locations reported incomes below $10,000.

Housing

The vast majority of respondents lived in single-family detached housing units (Figure 6). The only two exceptions were Rockaway, NY were 39% said they lived in high-rise apartments and on the Delaware mainland where 55% lived in

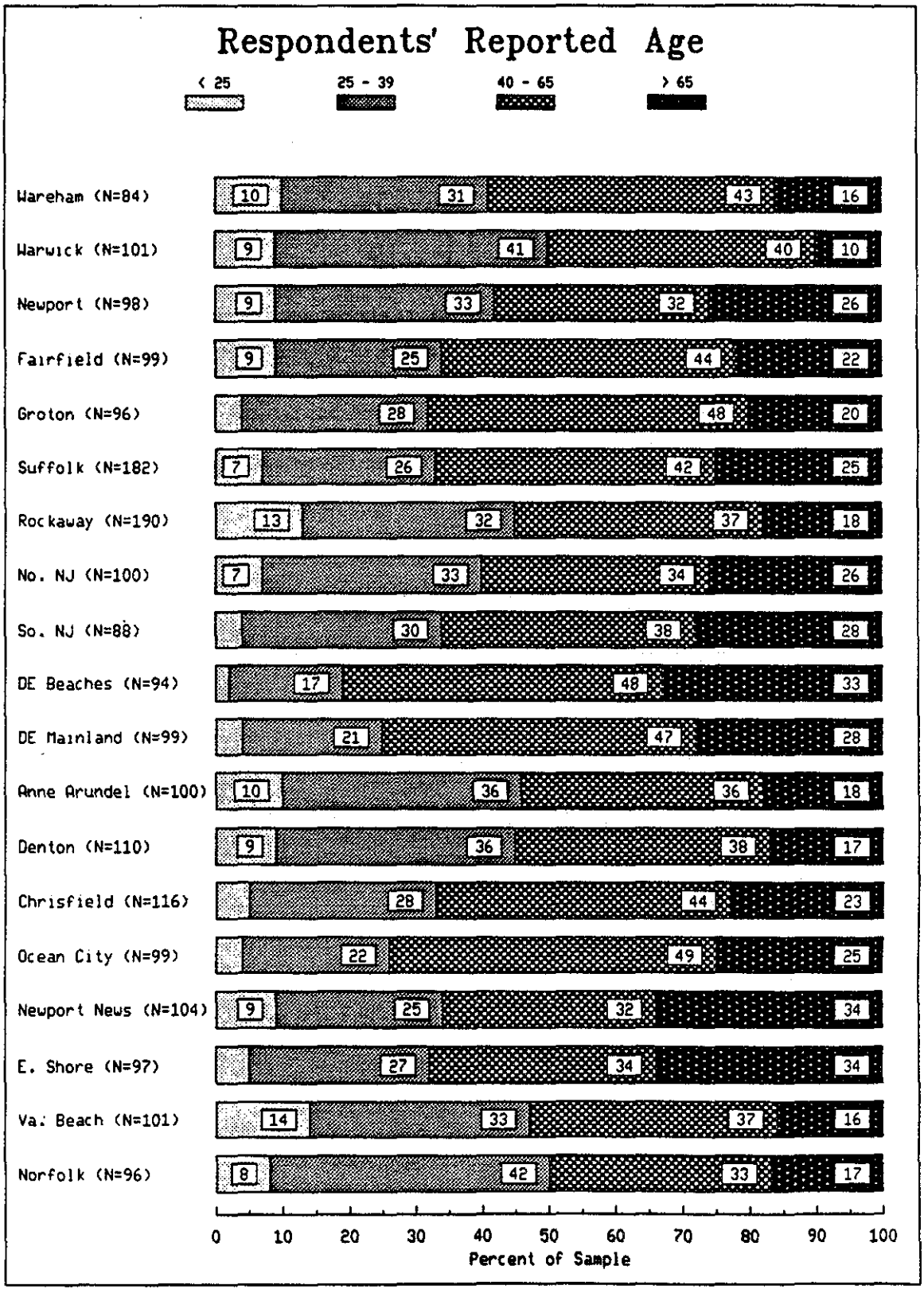
Respondents' Reported Age
< 25
25 - 39
40 - 65
> 65
Wareham (N=84) 10 31 43 16
Warwick (N=101) 9 41 40 10
Newport (N=98) 9 33 32 26
Fairfield (N=99) 9 25 44 22
Groton (N=96) 28 48 20
Suffolk (N=182) 7 26 42 25
Rockaway (N=190) 13 32 37 18
No. NJ (N=100) 7 33 34 26
So. NJ (N=88) 30 38 28
DE Beaches (N=94) 17 48 33
DE Mainland (N=99) 21 47 28
Anne Arundel (N=100) 10 36 36 18
Denton (N=110) 9 36 38 17
Chrisfield (N=116) 28 44 23
Ocean City (N=99) 22 49 25
Newport News (N=104) 9 25 32 34
E. Shore (N=97) 27 34 34
Va. Beach (N=101) 14 33 37 16
Norfolk (N=96) 8 42 33 17
0 10 20 30 40 50 60 70 80 90 100
Percent of Sample

FIG. 4

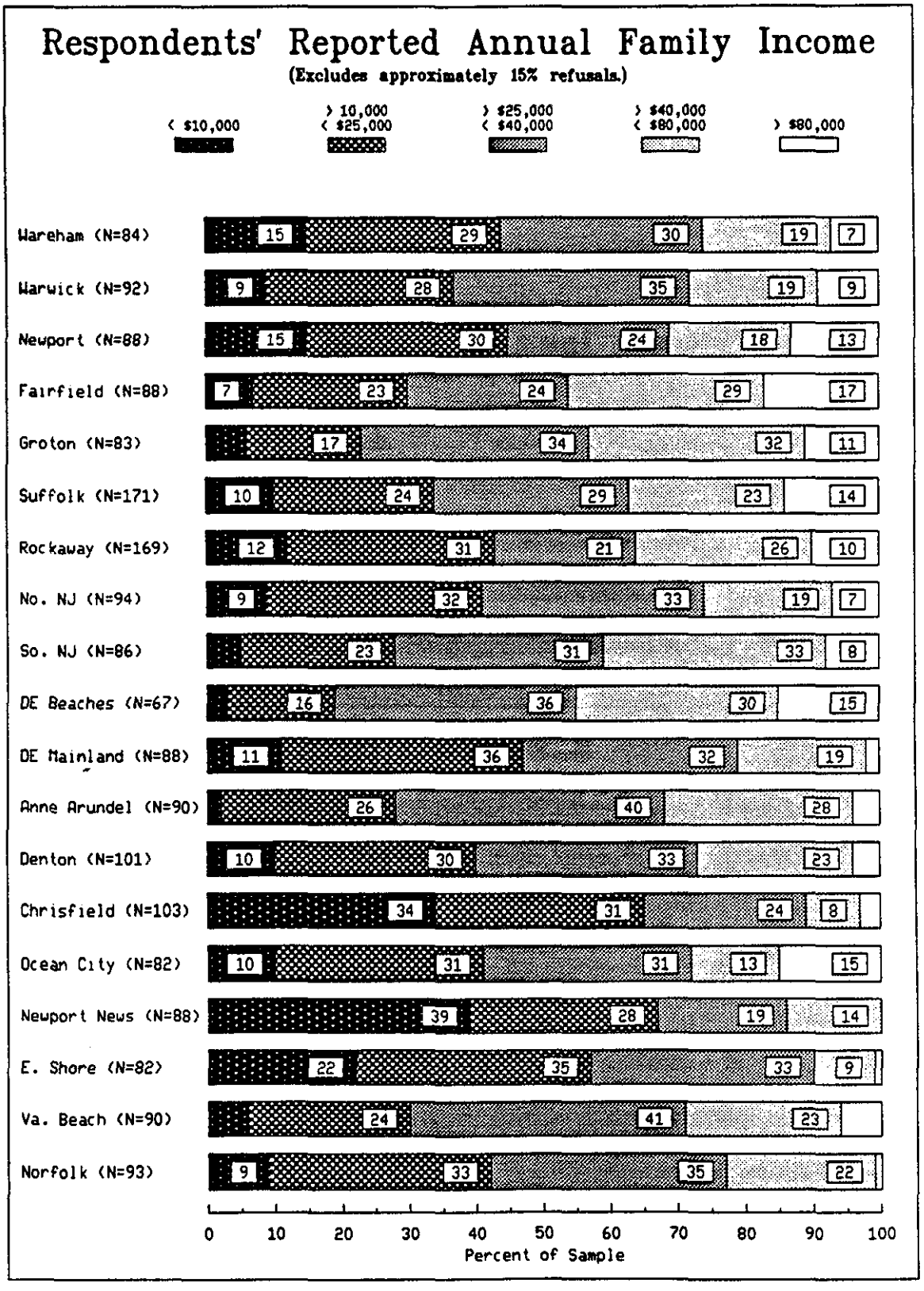
Respondents' Reported Annual Family Income
(Excludes approximately 15% refusals.)
< $10,000
> 10,000 < $25,000
> $25,000 < $40,000
> $40,000 < $80,000
> $80,000
Wareham (N=84) 15 29 30 19 7
Warwick (N=92) 9 28 35 19 9
Newport (N=88) 15 30 24 18 13
Fairfield (N=88) 7 23 24 29 17
Groton (N=83) 17 34 32 11
Suffolk (N=171) 10 24 29 23 14
Rockaway (N=169) 12 31 21 26 10
No. NJ (N=94) 9 32 33 19 7
So. NJ (N=86) 23 31 33 8
DE Beaches (N=67) 16 36 30 15
DE Mainland (N=88) 11 36 32 19
Anne Arundel (N=90) 26 40 28
Denton (N=101) 10 30 33 23
Chrisfield (N=103) 34 31 24 8
Ocean City (N=82) 10 31 31 13 15
Newport News (N=88) 39 28 19 14
E. Shore (N=82) 22 35 33 9
Va. Beach (N=90) 24 41 23
Norfolk (N=93) 9 33 35 22
0 10 20 30 40 50 60 70 80 90 100
Percent of Sample

FIG. 5

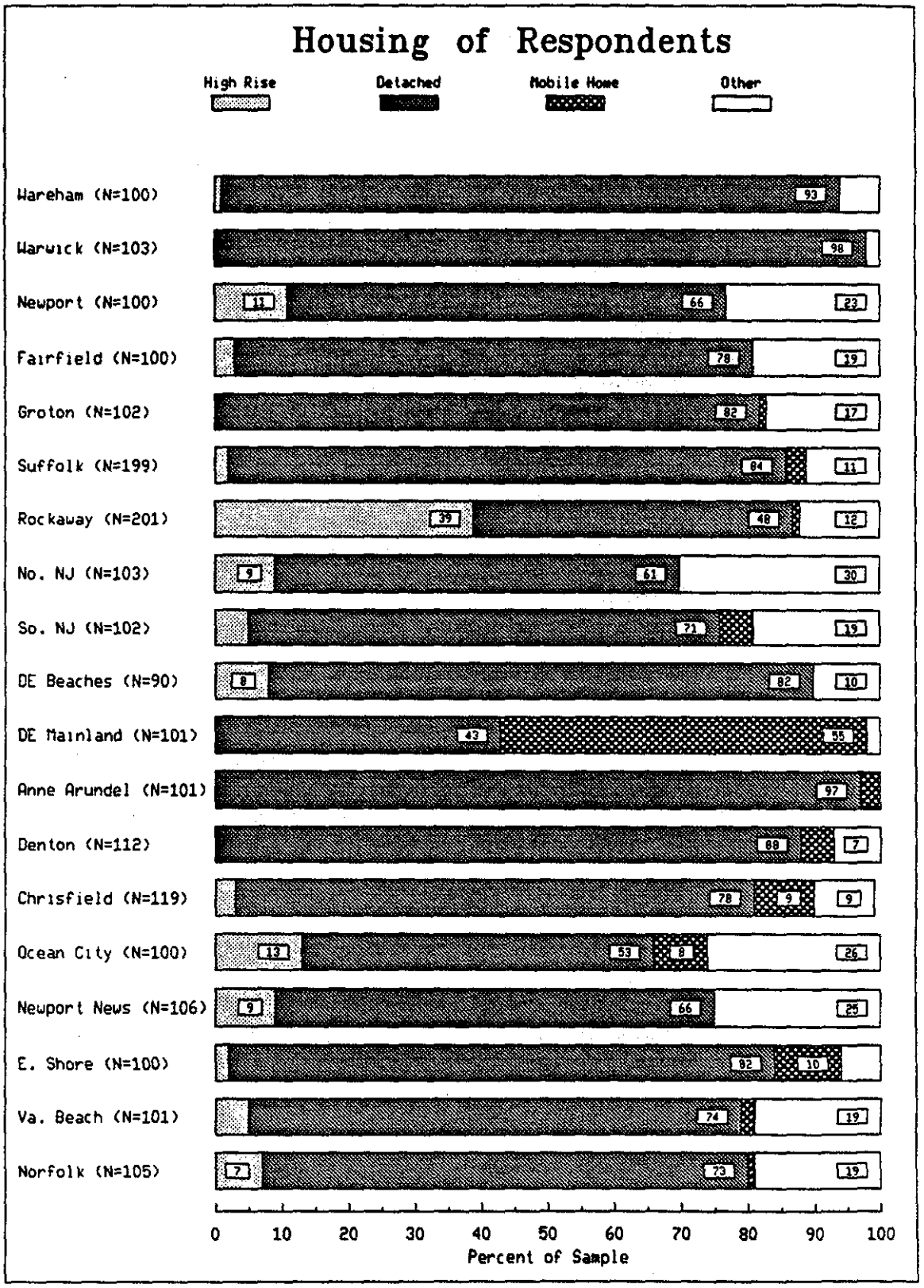
Housing of Respondents
High Rise
Detached
Mobile Home
Other
Wareham (N=100)
93
Warwick (N=103)
98
Newport (N=100)
11
66
23
Fairfield (N=100)
78
19
Groton (N=102)
82
17
Suffolk (N=199)
84
11
Rockaway (N=201)
39
48
12
No. NJ (N=103)
9
61
30
So. NJ (N=102)
71
19
DE Beaches (N=90)
8
82
10
DE Mainland (N=101)
43
55
Anne Arundel (N=101)
97
Denton (N=112)
89
7
Chrisfield (N=119)
78
9
9
Ocean City (N=100)
13
53
8
26
Newport News (N=106)
9
66
25
E. Shore (N=100)
82
10
Va. Beach (N=101)
74
19
Norfolk (N=105)
7
73
19
0
10
20
30
40
50
60
70
80
90
100
Percent of Sample

FIG. 6

mobile homes. "Other" refers primarily to duplexes and medium density apartments or condos.

Proximity to Water

The sample sites themselves vary in terms of flooding propensity and proximity to water, but there is also variation within the sites (Fig. 7). At most interview locations between 25% and 50% of the respondents said they lived within a block of a water body (ocean, harbor, bay, sound). As many as 31% (Groton) said they lived adjacent to such a water body. Many of the sites also had a substantial portion of the respondents living more than a mile from any water.

To some extent measurement of this variable is subject to judgment on the part of people answering the question. Most people underestimate distances, for example, so some of the individuals saying they lived more than a block but less than a mile from water might actually live more than a mile from water. Overall, though, it's reasonable to assume that most people in the "more than a mile" category are in fact farther from water than most in the other categories.

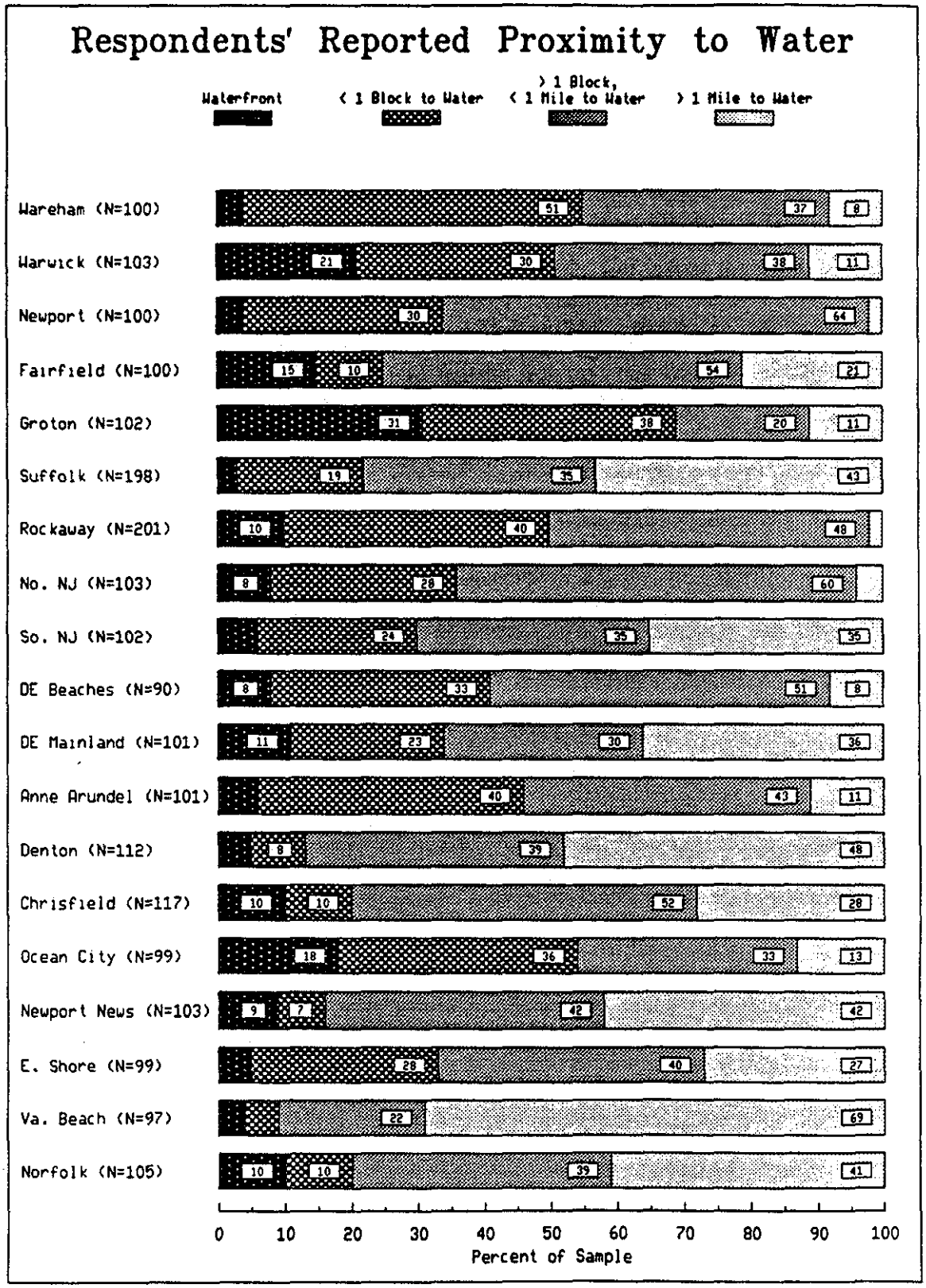
Respondents' Reported Proximity to Water
Waterfront
< 1 Block to Water
> 1 Block, < 1 Mile to Water
> 1 Mile to Water
Wareham (N=100)
51
37
8
Warwick (N=103)
21
30
38
11
Newport (N=100)
30
64
Fairfield (N=100)
15
10
54
21
Groton (N=102)
31
38
20
11
Suffolk (N=198)
19
35
43
Rockaway (N=201)
10
40
48
No. NJ (N=103)
8
28
60
So. NJ (N=102)
24
35
35
DE Beaches (N=90)
8
33
51
8
DE Mainland (N=101)
11
23
30
36
Anne Arundel (N=101)
40
43
11
Denton (N=112)
8
39
48
Chrisfield (N=117)
10
10
52
28
Ocean City (N=99)
18
36
33
13
Newport News (N=103)
9
7
42
42
E. Shore (N=99)
28
40
27
Va. Beach (N=97)
22
69
Norfolk (N=105)
10
10
39
41
0
10
20
30
40
50
60
70
80
90
100
Percent of Sample

FIG. 7

Evacuation

In only 5 of the 19 survey sites did a majority of respondents evacuate: Delaware beaches, Delaware mainland, Ocean City, MD, Southern New Jersey, and Warwick, RI (Figure 8). Denton, MD had by far the lowest evacuation rate (8% and too small to break down in a number of subsequent figures). These figures alone, however, are not useful in evaluating the applicability of the general response model to the region. For that, response variations in the sample must be analyzed.

Reasons Given for Evacuating

Figure 9 depicts the reasons given for leaving. It should be noted that these answers were in response to an open-ended question in which people simply volunteered reasons. Asking specifically whether each factor played a role in their decision to leave would have almost certainly resulted in more people attributing their decision to these factors.

It should also be noted that this is not the most reliable procedure for ascertaining what actually determined evacuation behavior. Most people are poor at articulating the factors which truly cause their behavior.

Reasons fall into two general types of response: information sources and information itself. Most evacuees in all 19 sites indicated that they left because of information from public officials, the National Weather Service, police, media, or friends and relatives. The proportions vary from place to place, but the media was mentioned more than other sources in most locations.

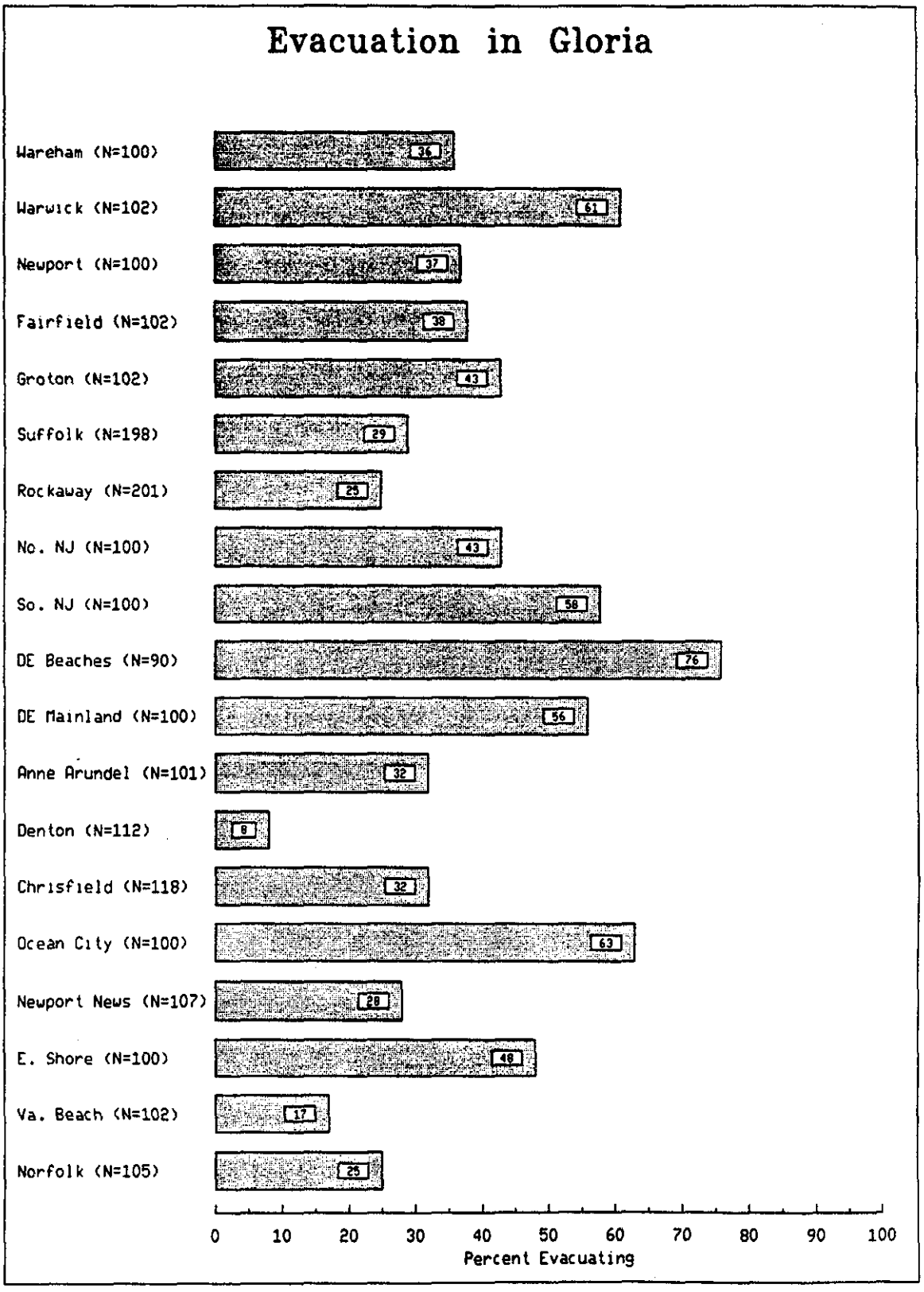
Evacuation in Gloria
Wareham (N=100)
36
Warwick (N=102)
61
Newport (N=100)
37
Fairfield (N=102)
38
Groton (N=102)
43
Suffolk (N=198)
29
Rockaway (N=201)
25
No. NJ (N=100)
43
So. NJ (N=100)
58
DE Beaches (N=90)
76
DE Mainland (N=100)
56
Anne Arundel (N=101)
32
Denton (N=112)
8
Chrisfield (N=118)
32
Ocean City (N=100)
63
Newport News (N=107)
28
E. Shore (N=100)
48
Va. Beach (N=102)
17
Norfolk (N=105)
25
0
10
20
30
40
50
60
70
80
90
100
Percent Evacuating

FIG. 8

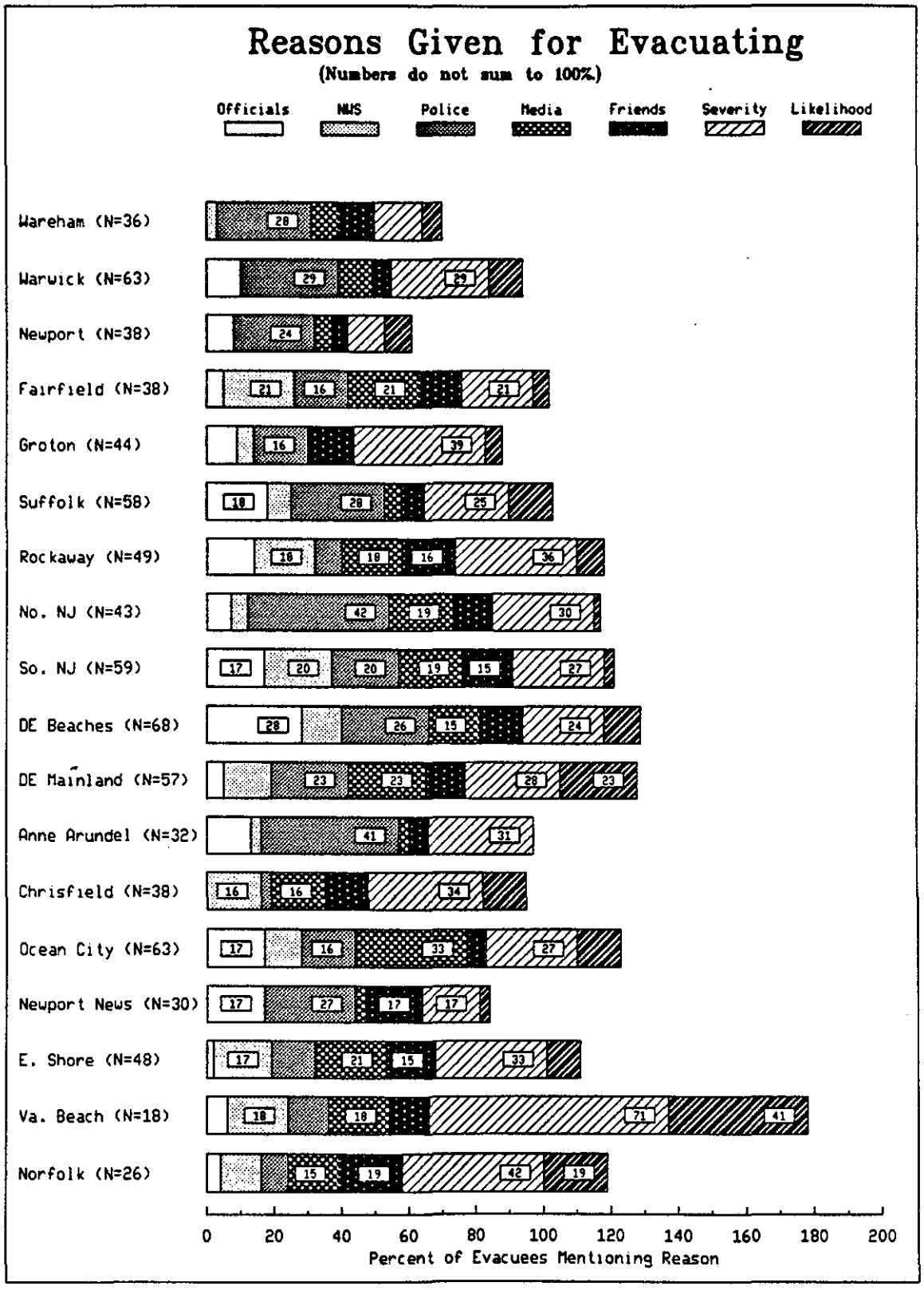
Reasons Given for Evacuating
(Numbers do not sum to 100%)
Officials
NWS
Police
Media
Friends
Severity
Likelihood
Wareham (N=36)
28
Warwick (N=63)
29
29
Newport (N=38)
24
Fairfield (N=38)
21
16
21
21
Groton (N=44)
16
39
Suffolk (N=58)
10
28
25
Rockaway (N=49)
18
18
16
36
No. NJ (N=43)
42
19
30
So. NJ (N=59)
17
20
20
19
15
27
DE Beaches (N=68)
28
26
15
24
DE Mainland (N=57)
23
23
28
23
Anne Arundel (N=32)
41
31
Chrisfield (N=38)
16
16
34
Ocean City (N=63)
17
16
33
27
Newport News (N=30)
17
27
17
17
E. Shore (N=48)
17
21
15
33
Va. Beach (N=18)
18
18
71
41
Norfolk (N=26)
15
19
42
19
0
20
40
60
80
100
120
140
160
180
200
Percent of Evacuees Mentioning Reason

FIG. 9

The two sorts of information mentioned concerned either the severity of hurricane Gloria or the likelihood that the storm would strike the respondent's location. Severity was cited more frequently than likelihood of hitting.

Effect of Evacuation Notices

Figure 10 shows the percentage of interviewees who, when asked explicitly, said they that public officials in their area said they should evacuate. Affirmative responses do not necessarily mean that officials actually said the respondents should leave, but the respondents believed that to have been the case. At 7 sites more than 45% said they heard officials say to leave. The beach area of the Delaware sample was highest at 74%. Denton was by far the lowest at 6%. It is no coincidence that the Delaware beach sample also had the highest evacuation rate and Denton the lowest.

Figure 11 illustrates the point even more clearly. In every survey site, people who said they heard evacuation notices from officials were substantially more likely to evacuate than those who said they didn't hear such notices. Only in Delaware and Ocean City, MD were the differences small, but in those instances a high percentage of both groups left. Overall, as indicated by the two sets of bars at the bottom of the graph, people hearing from officials that they were supposed to evacuate were three times as likely to evacuate as others.

Most people saying they heard an official evacuation notice understood the notice to be a recommendation rather than a mandatory order (Fig. 12). Respondents believing they were being ordered to evacuate were much more likely to leave than those who believed the notice was advisory (Fig. 13). In the northern sample 93% "hearing" an order evacuated, as did 84% in the southern area.

The effect of perceived notices and orders in Gloria was exactly the effect observed elsewhere in other hurricanes. If officials want residents to evacuate, they must tell them. But if they tell them, compliance will be good.

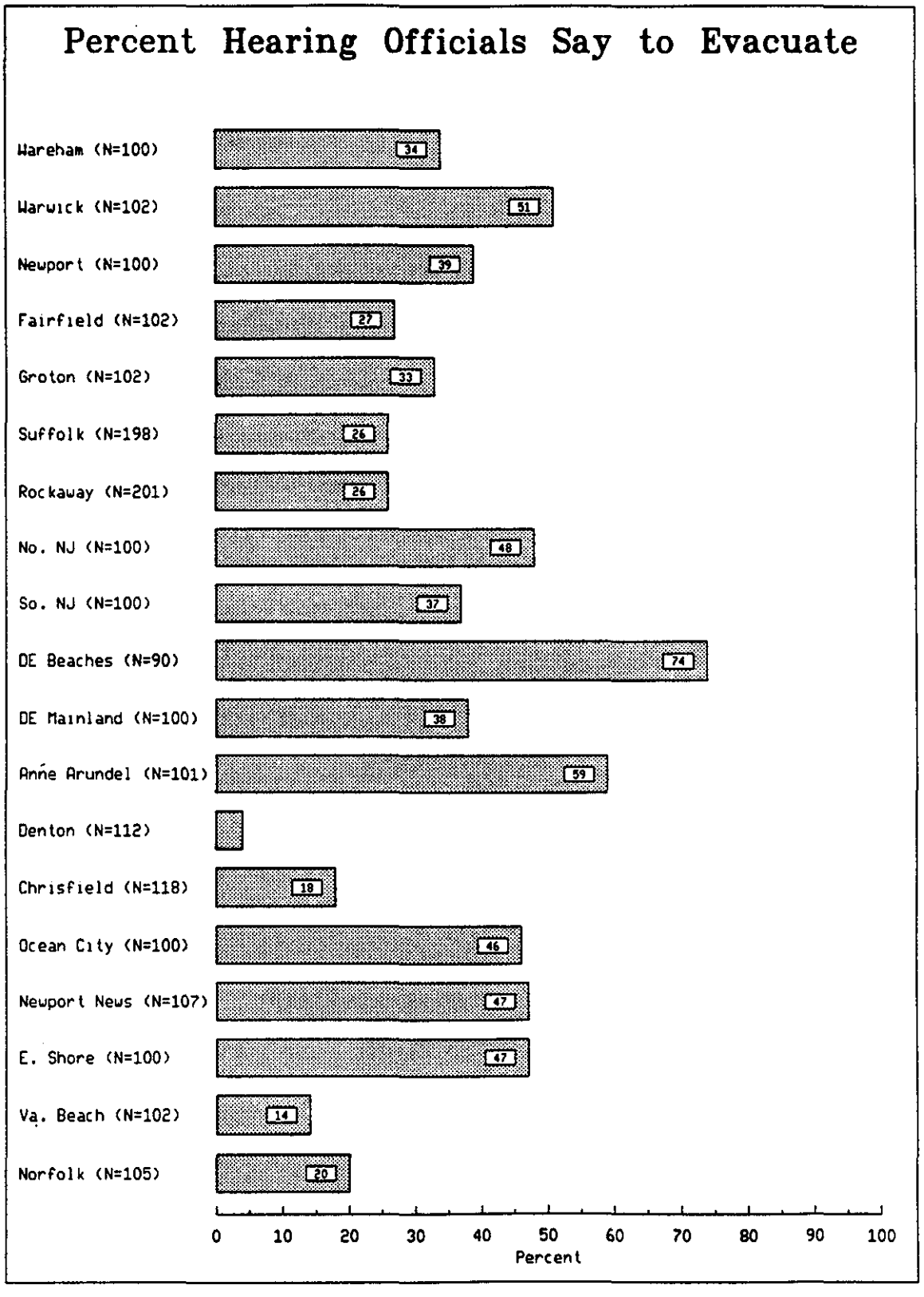
Percent Hearing Officials Say to Evacuate
Wareham (N=100)
34
Warwick (N=102)
51
Newport (N=100)
39
Fairfield (N=102)
27
Groton (N=102)
33
Suffolk (N=198)
26
Rockaway (N=201)
26
No. NJ (N=100)
48
So. NJ (N=100)
37
DE Beaches (N=90)
74
DE Mainland (N=100)
38
Anne Arundel (N=101)
59
Denton (N=112)
Chrisfield (N=118)
18
Ocean City (N=100)
46
Newport News (N=107)
47
E. Shore (N=100)
47
Va. Beach (N=102)
14
Norfolk (N=105)
20
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 10

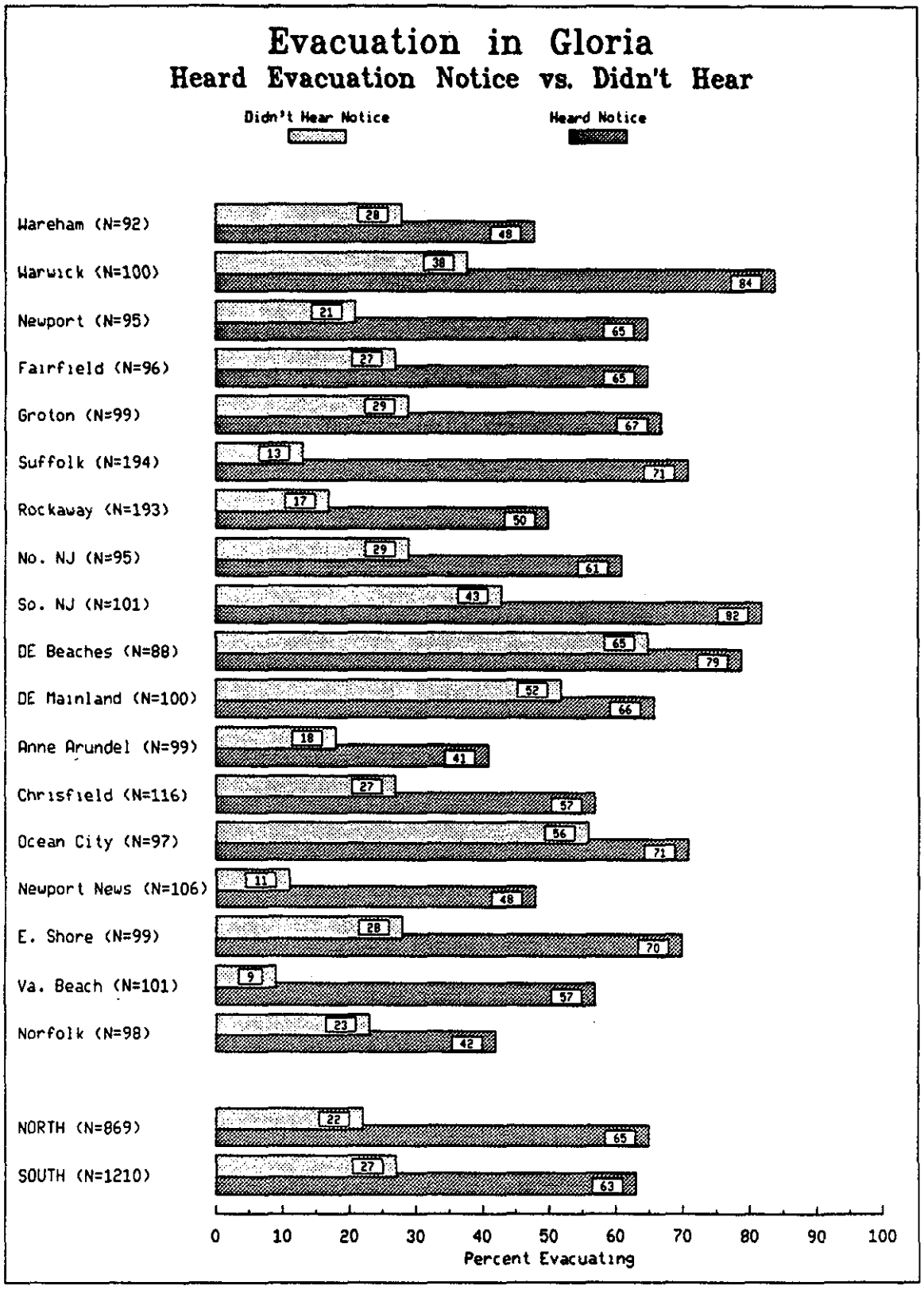
Evacuation in Gloria
Heard Evacuation Notice vs. Didn't Hear
Didn't Hear Notice
Heard Notice
Wareham (N=92)
28
48
Warwick (N=100)
38
84
Newport (N=95)
21
65
Fairfield (N=96)
27
65
Groton (N=99)
29
67
Suffolk (N=194)
13
71
Rockaway (N=193)
17
50
No. NJ (N=95)
29
61
So. NJ (N=101)
43
82
DE Beaches (N=88)
65
79
DE Mainland (N=100)
52
66
Anne Arundel (N=99)
18
41
Chrisfield (N=116)
27
57
Ocean City (N=97)
56
71
Newport News (N=106)
11
48
E. Shore (N=99)
28
70
Va. Beach (N=101)
9
57
Norfolk (N=98)
23
42
NORTH (N=869)
22
65
SOUTH (N=1210)
27
63
0
10
20
30
40
50
60
70
80
90
100
Percent Evacuating

FIG. 11

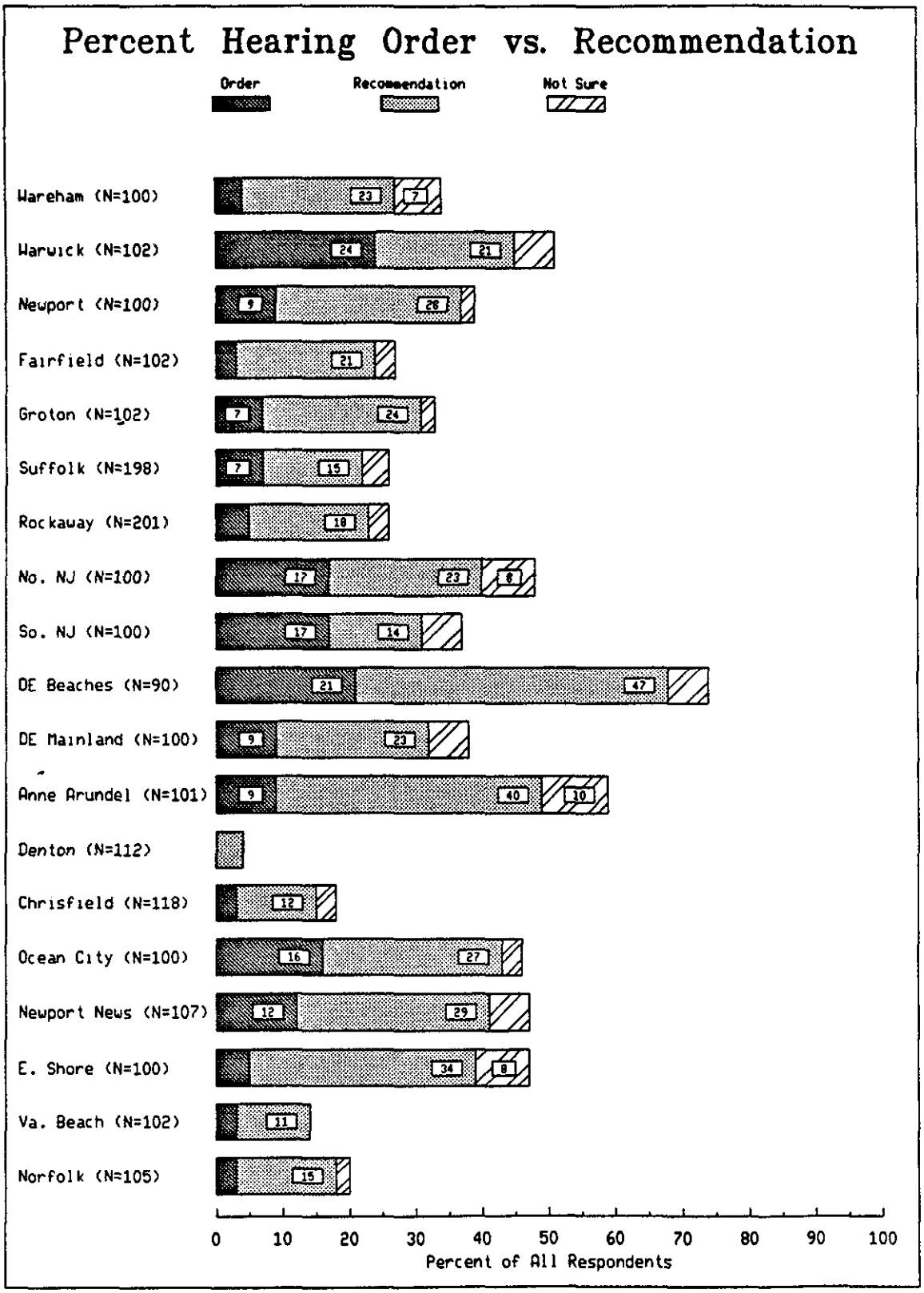
Percent Hearing Order vs. Recommendation
Order
Recommendation
Not Sure
Wareham (N=100)
23
7
Warwick (N=102)
24
21
Newport (N=100)
9
26
Fairfield (N=102)
21
Groton (N=102)
7
24
Suffolk (N=198)
7
15
Rockaway (N=201)
10
No. NJ (N=100)
17
23
6
So. NJ (N=100)
17
14
DE Beaches (N=90)
21
47
DE Mainland (N=100)
9
23
Anne Arundel (N=101)
9
40
10
Denton (N=112)
Chrisfield (N=118)
12
Ocean City (N=100)
16
27
Newport News (N=107)
12
29
E. Shore (N=100)
34
8
Va. Beach (N=102)
11
Norfolk (N=105)
15
0
10
20
30
40
50
60
70
80
90
100
Percent of All Respondents

FIG. 12

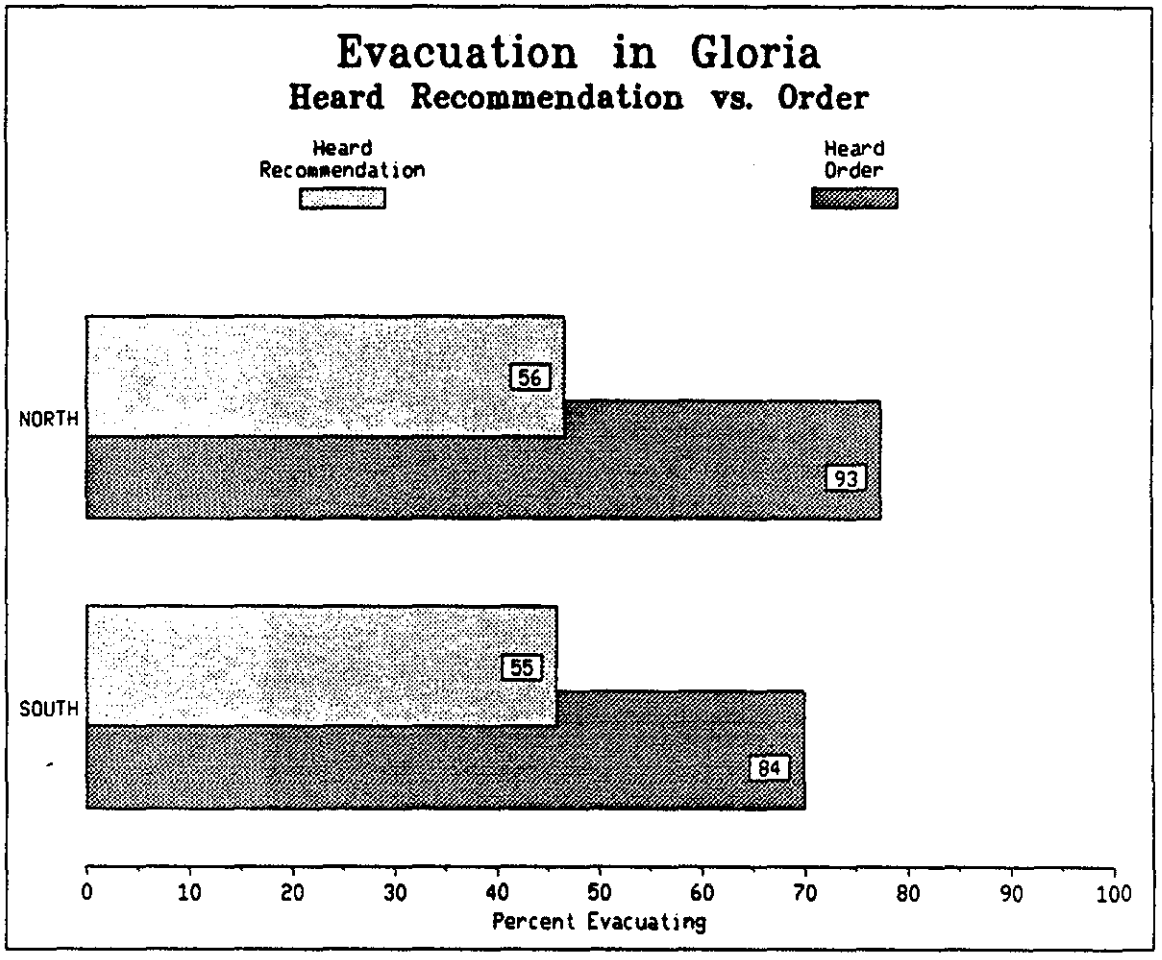
Evacuation in Gloria
Heard Recommendation vs. Order
Heard Recommendation
Heard Order
NORTH
56
93
SOUTH
55
84
0
10
20
30
40
50
60
70
80
90
100
Percent Evacuating

FIG. 13

It is also important that roughly 25% of the people not hearing official evacuation notices also left. The "shadow" evacuation phenomenon, whereby more people leave than actually need to, is common.

Effect of Perceived Safety

Proximity to water is not a perfect surrogate for hazardousness of a dwelling because elevation might rise quickly only a short distance from the shore or flooding might extend miles inland. In general, though, people who lived closer to the water were more likely to evacuate than other people (Fig. 14). The only confusion in the trend was in the southern sample where people living within a block of water appeared slightly more likely to evacuate than waterfront residents.

This pattern is common in hurricane evacuations and predicted by the general response model. Officials are more likely to tell people in more hazardous locations to evacuate, but residents of those areas are also more aware of the risk they take in staying.

Interviewees in the northern sample were asked whether they felt their house would be safe in a hurricane. A majority in all sites except Warwick felt their home would be safe, but in all locations a substantial minority considered their dwellings unsafe (Fig. 15). People believing their house was unsafe were more than twice as likely to evacuate as others (Fig. 16). The fact that only about half those saying their home would be unsafe evacuated in Gloria attests to the fact that more than belief that one's dwelling is dangerous is necessary to compel people to evacuate. Figure 17 depicts the association between belief one's house is safe (unsafe) and proximity to water.

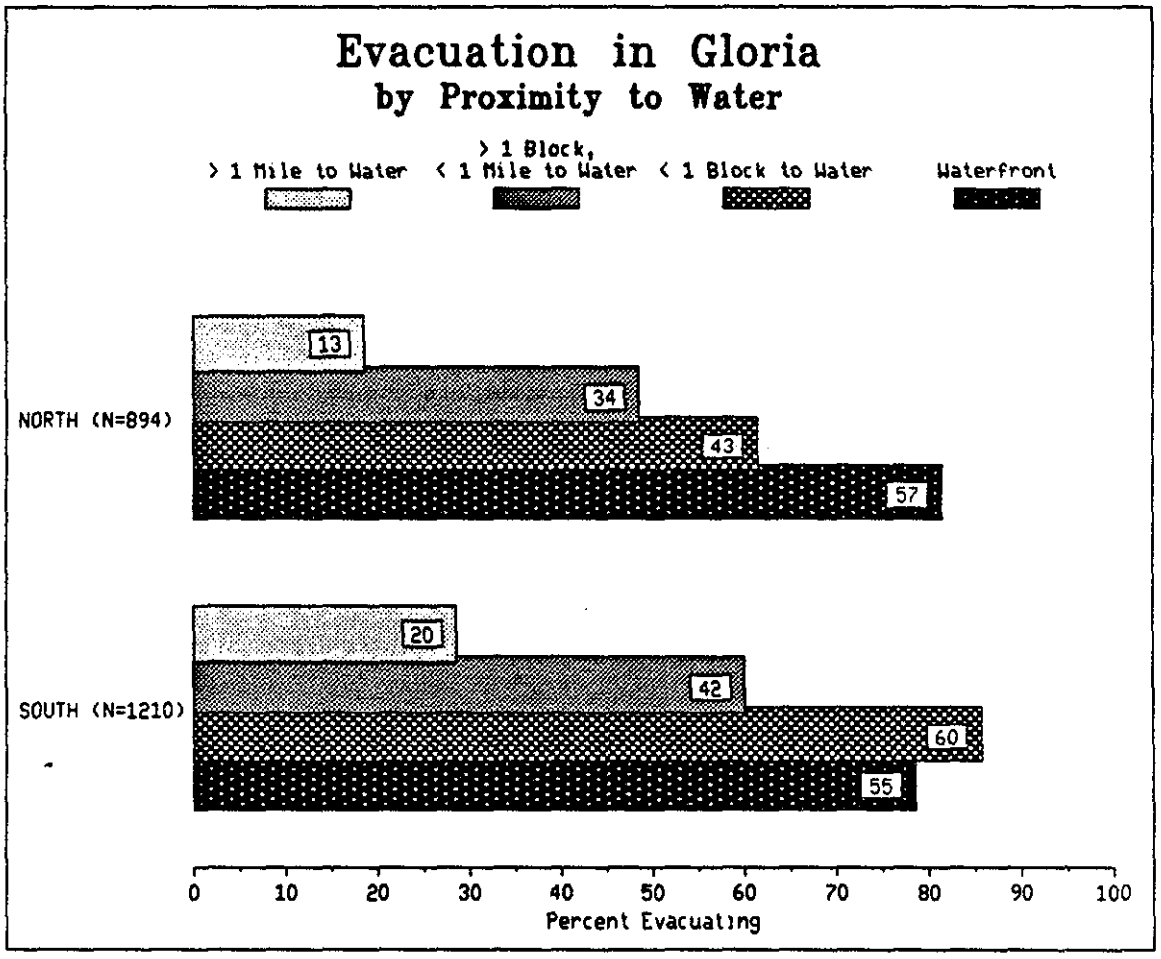
Evacuation in Gloria
by Proximity to Water
> 1 Mile to Water
> 1 Block, < 1 Mile to Water
< 1 Block to Water
Waterfront
NORTH (N=894)
13
34
43
57
SOUTH (N=1210)
20
42
60
55
0
10
20
30
40
50
60
70
80
90
100
Percent Evacuating

FIG. 14

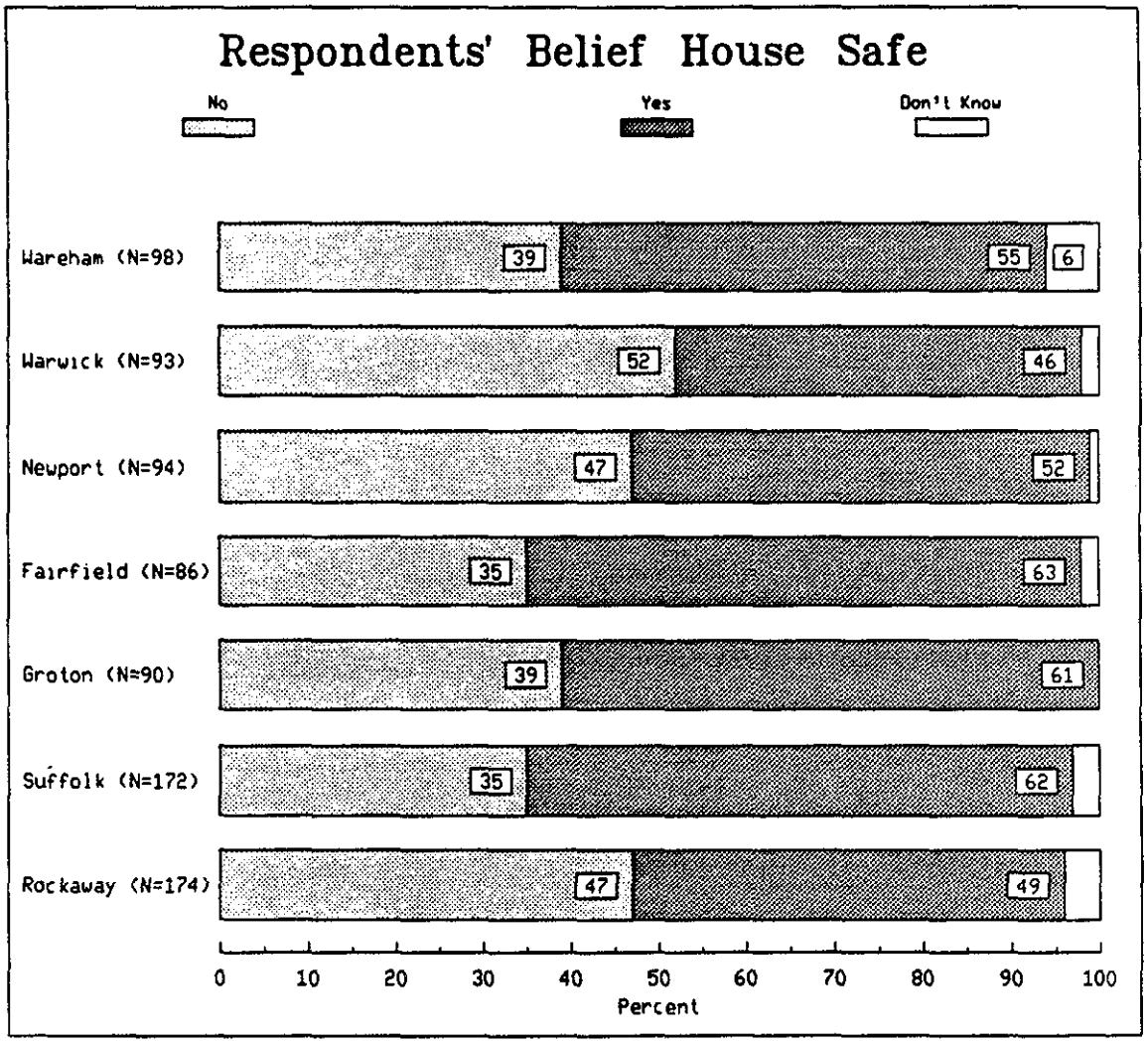
Respondents' Belief House Safe
No
Yes
Don't Know
Wareham (N=98)
39
55
6
Warwick (N=93)
52
46
Newport (N=94)
47
52
Fairfield (N=86)
35
63
Groton (N=90)
39
61
Suffolk (N=172)
35
62
Rockaway (N=174)
47
49
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 15

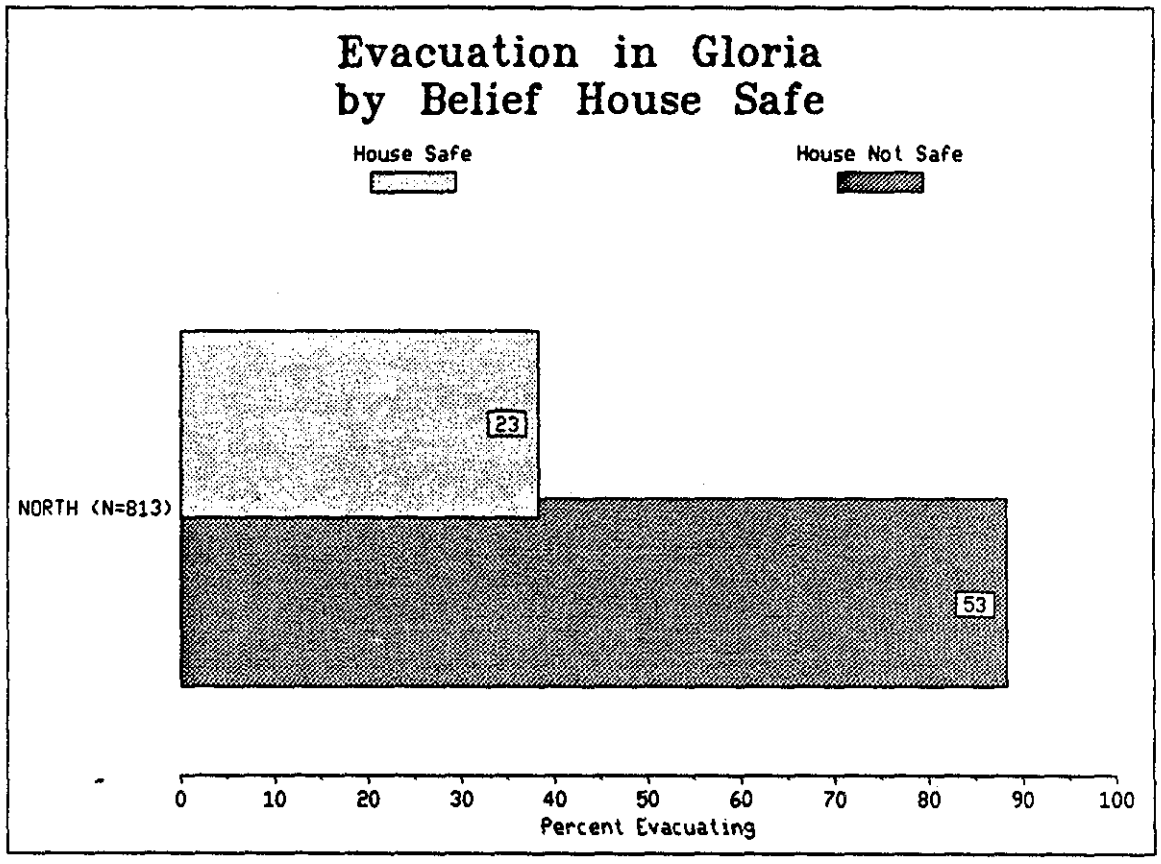
Evacuation in Gloria
by Belief House Safe
House Safe
House Not Safe
23
53
NORTH (N=813)
0
10
20
30
40
50
60
70
80
90
100
Percent Evacuating

FIG. 16

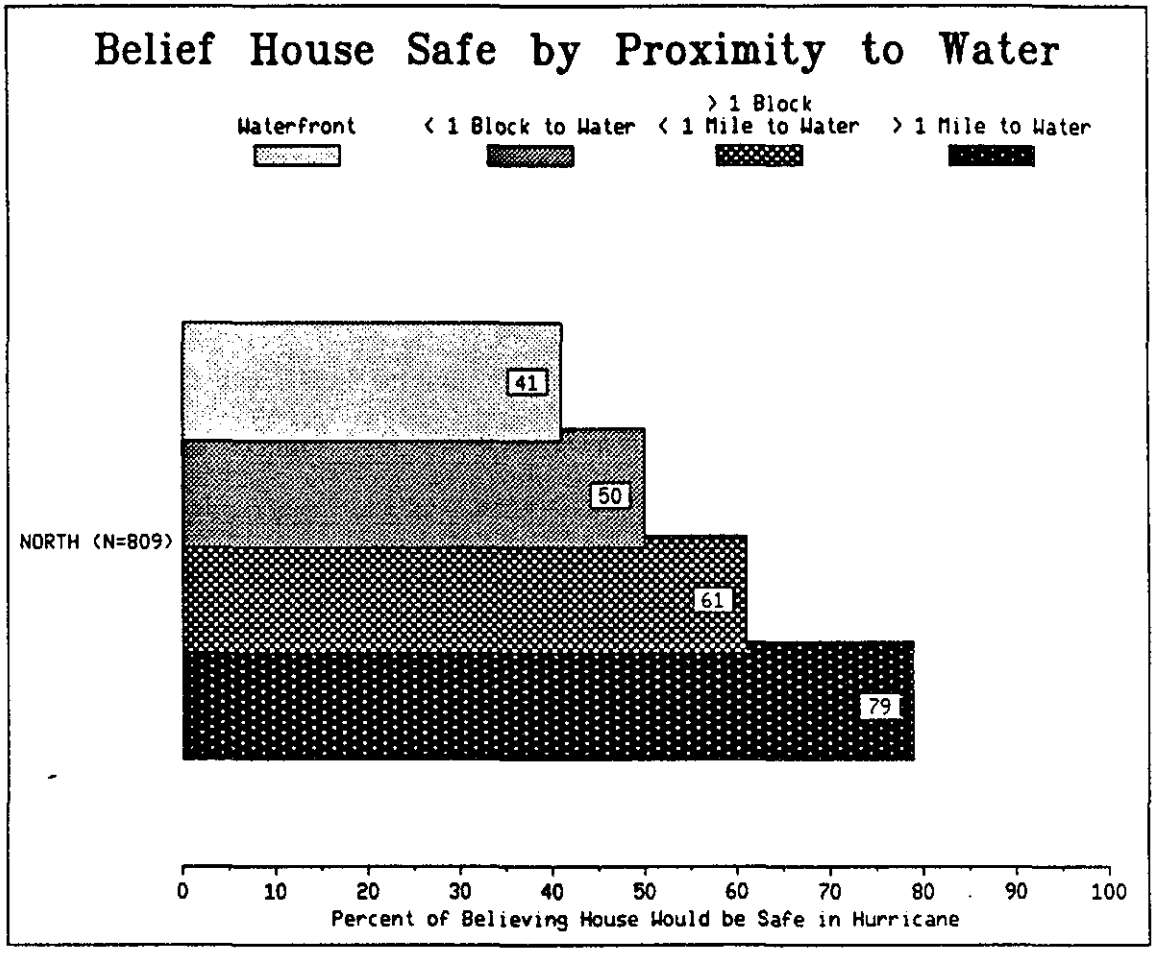
Belief House Safe by Proximity to Water
Waterfront
< 1 Block to Water
> 1 Block < 1 Mile to Water
> 1 Mile to Water
NORTH (N=809)
41
50
61
79
0
10
20
30
40
50
60
70
80
90
100
Percent of Believing House Would be Safe in Hurricane

FIG. 17

Reasons Given for Not Evacuating

The most common reason given for not evacuating in Gloria was that respondents felt safe staying where they were -- either they didn't believe the storm was severe enough to threaten their dwelling or the storm wouldn't strike their area (Fig. 18). A variety of other reasons were also volunteered.

Reasons attributing the decision to not evacuate to specific types or sources of information are graphed in Figure 19. As many as 19% (in Denton) said they stayed because officials didn't tell them to leave. Many respondents said they stayed for reasons having nothing to do with safety or information (Fig. 20). In only three survey locations (Rockaway, Denton, and Ocean City, MD) did anyone say they failed to evacuate because they had no transportation. A number in most places, however, said they stayed because they had no place to go.

There are no clear differences in reasons given across the region as a whole to distinguish the area from other locations in other hurricane threats.

Other Predictors and Non-predictors

Housing varied too little to test for response differences in all but two locations. Thirty-nine percent of the Rockaway sample contained high-rise residents, and only 8% of them evacuated, compared to 40% of single-family homes. In the Delaware mainland sample 45% of the dwellings were mobile homes, 75% of which were evacuated, whereas only 35% of other housing was evacuated. The mobile home finding is common, but there has been little comparative evidence elsewhere concerning high-rise dwellings.

Neither income nor age were associated with whether people evacuated. Income is seldom found to predict evacuation in other parts of the nation. Age is usually a factor only in areas where there are a large number of retirees such as south Florida.

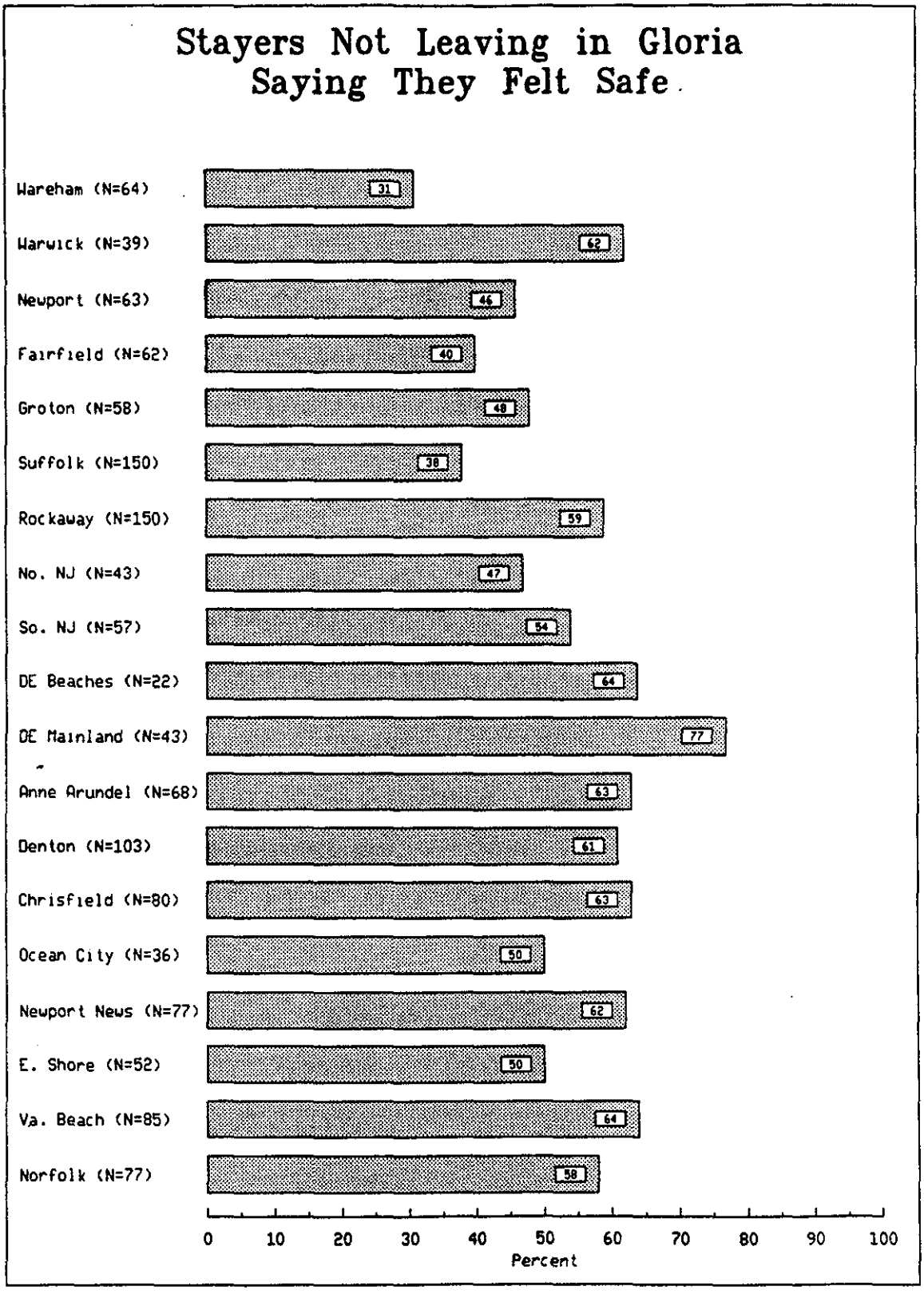
Stayers Not Leaving in Gloria
Saying They Felt Safe
Wareham (N=64)
31
Warwick (N=39)
62
Newport (N=63)
46
Fairfield (N=62)
40
Groton (N=58)
48
Suffolk (N=150)
38
Rockaway (N=150)
59
No. NJ (N=43)
47
So. NJ (N=57)
54
DE Beaches (N=22)
64
DE Mainland (N=43)
77
Anne Arundel (N=68)
63
Denton (N=103)
61
Chrisfield (N=80)
63
Ocean City (N=36)
50
Newport News (N=77)
62
E. Shore (N=52)
50
Va. Beach (N=85)
64
Norfolk (N=77)
58
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 18

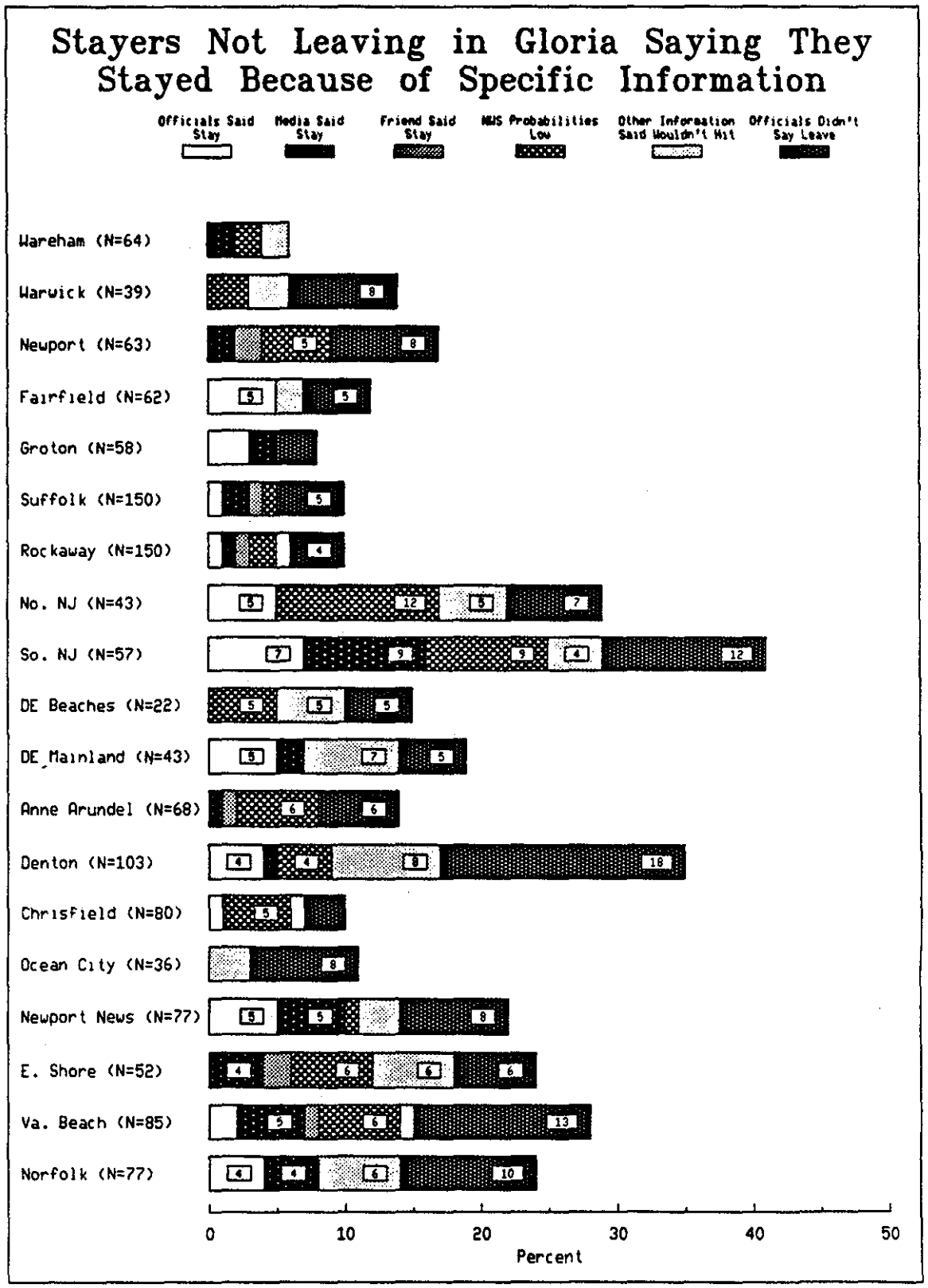
Stayers Not Leaving in Gloria Saying They Stayed Because of Specific Information
Officials Said Stay
Media Said Stay
Friend Said Stay
NHS Probabilities Low
Other Information Said Wouldn't Hit
Officials Didn't Say Leave
Wareham (N=64)
Warwick (N=39)
Newport (N=63)
Fairfield (N=62)
Groton (N=58)
Suffolk (N=150)
Rockaway (N=150)
No. NJ (N=43)
So. NJ (N=57)
DE Beaches (N=22)
DE Mainland (N=43)
Anne Arundel (N=68)
Denton (N=103)
Chrisfield (N=80)
Ocean City (N=36)
Newport News (N=77)
E. Shore (N=52)
Va. Beach (N=85)
Norfolk (N=77)
0
10
20
30
40
50
Percent

FIG. 19

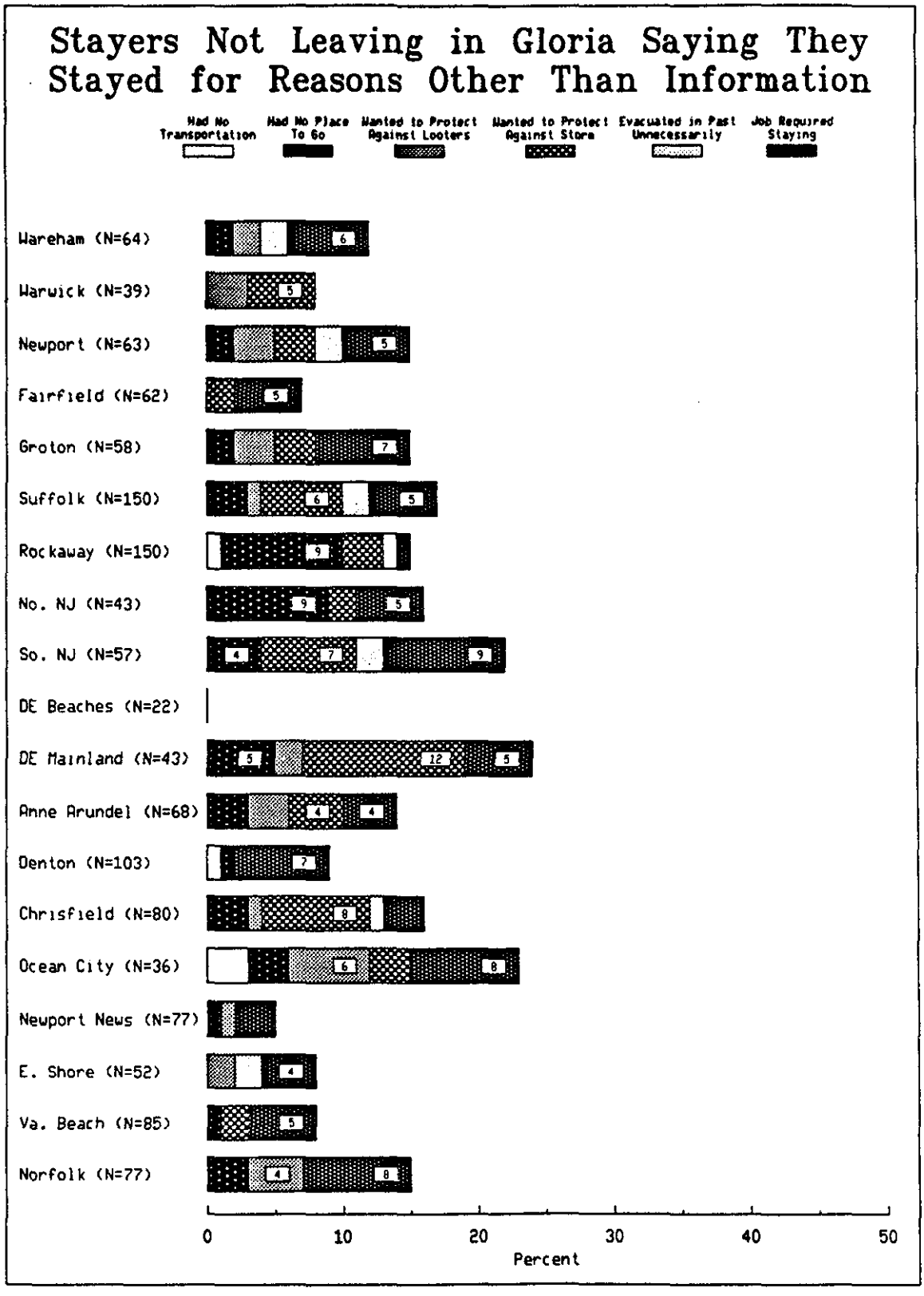
Stayers Not Leaving in Gloria Saying They Stayed for Reasons Other Than Information
Had No Transportation
Had No Place To Go
Wanted to Protect Against Looters
Wanted to Protect Against Store
Evacuated in Past Unnecessarily
Job Required Staying
Wareham (N=64)
Warwick (N=39)
Newport (N=63)
Fairfield (N=62)
Groton (N=58)
Suffolk (N=150)
Rockaway (N=150)
No. NJ (N=43)
So. NJ (N=57)
DE Beaches (N=22)
DE Mainland (N=43)
Anne Arundel (N=68)
Denton (N=103)
Chrisfield (N=80)
Ocean City (N=36)
Newport News (N=77)
E. Shore (N=52)
Va. Beach (N=85)
Norfolk (N=77)
0
10
20
30
40
50
Percent

FIG. 20

In the northern area income was not correlated at all with proximity to water, and in the southern area, the association wasn't strong (Figure 21). In neither area was age related to water proximity. Elderly residents were slightly more likely to say their house would be safe in a hurricane than other respondents (Fig. 22).

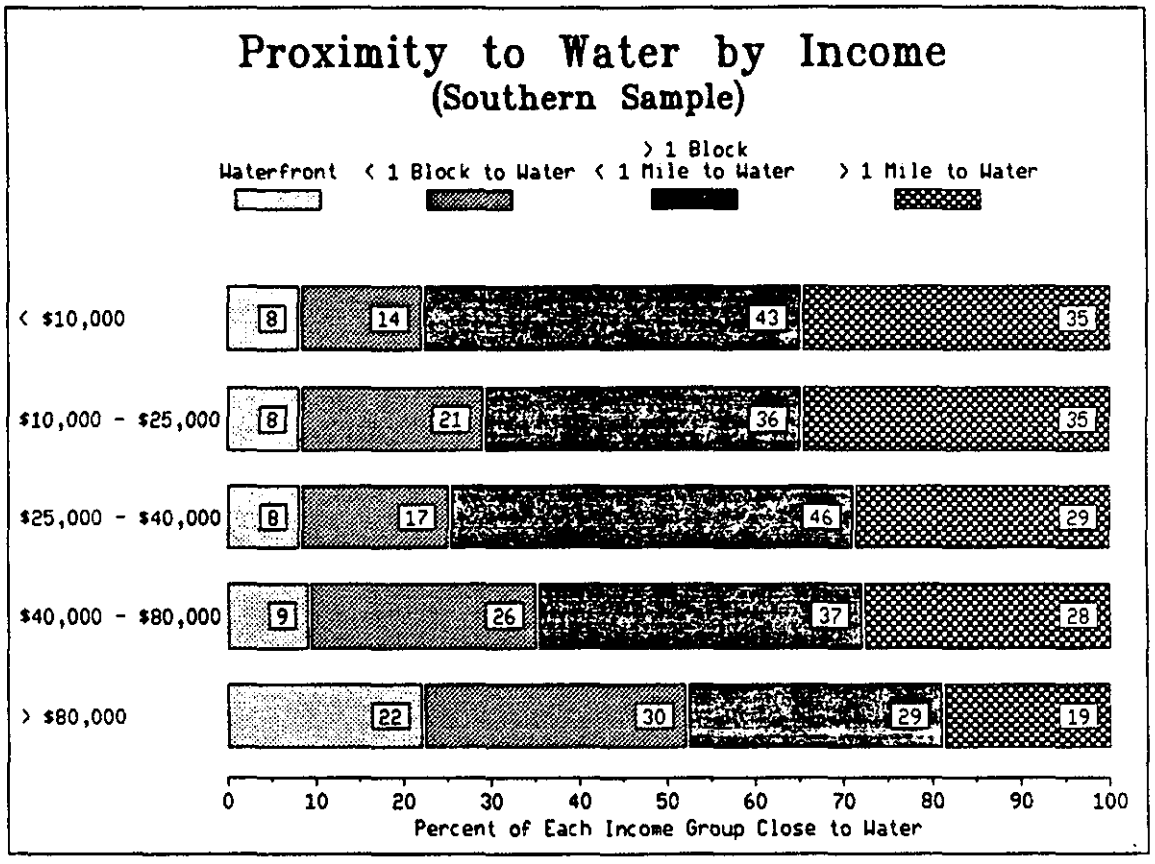
Proximity to Water by Income
(Southern Sample)
Waterfront
< 1 Block to Water
> 1 Block
< 1 Mile to Water
> 1 Mile to Water
< $10,000
8
14
43
35
$10,000 - $25,000
8
21
36
35
$25,000 - $40,000
8
17
46
29
$40,000 - $80,000
9
26
37
28
> $80,000
22
30
29
19
0
10
20
30
40
50
60
70
80
90
100
Percent of Each Income Group Close to Water

FIG. 21

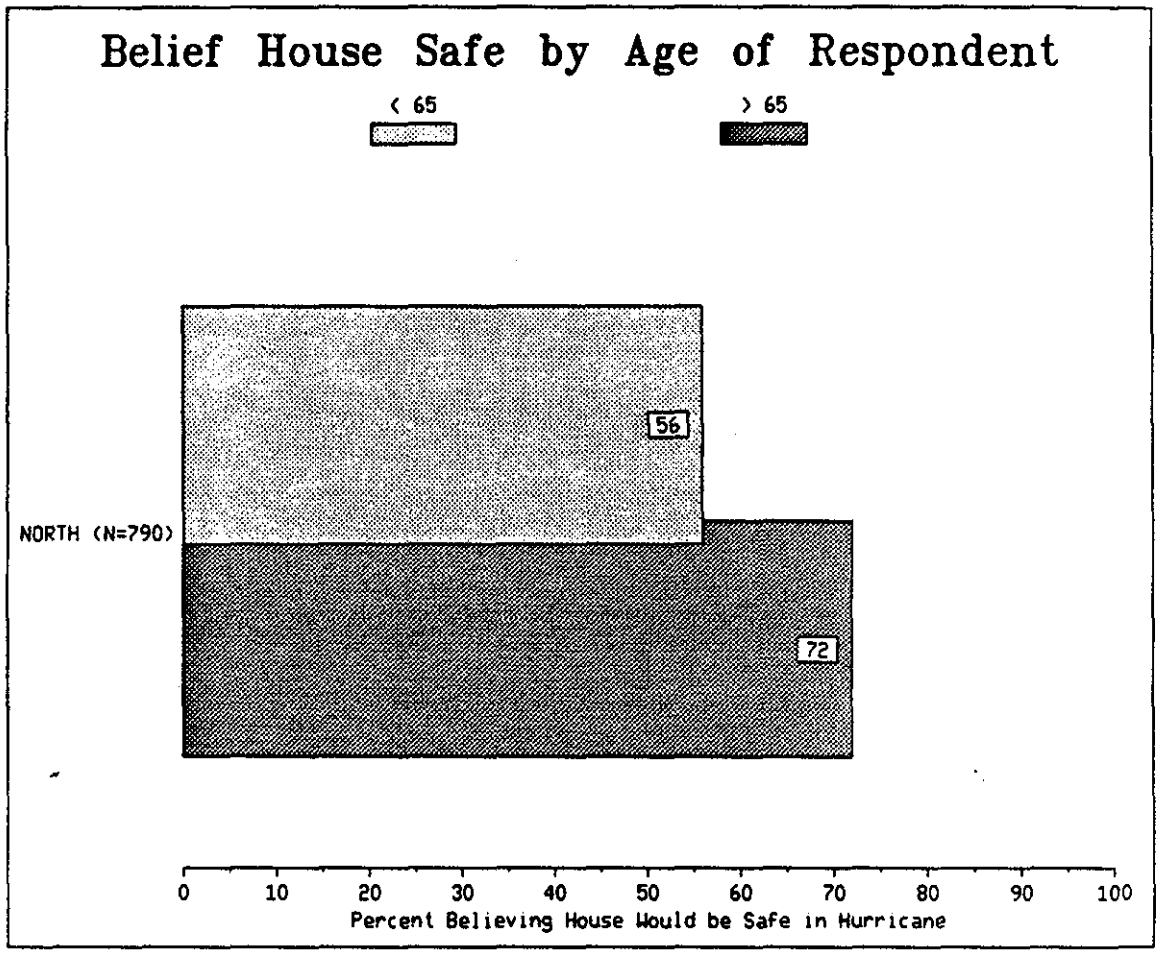
Belief House Safe by Age of Respondent
< 65
> 65
NORTH (N=790)
56
72
0
10
20
30
40
50
60
70
80
90
100
Percent Believing House Would be Safe in Hurricane

FIG. 22

Evacuation Timing

Evacuation timing is concerned with how many of the eventual evacuees leave at various times after (or before) being told to evacuate or relative to the arrival of a hurricane. Figure 23 shows the date on which Gloria evacuees said they evacuated. Clearly and understandably, people left earlier in the southern area than in the northern. This was undoubtedly a consequence of the fact that the storm threatened southern sites earlier and officials told people earlier to leave.

Evacuees were also asked what time of day they left. Plotting that data yields a cumulative evacuation curve like the ones in Figure 24 for the two Delaware survey locations. In this particular case, such curves could be misleading, however. Respondents are being asked to recall the time of day they did something two years earlier, and recall might not be good enough to place great confidence in such specific information. Even if people could remember accurately, the sample sizes make the exact shape of the plotted curves suspect.

These considerations present no difficulty in deriving planning assumptions for the region, however. Other evidence has already shown that most people didn't evacuate in Gloria without being told to do so by officials. The timing of evacuation notices, therefore, will be the primary determinant of evacuation timing, just as it is in other locations. Just how promptly people will leave after being told can't be generalized from a single evacuation in any case. People will leave as promptly or as leisurely as they believe they must, based upon information available during a particular threat. Planning recommendations, therefore, will contain three different response timing curves, each fitting a set of circumstances which are plausible at each study location.

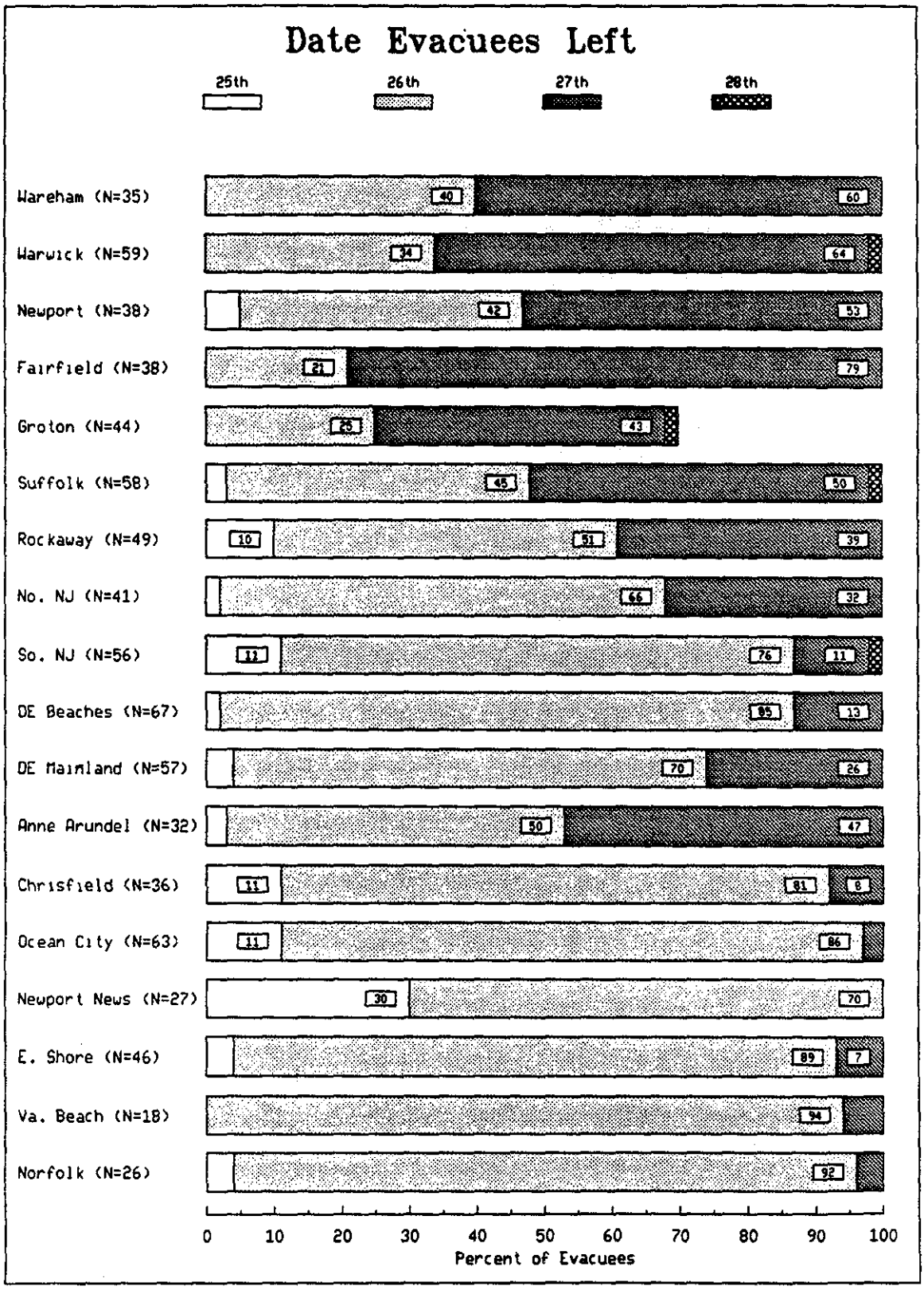
Date Evacuees Left
25th
26th
27th
28th
Wareham (N=35)
40
60
Warwick (N=59)
34
64
Newport (N=38)
42
53
Fairfield (N=38)
21
79
Groton (N=44)
25
43
Suffolk (N=58)
45
50
Rockaway (N=49)
10
51
39
No. NJ (N=41)
66
32
So. NJ (N=56)
13
76
11
DE Beaches (N=67)
85
13
DE Mainland (N=57)
70
26
Anne Arundel (N=32)
50
47
Chrisfield (N=36)
11
81
8
Ocean City (N=63)
11
86
Newport News (N=27)
30
70
E. Shore (N=46)
89
7
Va. Beach (N=18)
94
Norfolk (N=26)
92
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuees

FIG. 23

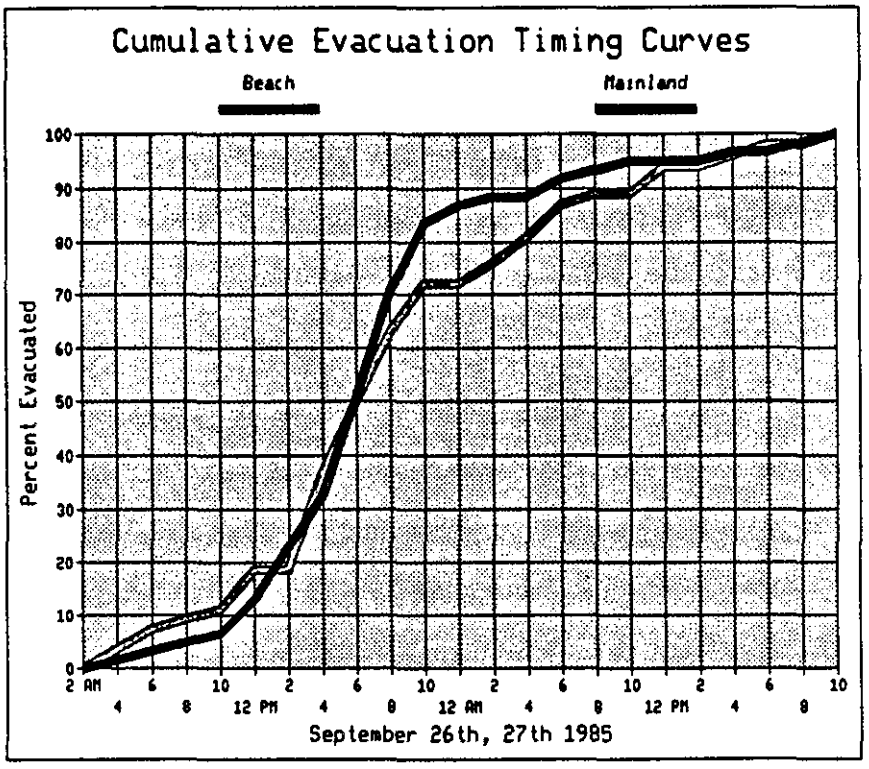
Cumulative Evacuation Timing Curves
Beach
Mainland
Percent Evacuated
100
90
80
70
60
50
40
30
20
10
0
2 AM
4
6
8
10
12 PM
2
4
6
8
10
12 AM
2
4
6
8
10
12 PM
2
4
6
8
10
September 26th, 27th 1985

FIG. 24

Types of Refuge Used

Response in Gloria

Figure 25 indicates the types of refuge used by evacuees in Gloria. Bear in mind that in most of the samples fewer than 50 people evacuated, yielding only marginally reliable data on this variable. (A sample of 50 will yield data accurate within 10 percentage points of the population value 90% of the time.)

In all but five survey sites a fourth or fewer of all evacuees went to public shelters, but there was widespread variation from site to site. Anne Arundel and Newport News had the highest shelter use rates, at 49% and 45% respectively, but both also had relatively few total evacuees (33 and 29). Newport, RI had the lowest use of public shelters, but Warwick, Rockaway, southern New Jersey, and Norfolk also had very low shelter use rates. Very few people evacuating out of their own town went to public shelters, but more did so in the southern sample than in the northern (Figure 26).

The "other" category was large in some locations. The most common of these responses was going to a second home the respondent owned, their place of work, or to a church not being operated as a Red Cross shelter.

(Non)Predictors of Shelter Use

Common predictors of public shelter use were not verified in the Gloria data. It is unclear whether the region is different, Gloria was different, or idiosyncrasies of the data set simply make verification impossible.

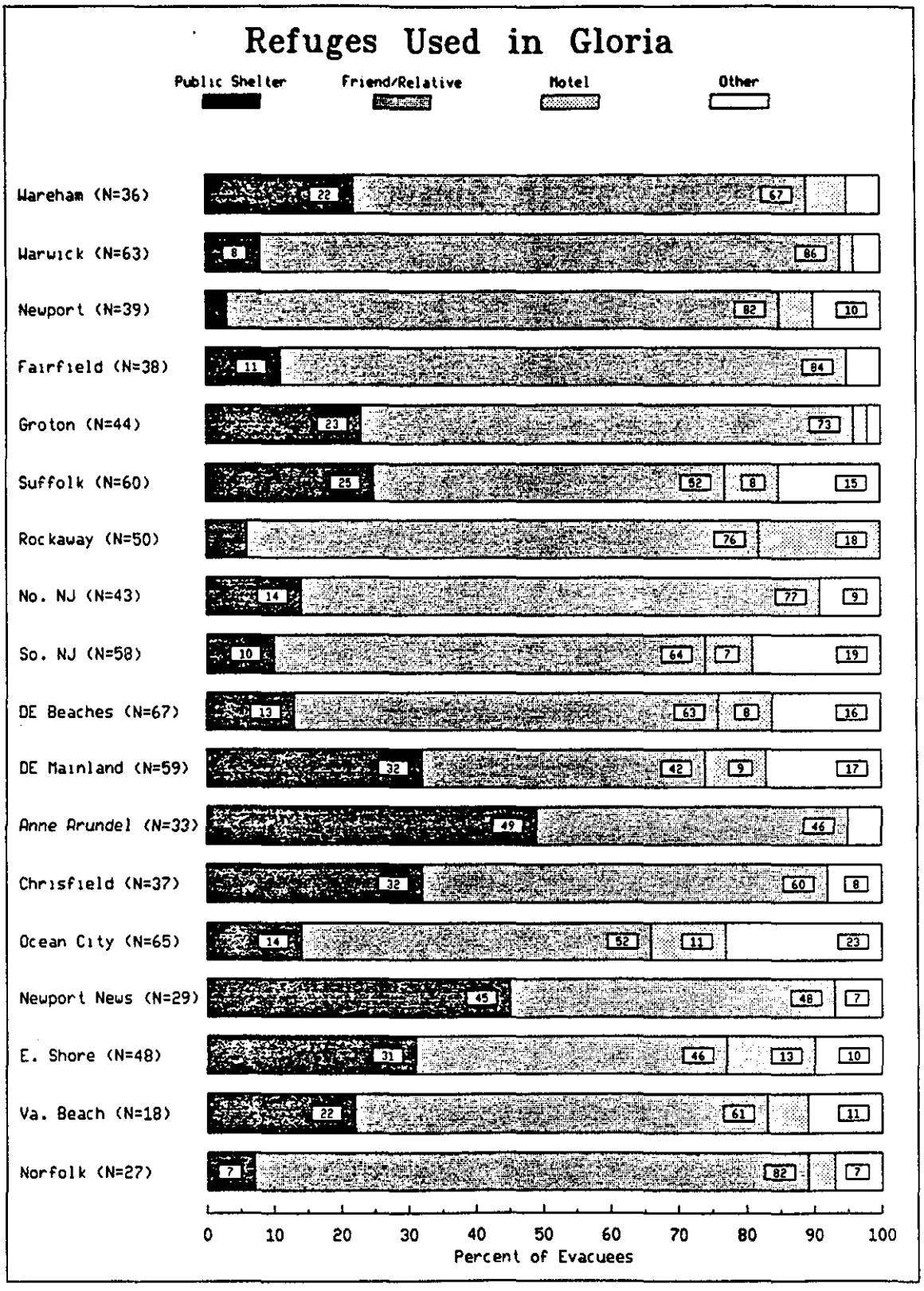
Refuges Used in Gloria
Public Shelter
Friend/Relative
Motel
Other
Wareham (N=36)
22
67
Warwick (N=63)
8
86
Newport (N=39)
82
10
Fairfield (N=38)
11
84
Groton (N=44)
23
73
Suffolk (N=60)
25
52
8
15
Rockaway (N=50)
76
18
No. NJ (N=43)
14
77
9
So. NJ (N=58)
10
64
7
19
DE Beaches (N=67)
13
63
8
16
DE Mainland (N=59)
32
42
9
17
Anne Arundel (N=33)
49
46
Chrisfield (N=37)
32
60
8
Ocean City (N=65)
14
52
11
23
Newport News (N=29)
45
48
7
E. Shore (N=48)
31
46
13
10
Va. Beach (N=18)
22
61
11
Norfolk (N=27)
7
82
7
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuees

FIG. 25

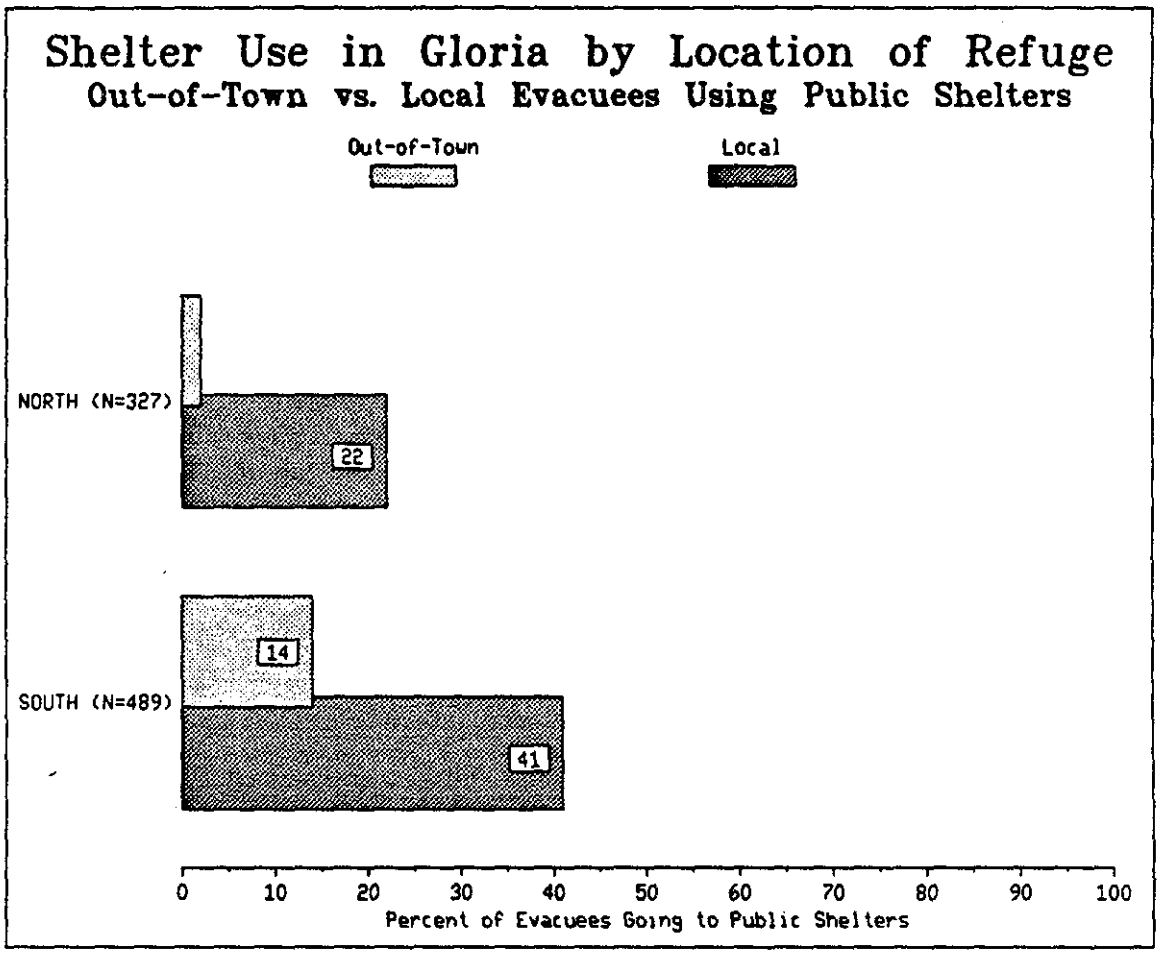
Shelter Use in Gloria by Location of Refuge
Out-of-Town vs. Local Evacuees Using Public Shelters
Out-of-Town
Local
NORTH (N=327)
22
SOUTH (N=489)
14
41
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuees Going to Public Shelters

FIG. 26

For example, income is normally associated with shelter use: low income evacuees are usually more likely to go to public shelters than more affluent evacuees. There is some evidence to support the notion in the Gloria data. Newport News and Chrisfield, with the highest incidence of low income residents in the samples, had two of the highest rates of public shelter use. Anne Arundel, however, with the highest shelter use rate, also had the lowest percentage of surveyed households reporting incomes below $10,000/yr.

Because of the small number of evacuees and even smaller number of public shelter users at each interview location it was not possible to test reliably for associations between income and shelter use in each location. When the samples were aggregated into northern and southern areas to increase sample sizes, no relationship was found between income and shelter use. Aggregating samples, however, can sometimes obscure relationships which exist at lower levels, and that could be occurring in this case. For example, actions by local officials can either encourage or discourage shelter use at the local level. As such actions undoubtedly varied from site to site in Gloria, lumping all the sites together would tend to make it more difficult to detect the effect of other factors such as income. There is also the larger question of whether respondents were candid about their actual incomes and whether the refusal of many people to answer that question might have affected these tests.

Another common predictor of shelter use is hazardousness of one's location. Evacuees from dangerous places such as barrier islands are less likely to use public shelters than evacuees from low-risk areas. Again, there is evidence of this at one scale in the Gloria data: Evacuees from the Delaware beach sample were much less likely to use public shelters than Delaware mainland evacuees. Other beach sample areas such as Ocean City, MD, and the New Jersey samples had some of the lowest shelter use rates.

Sample sizes were too small in individual survey sites to test whether people living farther from water bodies were more likely to use public shelters. When the data was aggregated into northern and southern areas, no relationship was found.

Age is not usually associate with shelter use except in retirement areas, and this proved also to be the case in Gloria.

Hypothetical Refuge Use

Respondents who didn't evacuate in Gloria were asked what sort of refuge they would have sought if they had evacuated. As indicated in Figure 27, hypothetical shelter use was much higher than actual use in most locations. An initial interpretation might be to infer that the people who didn't evacuate in Gloria were actually more prone to use public shelters than those who did evacuate. This relationship between hypothetical and actual shelter use is common, however, and the very same individuals who say they would use public shelters are actually about half as likely to as they themselves believe. Figure 28 compares intended and actual shelter use in a number of locations and storms.

In some surveys people who said they would use public shelters were then asked whether they had friends or relatives in safe locations with whom they could stay if necessary. Most answered affirmatively. Those were then asked whether they might not actually stay with those friends and relatives rather than going to a public shelter. Again, most answered affirmatively, indicating the tenuousness and instability of the hypothetical response.

One reason that actual shelter use tends to be lower than hypothetical is that during hurricane threats, people tend to contact one another, with residents in safe locations often inviting and even urging friends and relatives to come to their houses. Thus options become available that might not have been assumed during a

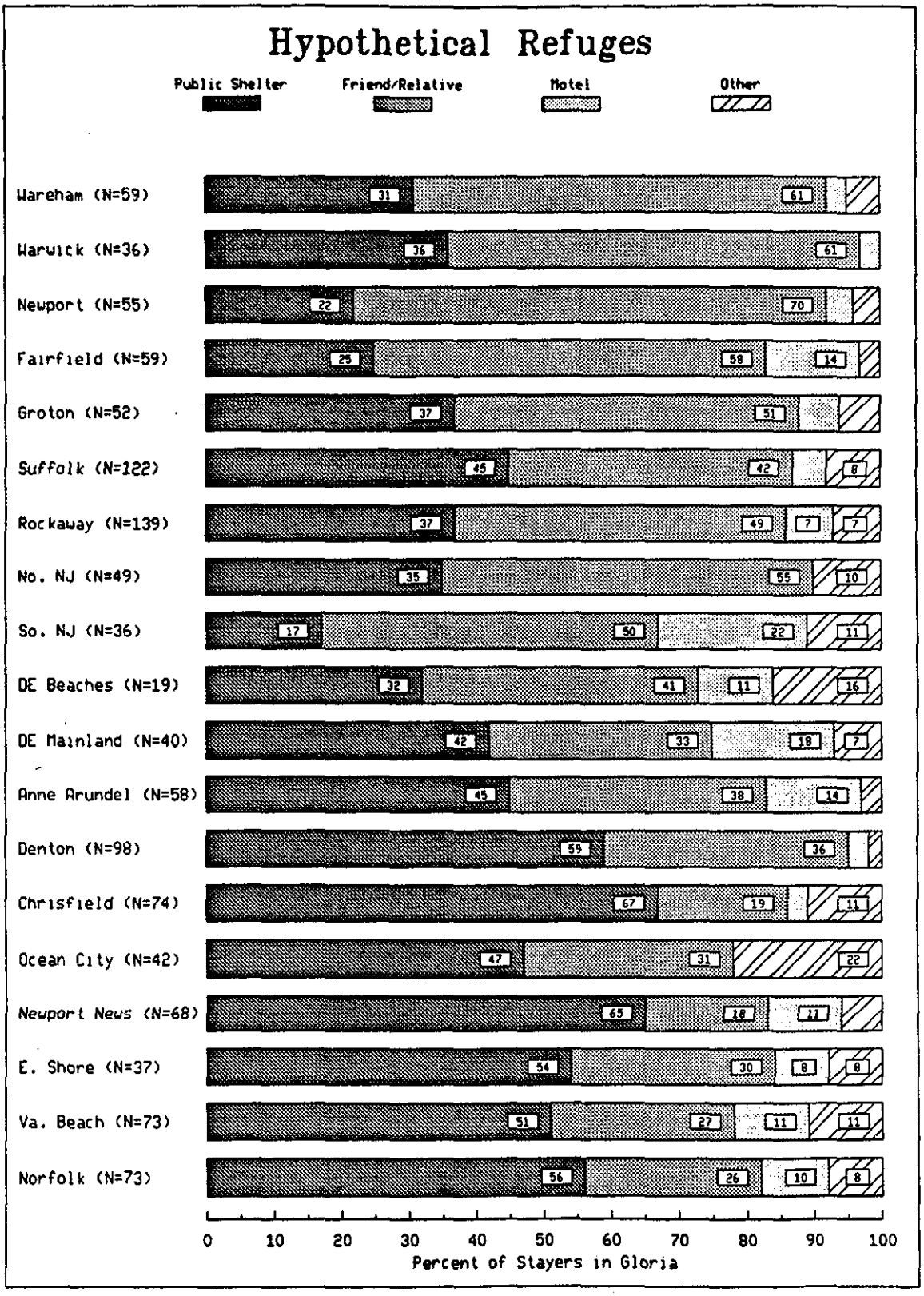
Hypothetical Refuges
Public Shelter
Friend/Relative
Motel
Other
Wareham (N=59)
31
61
Warwick (N=36)
36
61
Newport (N=55)
22
70
Fairfield (N=59)
25
58
14
Groton (N=52)
37
51
Suffolk (N=122)
45
42
8
Rockaway (N=139)
37
49
7
7
No. NJ (N=49)
35
55
10
So. NJ (N=36)
17
50
22
11
DE Beaches (N=19)
32
41
11
16
DE Mainland (N=40)
42
33
18
7
Anne Arundel (N=58)
45
38
14
Denton (N=98)
59
36
Chrisfield (N=74)
67
19
11
Ocean City (N=42)
47
31
22
Newport News (N=68)
65
18
11
E. Shore (N=37)
54
30
8
8
Va. Beach (N=73)
51
27
11
11
Norfolk (N=73)
56
26
10
8
0
10
20
30
40
50
60
70
80
90
100
Percent of Stayers in Gloria

FIG. 27

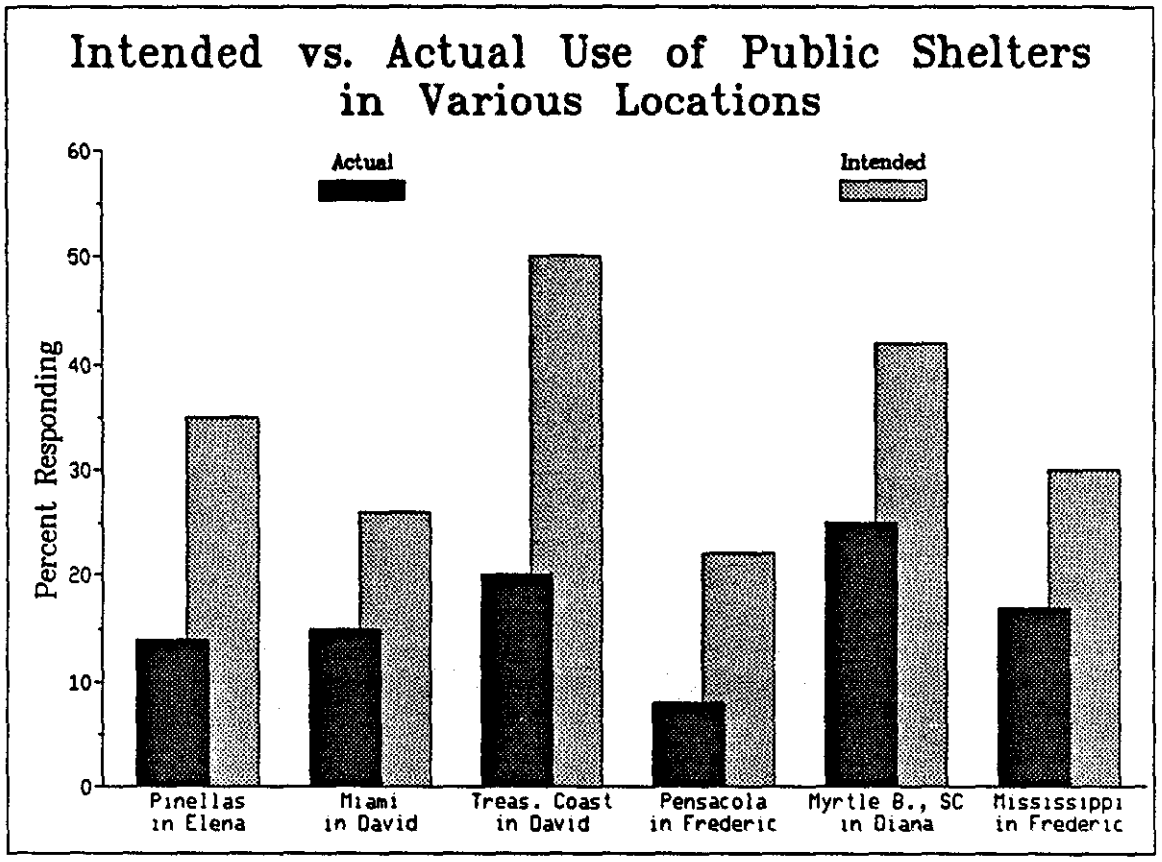
Intended vs. Actual Use of Public Shelters in Various Locations
Actual
Intended
Percent Responding
60
50
40
30
20
10
0
Pinellas in Elena
Miami in David
Treas. Coast in David
Pensacola in Frederic
Myrtle B., SC in Diana
Mississippi in Frederic

FIG. 28

hypothetical interview. It is also likely that as evacuation nears, people consider the pro's and con's of public shelters more carefully, with many deciding in retrospect that public shelter conditions are not so attractive after all.

Although hypothetical shelter use figures are not reliable in the absolute sense, they do have some validity in a relative sense. That is, if more people in one location say they would use public shelters than people in a second location, more of them probably will actually use public shelters in an evacuation, although the hypothetical numbers from both groups are inflated. More people in the southern area sample said they would use public shelters than in the northern sample, for example. This also appeared true, but less definitely, in the actual response data.

It's interesting that the income vs. shelter use relationship discussed earlier and not verified in Gloria is clearly present with hypothetical shelter use data (Figure 29). This gives a bit more reason for applying the generalization when deriving planning assumptions for the region.

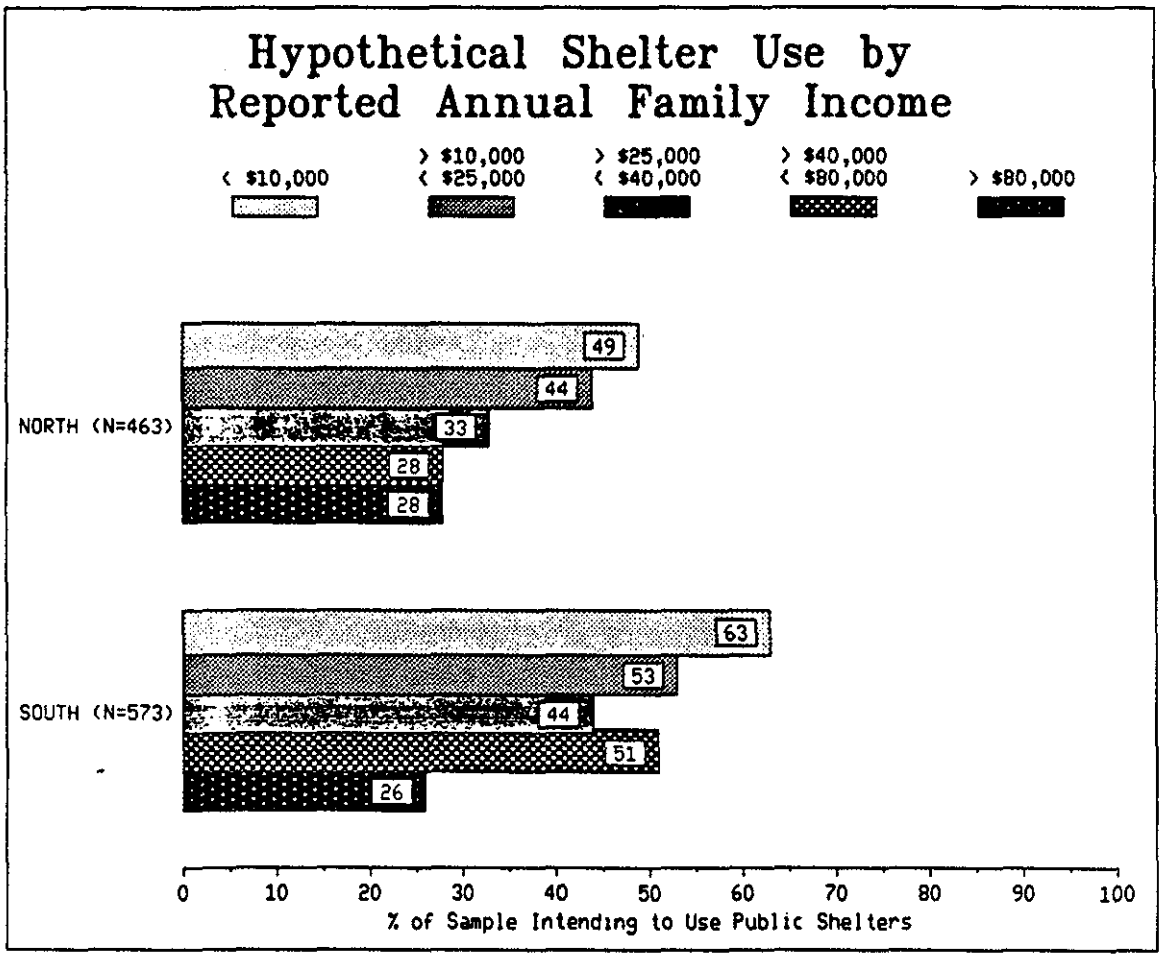
Hypothetical Shelter Use by
Reported Annual Family Income
< $10,000
> $10,000
< $25,000
> $25,000
< $40,000
> $40,000
< $80,000
> $80,000
NORTH (N=463)
49
44
33
28
28
SOUTH (N=573)
63
53
44
51
26
0
10
20
30
40
50
60
70
80
90
100
% of Sample Intending to Use Public Shelters

FIG. 29

Evacuation Destinations

Response in Gloria

There was much variation from site to site with respect to whether evacuees in Gloria left their local areas (usually meaning towns) or sought refuge nearby (Figure 30). Only 7% of the evacuees in Newport News left their local area, compared to 88% in the southern New Jersey area. In half the locations more than 50% of the evacuees went out-of-town.

Figure 31 suggests, though, that most evacuees didn't go very far, even if it was out-of-town. In 13 of 18 sites more than half the evacuees said they reached their destination in 30 minutes or less. In the New England states between 83% and 100% of the evacuees took less than 30 minutes.

It was noted previously that very few of the people going out of their local area went to public shelters, and that is common throughout the Gulf and Atlantic coasts. In most locations people in the highest risk locations (barrier islands primarily) are more likely to go out-of-town than evacuees from lower-risk areas. The proximity-to-water test tends to verify that generalization for Gloria in the southern area but not in the northern area (Fig. 32). Proximity to water, however, is not a good surrogate for hazardousness in all locations or when comparing one site to another. When simply looking at interview sites consisting primarily of beach areas (Delaware beaches, southern New Jersey, Ocean City, MD, etc.), it appears that those locations had substantially more evacuees leaving the local area and taking more than 30 minutes to reach their destinations than did most other sites.

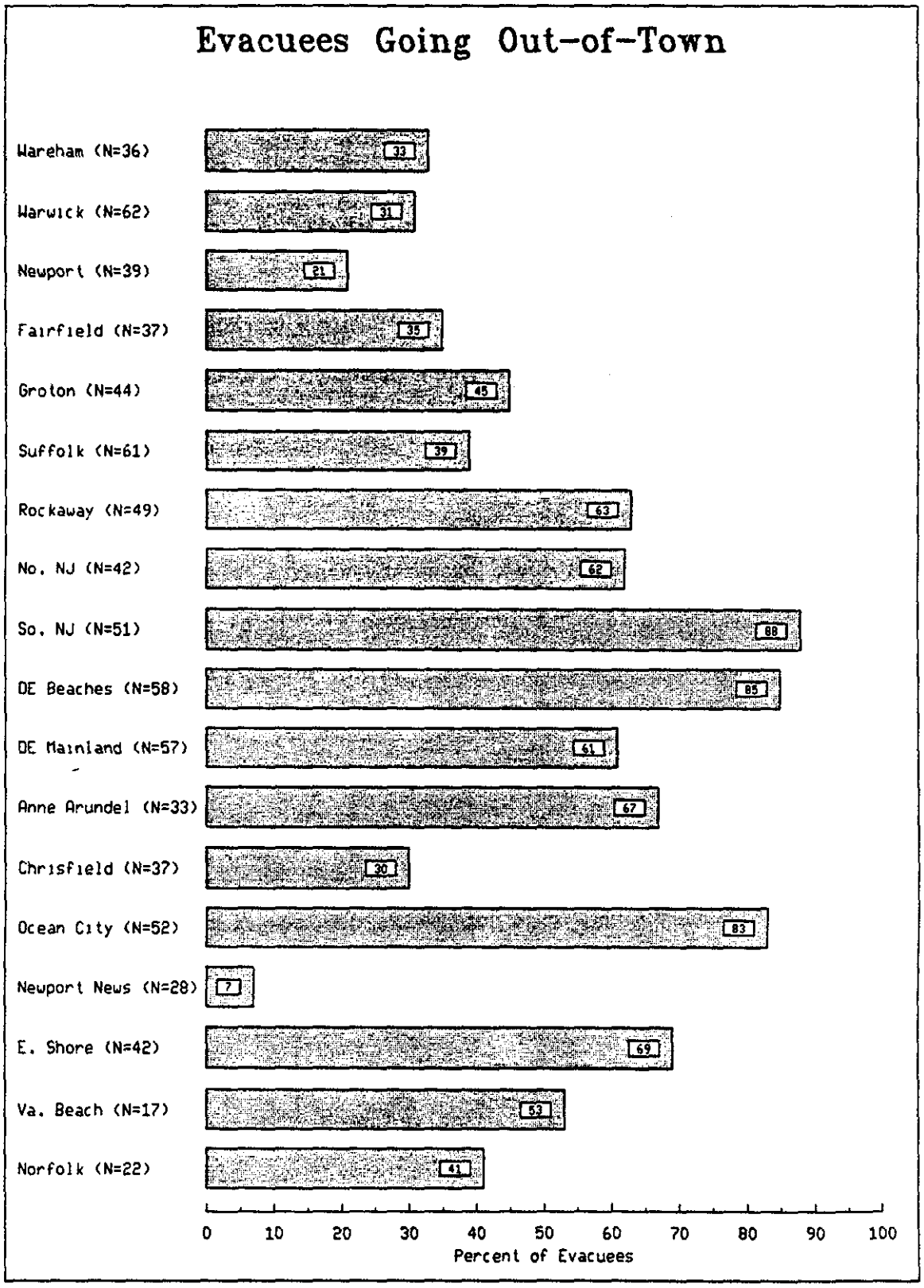
Evacuees Going Out-of-Town
Wareham (N=36)
33
Warwick (N=62)
31
Newport (N=39)
21
Fairfield (N=37)
35
Groton (N=44)
45
Suffolk (N=61)
39
Rockaway (N=49)
63
No. NJ (N=42)
62
So. NJ (N=51)
88
DE Beaches (N=58)
85
DE Mainland (N=57)
61
Anne Arundel (N=33)
67
Chrisfield (N=37)
30
Ocean City (N=52)
83
Newport News (N=28)
7
E. Shore (N=42)
69
Va. Beach (N=17)
53
Norfolk (N=22)
41
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuees

FIG. 30

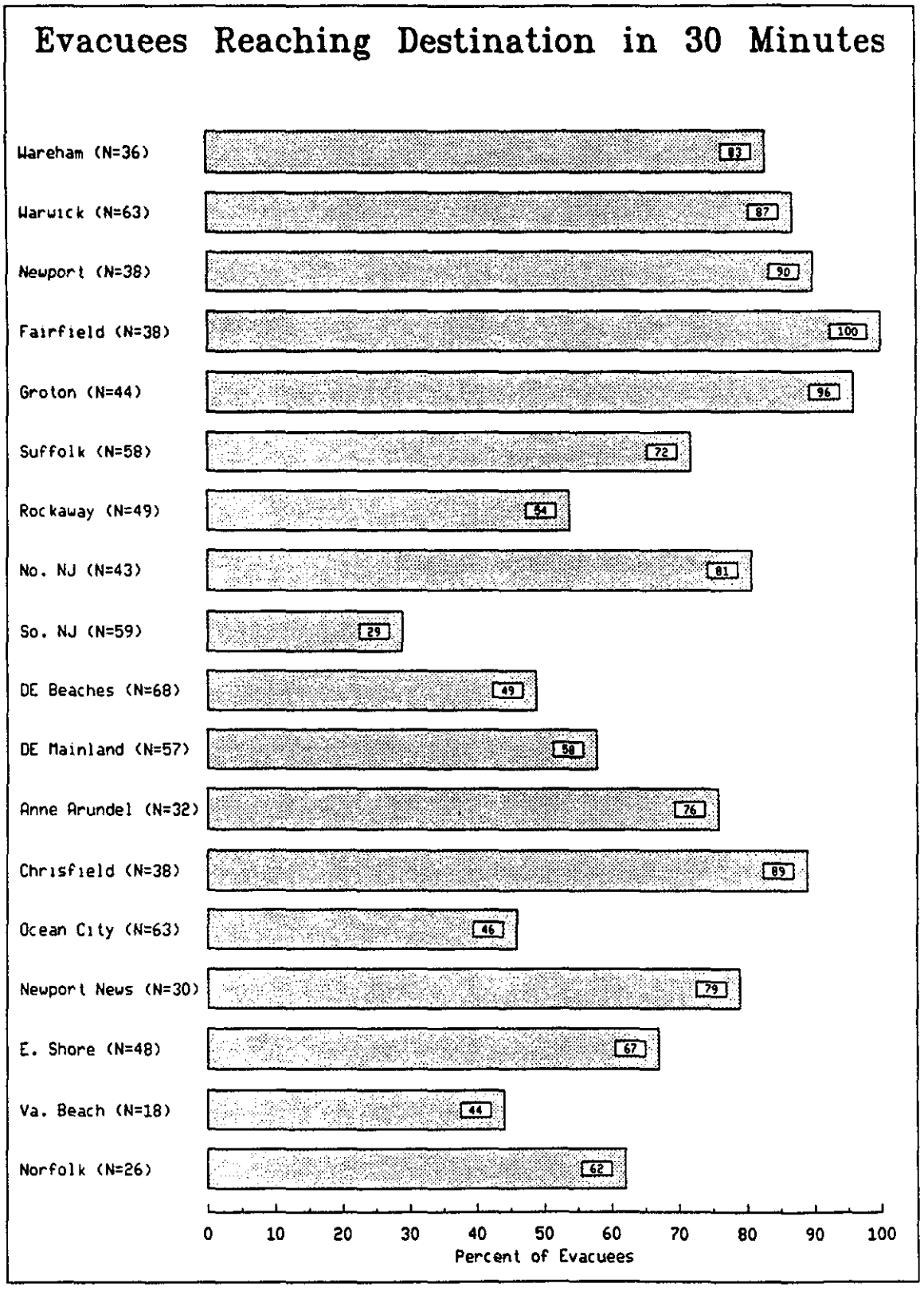
Evacuees Reaching Destination in 30 Minutes
Wareham (N=36)
83
Warwick (N=63)
87
Newport (N=38)
90
Fairfield (N=38)
100
Groton (N=44)
96
Suffolk (N=58)
72
Rockaway (N=49)
54
No. NJ (N=43)
81
So. NJ (N=59)
29
DE Beaches (N=68)
49
DE Mainland (N=57)
58
Anne Arundel (N=32)
76
Chrisfield (N=38)
89
Ocean City (N=63)
46
Newport News (N=30)
79
E. Shore (N=48)
67
Va. Beach (N=18)
44
Norfolk (N=26)
62
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuees

FIG. 31

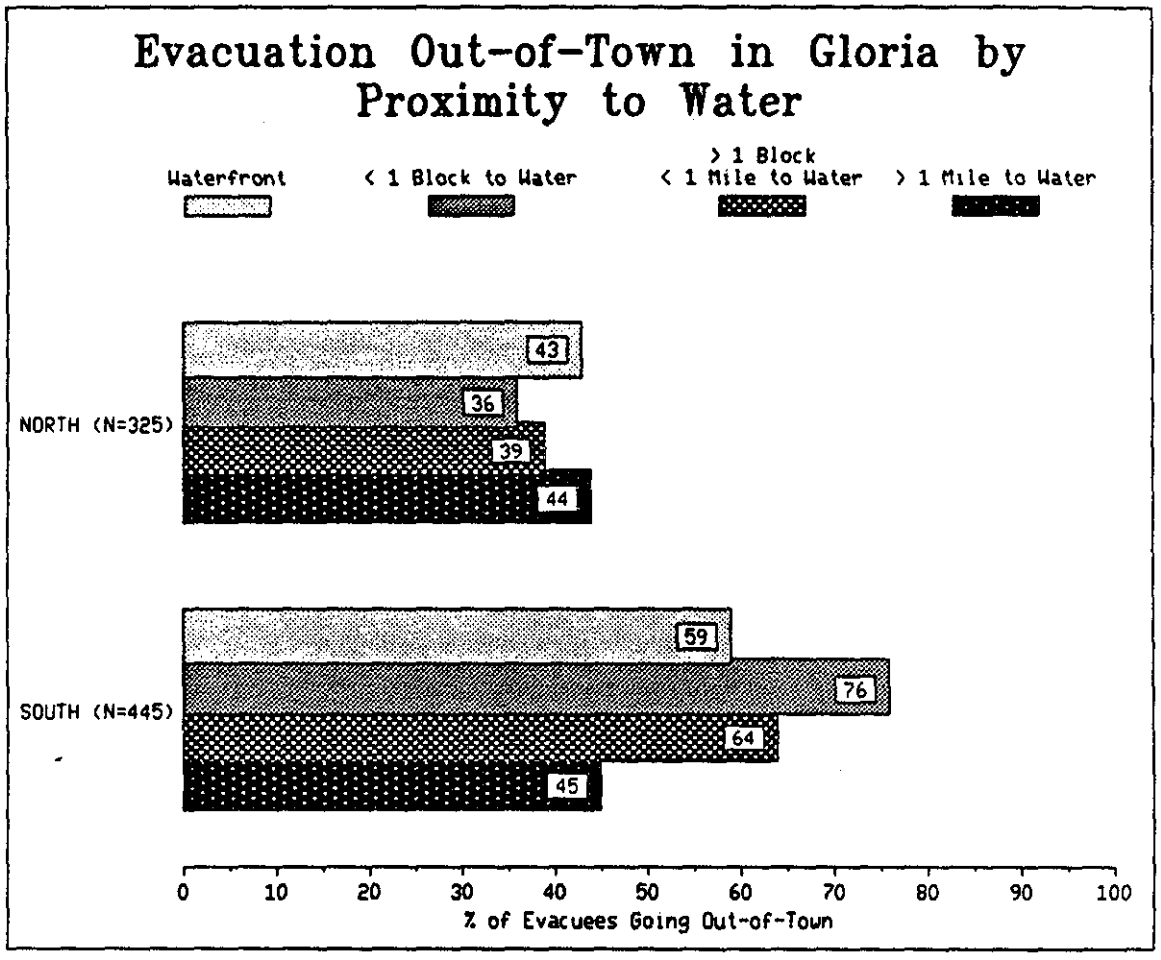
Evacuation Out-of-Town in Gloria by Proximity to Water
Waterfront
< 1 Block to Water
> 1 Block < 1 Mile to Water
> 1 Mile to Water
NORTH (N=325)
43
36
39
44
SOUTH (N=445)
59
76
64
45
0
10
20
30
40
50
60
70
80
90
100
% of Evacuees Going Out-of-Town

FIG. 32

Income can also be a clue to whether evacuees will leave their local area. This probably results from the fact that people with higher incomes are more likely to live near the beach, they are less likely to use public shelters, and they can more easily afford motels. In the Gloria data there was no income vs. out-of-town evacuation relationship in the southern sample, but there was in the northern area (Fig. 33).

Hypothetical Responses

In the northern area people who didn't evacuate in Gloria were asked where they thought they would have gone if they had evacuated. The results were fairly consistent with actual response data for the sites (Fig. 34). Higher income respondents were somewhat more likely to say they would leave the local area (Fig. 35).

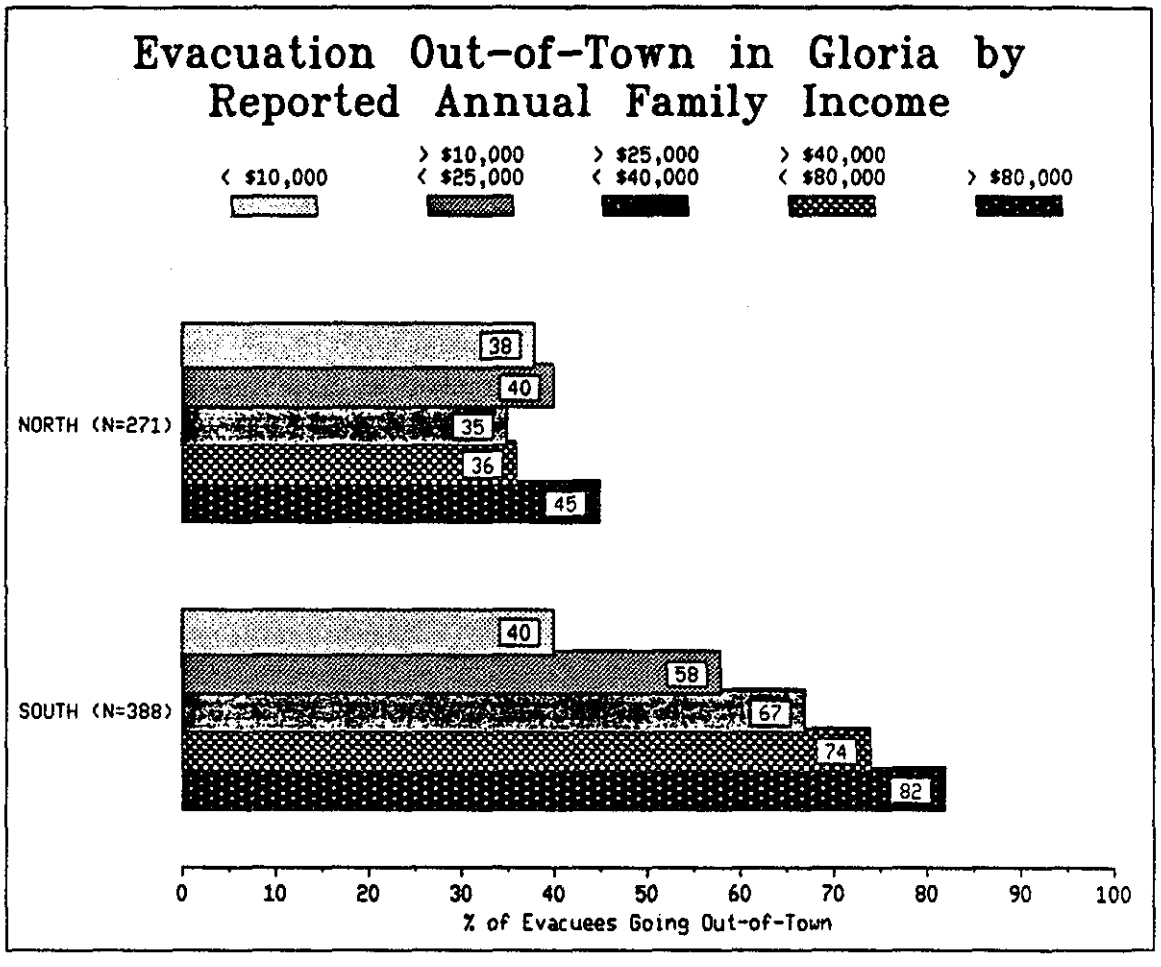
Evacuation Out-of-Town in Gloria by Reported Annual Family Income
< $10,000
> $10,000 < $25,000
> $25,000 < $40,000
> $40,000 < $80,000
> $80,000
NORTH (N=271)
38
40
35
36
45
SOUTH (N=388)
40
58
67
74
82
0
10
20
30
40
50
60
70
80
90
100
% of Evacuees Going Out-of-Town

FIG. 33

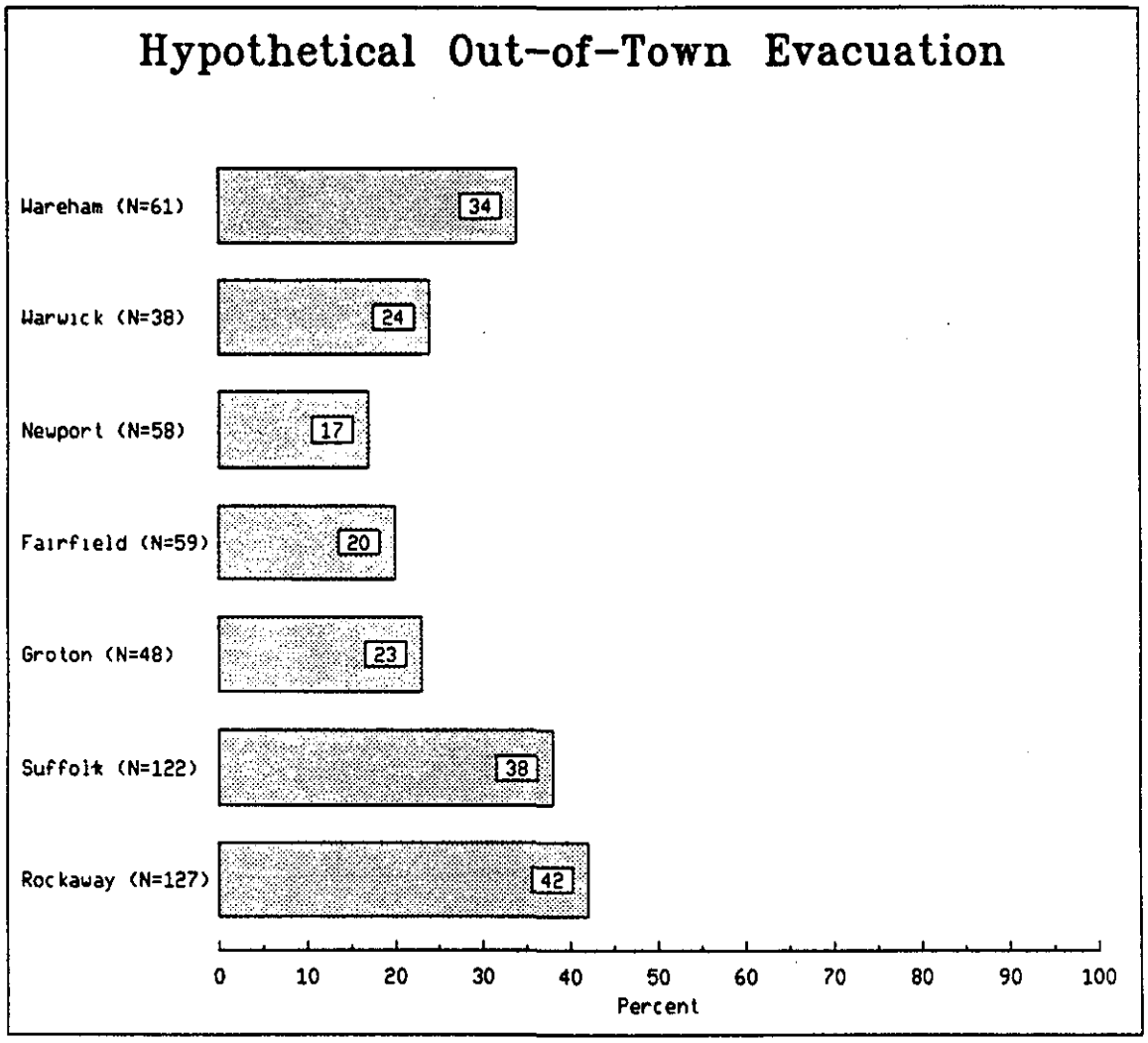
Hypothetical Out-of-Town Evacuation
Wareham (N=61)
34
Warwick (N=38)
24
Newport (N=58)
17
Fairfield (N=59)
20
Groton (N=48)
23
Suffolk (N=122)
38
Rockaway (N=127)
42
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 34

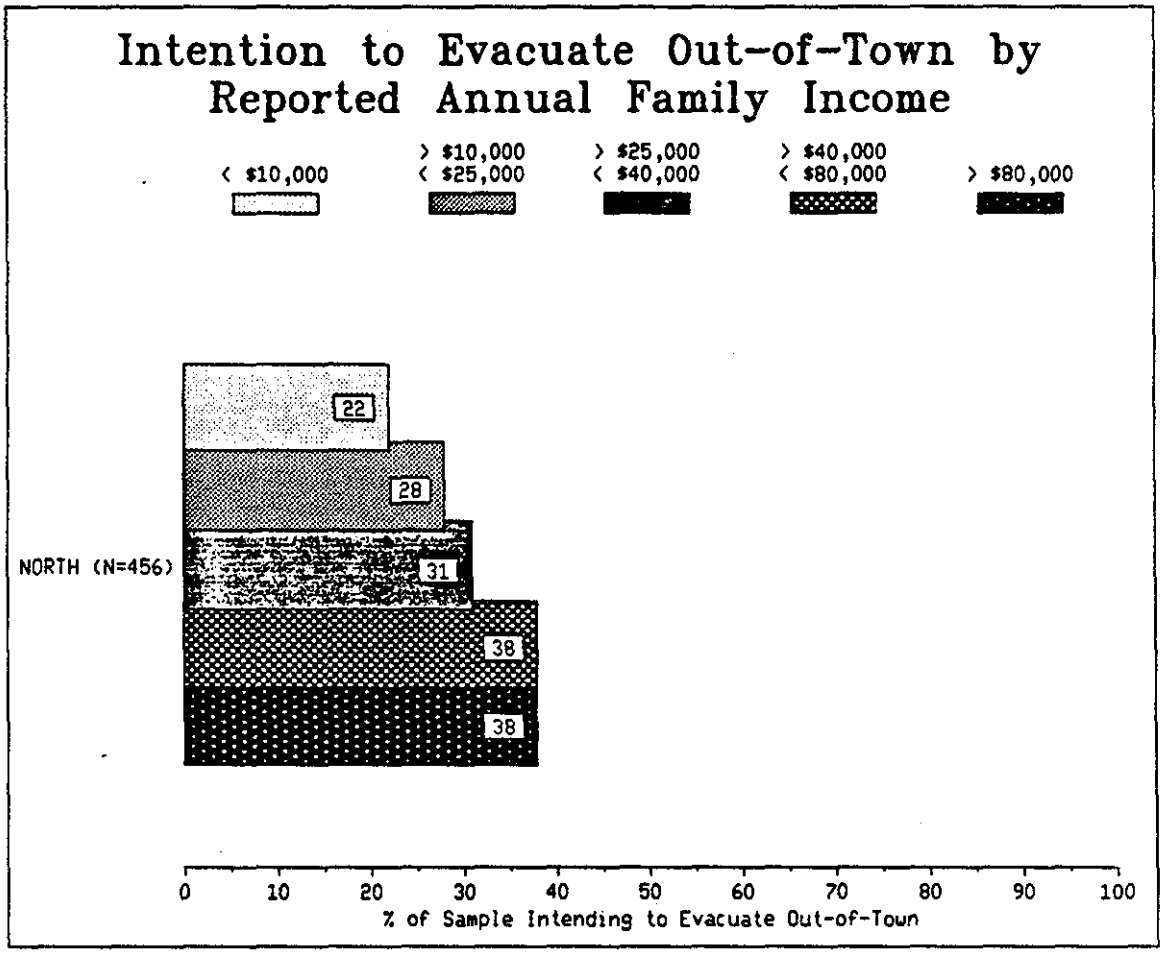
Intention to Evacuate Out-of-Town by Reported Annual Family Income
< $10,000
> $10,000 < $25,000
> $25,000 < $40,000
> $40,000 < $80,000
> $80,000
NORTH (N=456)
22
28
31
38
38
0
10
20
30
40
50
60
70
80
90
100
% of Sample Intending to Evacuate Out-of-Town

FIG. 35

Vehicle Use

Household Transportation

The great majority of evacuees in Gloria used only one vehicle, although some used more (Figure 36). That is almost always the case in hurricane evacuations. Figure 37 shows two additional variables: the percentage of available vehicles actually used by evacuating households and the average number of vehicles used per evacuating household. The average ranged from 1.0 to 1.5. In most cases between 65% and 75% of the vehicles available to households are actually used in evacuating. Fourteen of eighteen Gloria sites were within one percentage point of that range. The Delaware beach sample was abnormally high, and Virginia Beach and Anne Arundel were unusually low. Not all vehicles are used in evacuations because families want to avoid separating any more than necessary.

Public Transportation

In the northern area evacuees were asked what sort of transportation they used (Fig. 38). Almost everyone said they left in their own vehicle. Only in Rockaway did anyone mention using public transportation. Northern area respondents not leaving in Gloria were asked whether they had a car available in which to evacuate if they had chosen to (Fig. 39). Only in Rockaway, and to a much lesser degree Newport, did people say no. Recall also that people in only three sites said they didn't leave because of a lack of transportation (Ocean City,

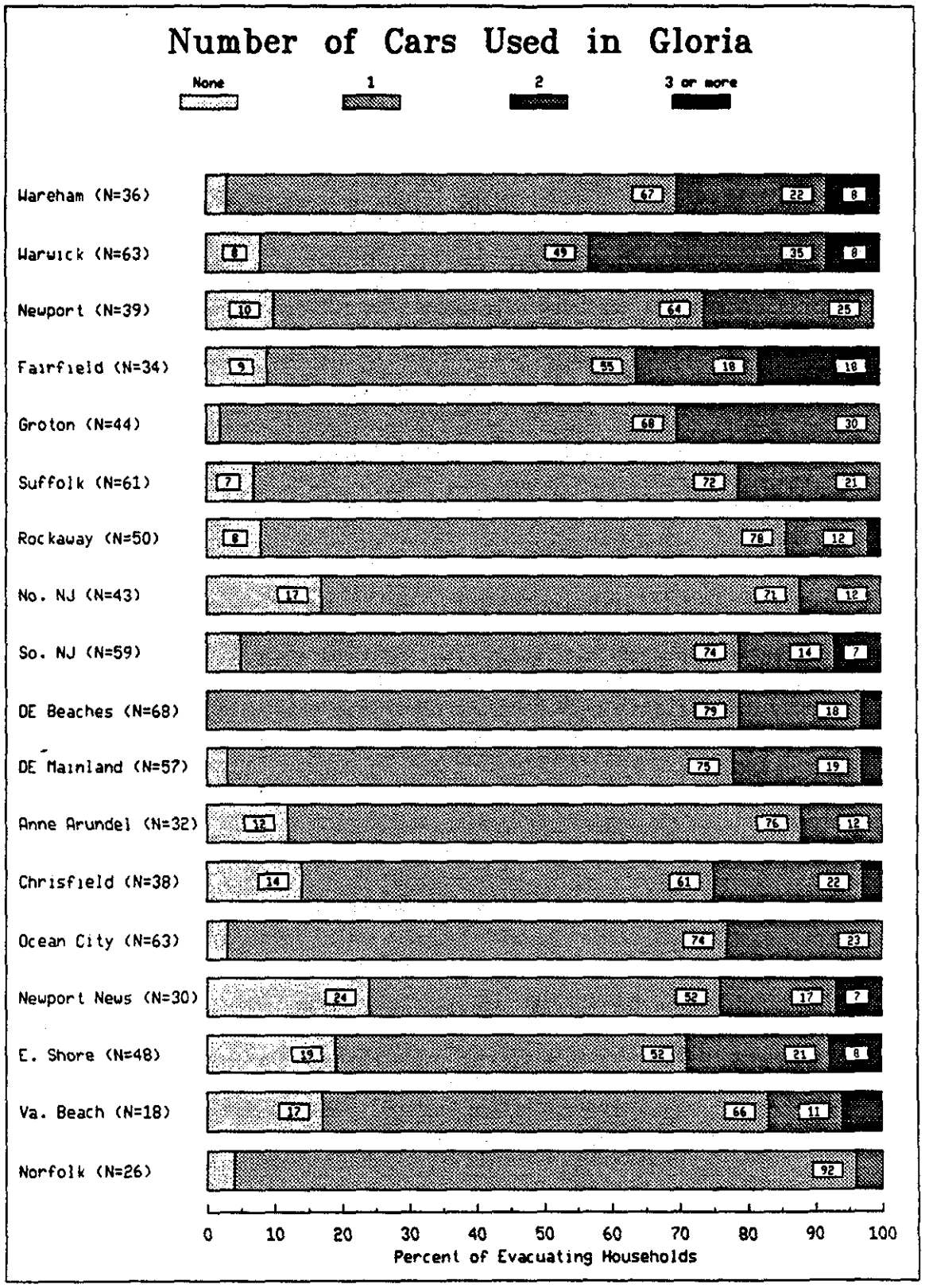
Number of Cars Used in Gloria
None
1
2
3 or more
Wareham (N=36)
67
22
8
Warwick (N=63)
8
49
35
8
Newport (N=39)
10
64
25
Fairfield (N=34)
9
55
18
18
Groton (N=44)
68
30
Suffolk (N=61)
7
72
21
Rockaway (N=50)
8
78
12
No. NJ (N=43)
17
71
12
So. NJ (N=59)
74
14
7
DE Beaches (N=68)
79
18
DE Mainland (N=57)
75
19
Anne Arundel (N=32)
12
76
12
Chrisfield (N=38)
14
61
22
Ocean City (N=63)
74
23
Newport News (N=30)
24
52
17
7
E. Shore (N=48)
19
52
21
8
Va. Beach (N=18)
17
66
11
Norfolk (N=26)
92
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuating Households

FIG. 36

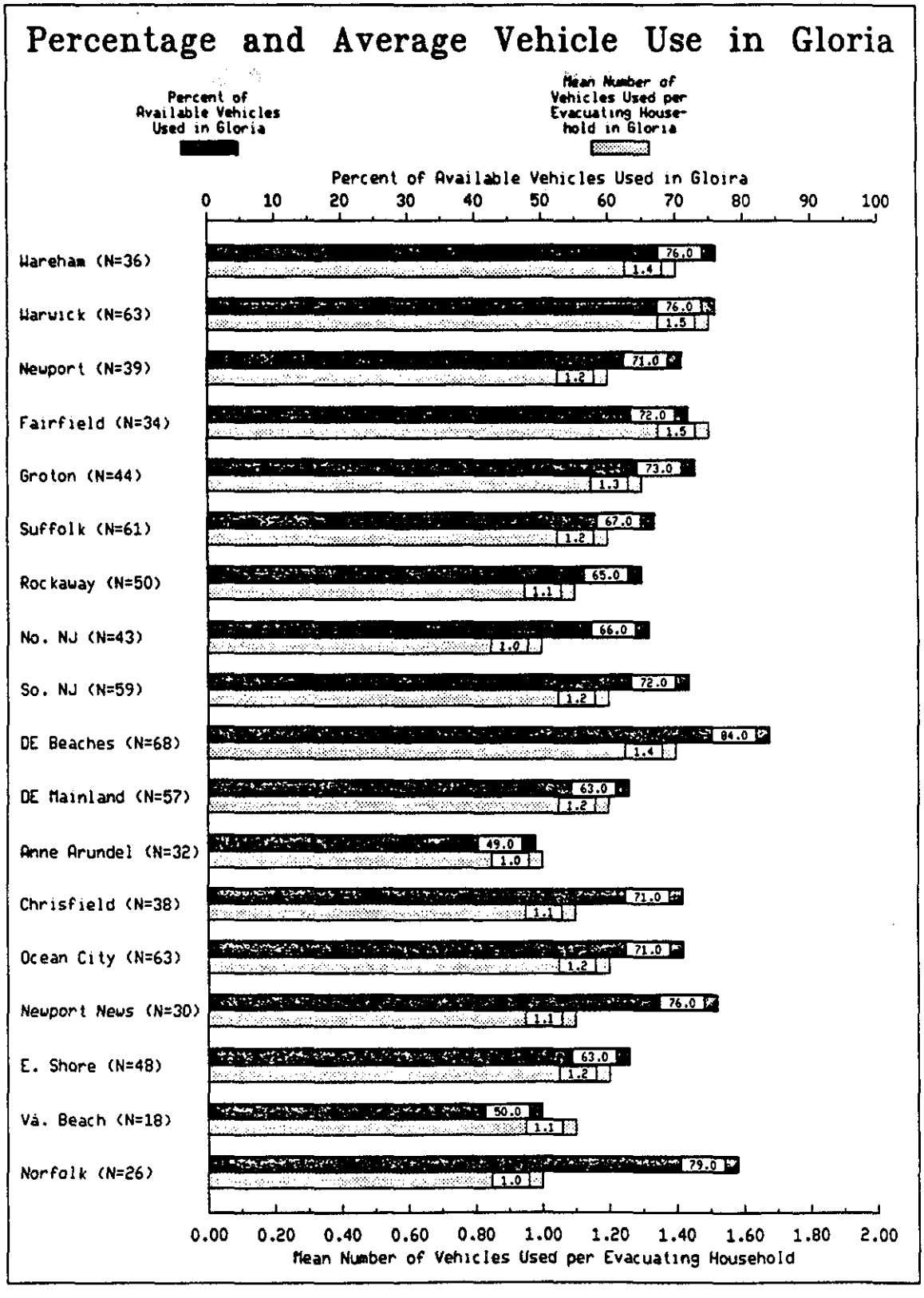
Percentage and Average Vehicle Use in Gloria
Percent of Available Vehicles Used in Gloria
Mean Number of Vehicles Used per Evacuating Household in Gloria
Percent of Available Vehicles Used in Gloira
0 10 20 30 40 50 60 70 80 90 100
Wareham (N=36) 76.0 1.4
Warwick (N=63) 76.0 1.5
Newport (N=39) 71.0 1.2
Fairfield (N=34) 72.0 1.5
Groton (N=44) 73.0 1.3
Suffolk (N=61) 67.0 1.2
Rockaway (N=50) 65.0 1.1
No. NJ (N=43) 66.0 1.0
So. NJ (N=59) 72.0 1.2
DE Beaches (N=68) 84.0 1.4
DE Mainland (N=57) 63.0 1.2
Anne Arundel (N=32) 49.0 1.0
Chrisfield (N=38) 71.0 1.1
Ocean City (N=63) 71.0 1.2
Newport News (N=30) 76.0 1.1
E. Shore (N=48) 63.0 1.2
Vá. Beach (N=18) 50.0 1.1
Norfolk (N=26) 79.0 1.0
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
Mean Number of Vehicles Used per Evacuating Household

FIG. 37

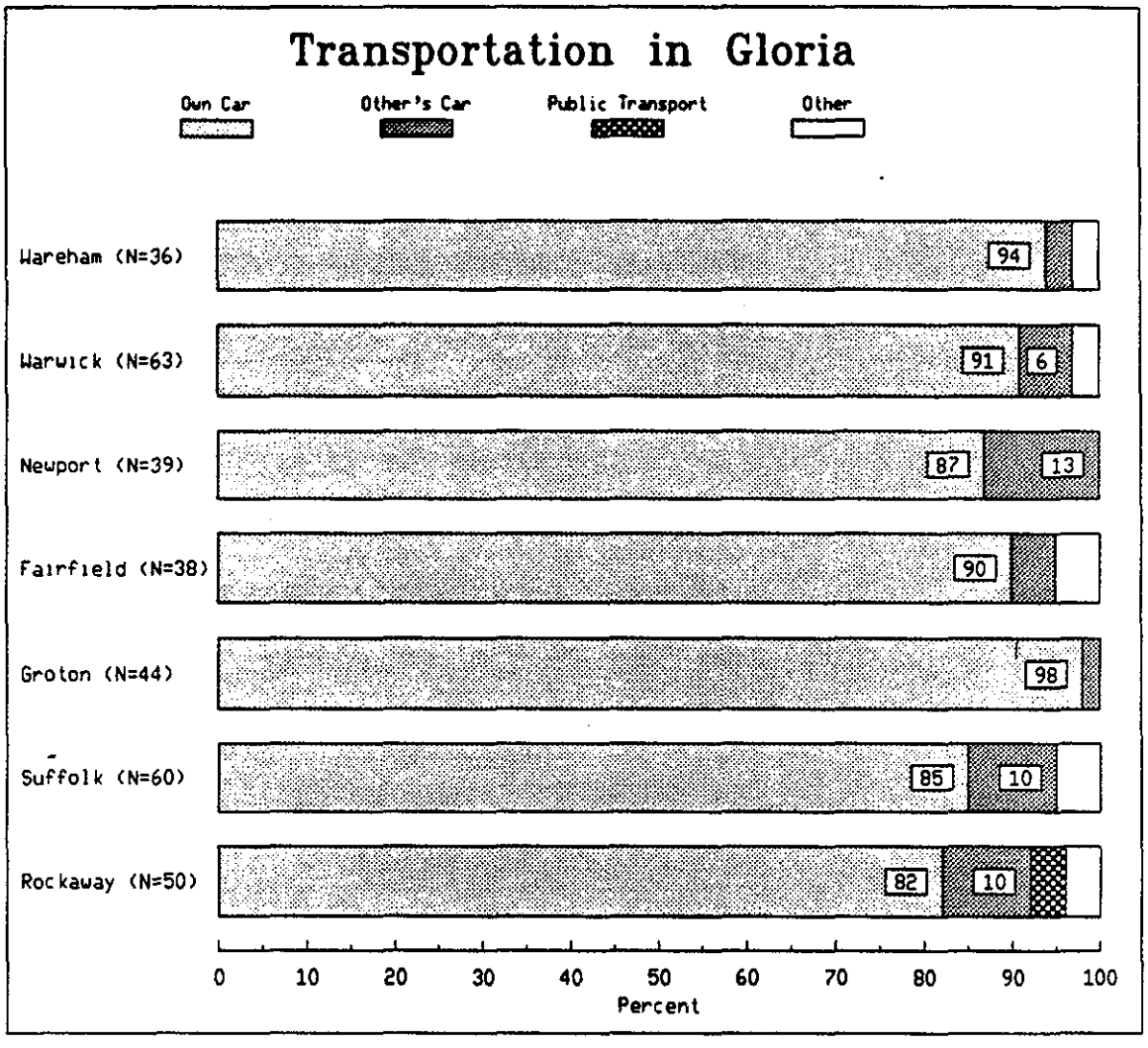
Transportation in Gloria
Own Car
Other's Car
Public Transport
Other
Wareham (N=36)
94
Warwick (N=63)
91
6
Newport (N=39)
87
13
Fairfield (N=38)
90
Groton (N=44)
98
Suffolk (N=60)
85
10
Rockaway (N=50)
82
10
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 38

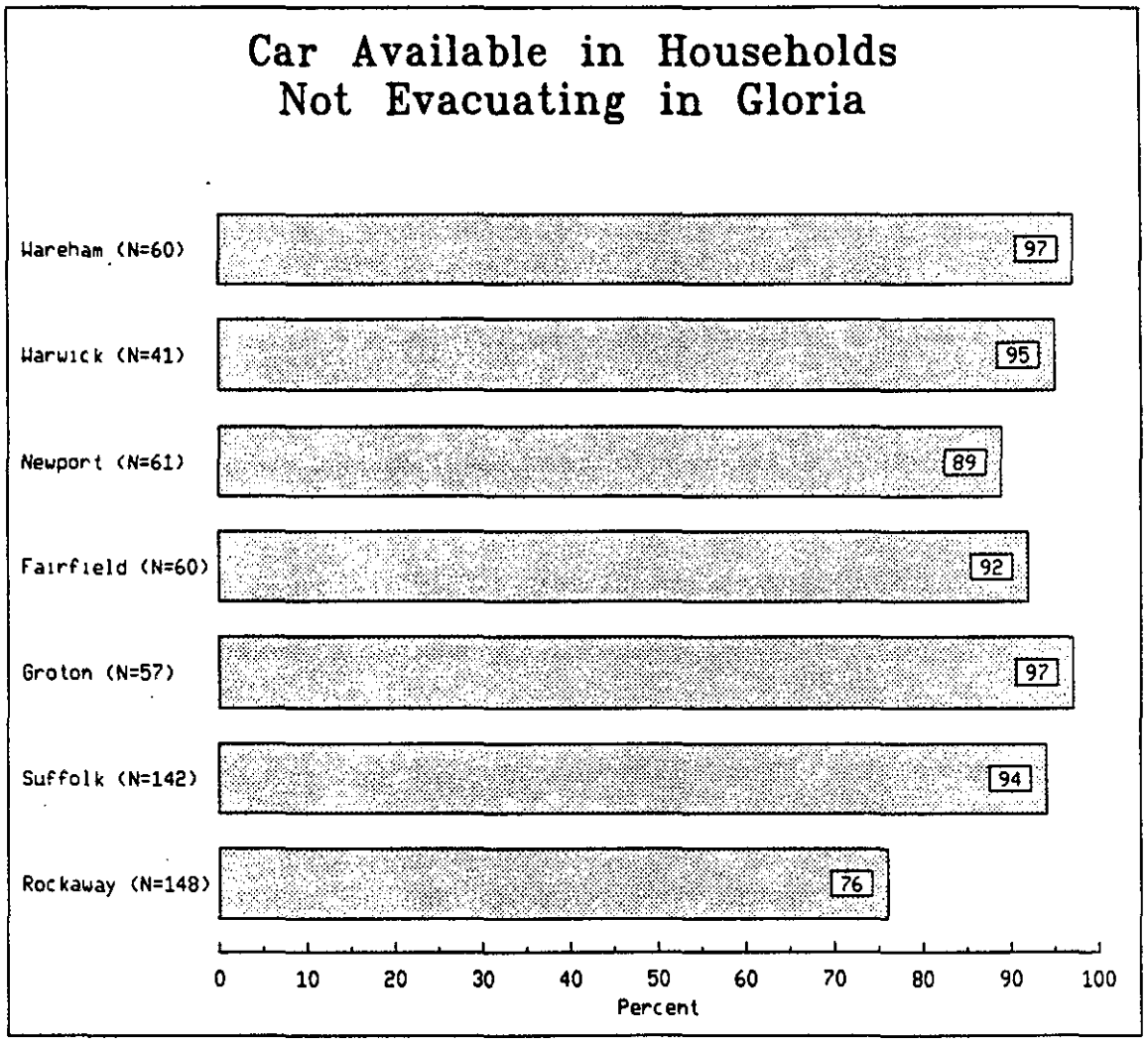
Car Available in Households
Not Evacuating in Gloria
Wareham (N=60)
97
Warwick (N=41)
95
Newport (N=61)
89
Fairfield (N=60)
92
Groton (N=57)
97
Suffolk (N=142)
94
Rockaway (N=148)
76
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 39

MD, Denton, and Rockaway) and in those cases it was 5% or fewer (of the nonevacuees). Rockaway (the question being asked only in the northern area) also had the greatest incidence of people saying they would need to use public transportation if they evacuated (Fig. 40).

Evacuation Assistance

Evacuees in all sites were asked whether they required outside assistance in evacuating in Gloria (Fig. 41). Very few said they did. In most locations no one said they needed help from an agency to evacuate, and of those who did, the figure was 5% or less every place except Chrisfield where it was 11% (+ or - 10% points).

Respondents not evacuating in Gloria were asked whether they would need help if they evacuated (Fig. 42). The question was asked the same way in the northern and southern areas, but responses were coded in more detail in the northern area. Thus, in the southern area there is the "yes, general" category, whereas in the northern area it is broken down into "yes, agency" and "yes, other." Variation in response was substantial from site to site. Where they could be specific, few said they would need agency assistance. In the southern area it's probably reasonable to assume that agency dependence would be comparable to that mentioned in the northern area. Newport News had the highest overall percentage saying help would be needed from someone outside the home.

These figures are not unusual. Most help from outside the household usually comes from friends and relatives. Even when residents believe they would require agency assistance, friends or relatives usually fill the need instead.

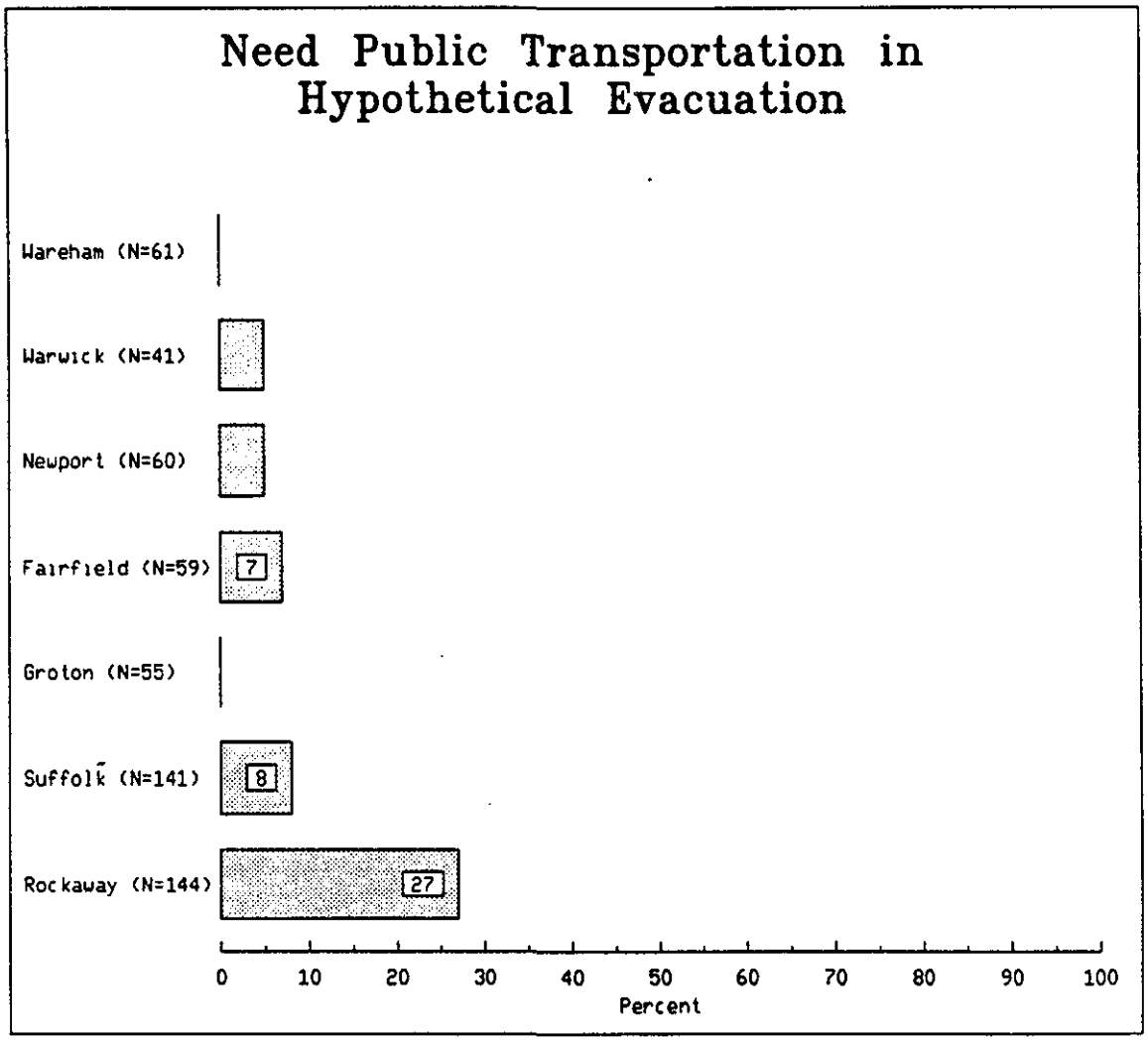
Need Public Transportation in Hypothetical Evacuation
Wareham (N=61)
Warwick (N=41)
Newport (N=60)
Fairfield (N=59)
7
Groton (N=55)
Suffolk (N=141)
8
Rockaway (N=144)
27
0
10
20
30
40
50
60
70
80
90
100
Percent

FIG. 40

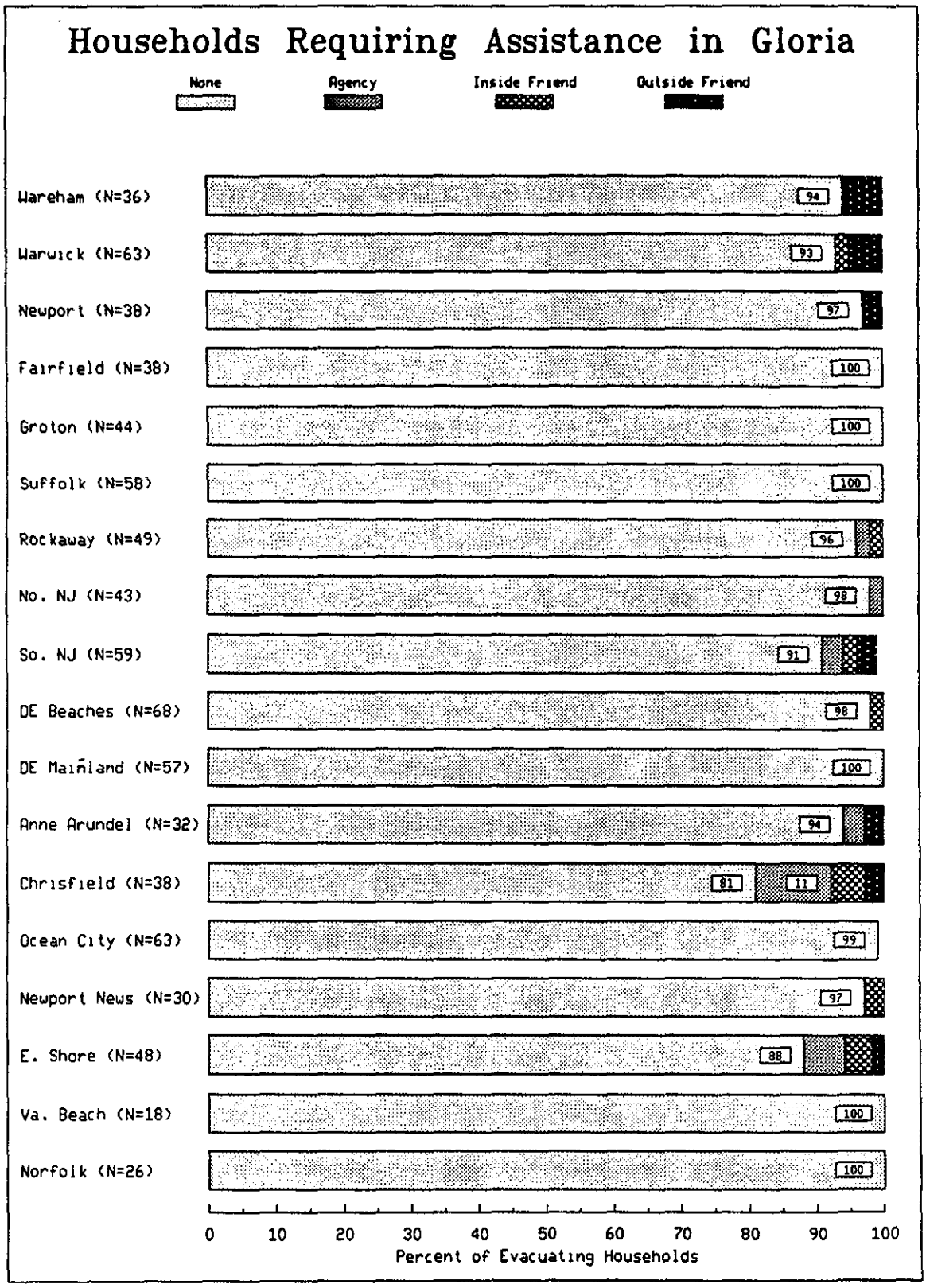
Households Requiring Assistance in Gloria
None
Agency
Inside Friend
Outside Friend
Wareham (N=36)
94
Warwick (N=63)
93
Newport (N=38)
97
Fairfield (N=38)
100
Groton (N=44)
100
Suffolk (N=58)
100
Rockaway (N=49)
96
No. NJ (N=43)
98
So. NJ (N=59)
91
DE Beaches (N=68)
98
DE Mainland (N=57)
100
Anne Arundel (N=32)
94
Chrisfield (N=38)
81
11
Ocean City (N=63)
99
Newport News (N=30)
97
E. Shore (N=48)
88
Va. Beach (N=18)
100
Norfolk (N=26)
100
0
10
20
30
40
50
60
70
80
90
100
Percent of Evacuating Households

FIG. 41

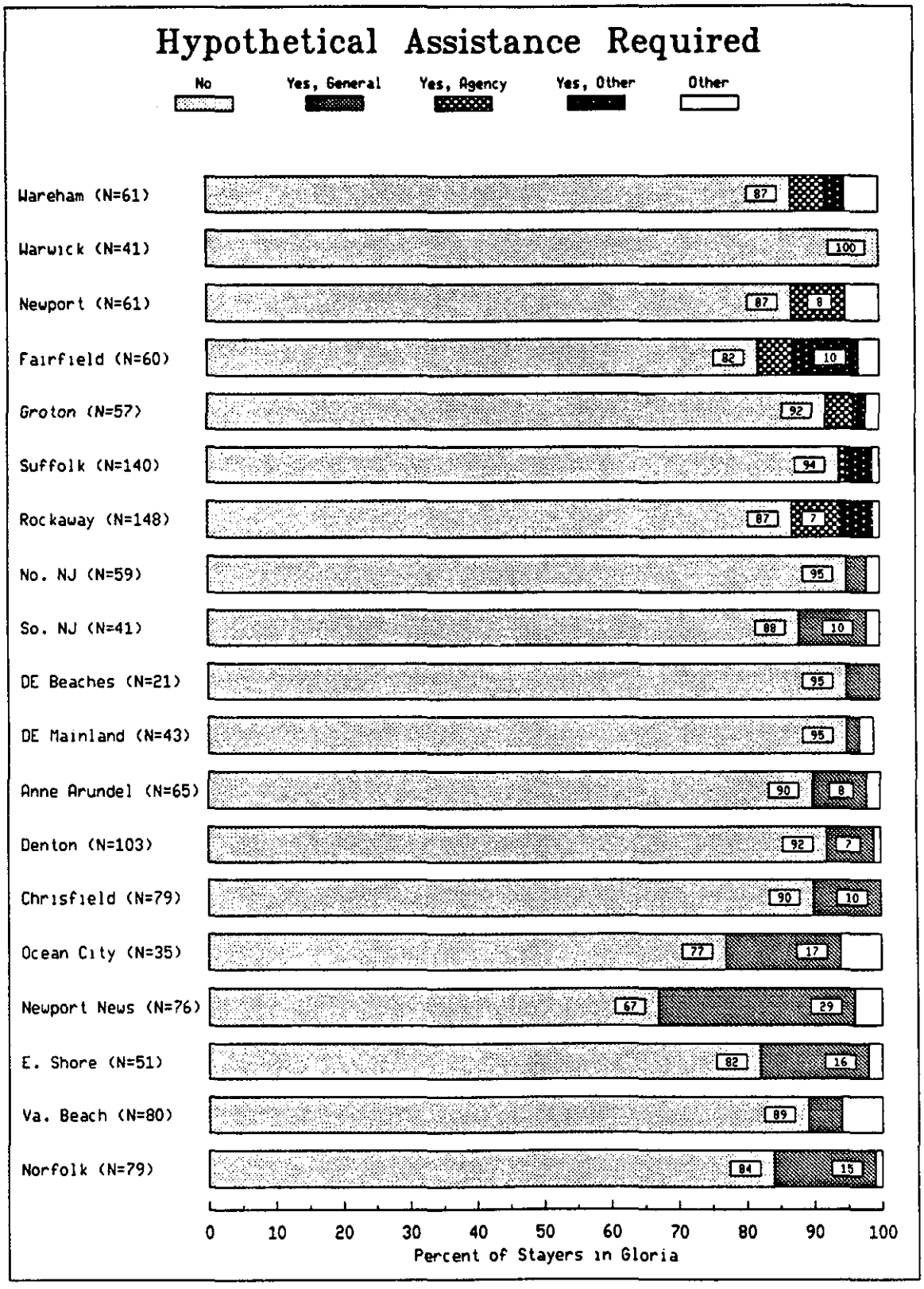
Hypothetical Assistance Required
No
Yes, General
Yes, Agency
Yes, Other
Other
Wareham (N=61)
87
Warwick (N=41)
100
Newport (N=61)
87
8
Fairfield (N=60)
82
10
Groton (N=57)
92
Suffolk (N=140)
94
Rockaway (N=148)
87
7
No. NJ (N=59)
95
So. NJ (N=41)
88
10
DE Beaches (N=21)
95
DE Mainland (N=43)
95
Anne Arundel (N=65)
90
8
Denton (N=103)
92
7
Chrisfield (N=79)
90
10
Ocean City (N=35)
77
17
Newport News (N=76)
67
29
E. Shore (N=51)
82
16
Va. Beach (N=80)
89
Norfolk (N=79)
84
15
0
10
20
30
40
50
60
70
80
90
100
Percent of Stayers in Gloria

FIG. 42

Appendix I

Questionnaire Used in Survey

HURRICANE GLORIA/MID-ATLANTIC/NORTHEAST SURVEY
PHASE II
NOVEMBER, 1987

1. Did you leave your home to go someplace safer in response to the hurricane threat?

--------- 1 Yes (GO TO Q.2)
| 5 No (SKIP TO Q.11)
| 7 Other (GO TO Q.2, IF APPLICABLE)

---> 2. Did you go to a:

1 Public Shelter
3 Friend or Relative's Home
5 Hotel/Motel
7 Other (_____)

3. Where was that located?

1 Locally (in same town as residence)
5 Out-of-town (_____)
(Specify name of town)

4. What convinced you to go someplace safer? (CODE UP TO 3 RESPONSES)

22 Advice or order by elected officials
33 Advice from Weather Service
44 Advice/order from police or fireman
55 Advice from media
66 Advice from friend/relative
77 Concern about severity of storm
88 Concern that storm <u>might</u> hit
91 Heard probability (odds) of hit
95 Other: (_____)
(Specify)

5. When did you leave your home to go someplace safer?

TIME: [ ][ ] : [ ][ ] AM [ ]

PM [ ]

DATE:

M	T	W	R	F	SA	SU
23	24	25	26	27	28	29

6. How long did it take you to get to where you were going?

__ __.__ Hrs (to nearest 1/2 hr)

(Never reached original destination=99.9)

7. When did you first return home from the place to which you evacuated?

T	W	R	F	SA	SU	M	T
24	25	26	27	28	29	30	31

8. Did you or anyone in your household require special assistance in evacuating?

   1 No
   3 Yes, by agency
   5 Yes, by friend or relative within household
   7 Yes, by friend or relative outside household
   9 Don't Know/Not Sure

8a. Did your household use your own vehicle(s) in evacuating, leave with someone else in theirs, or did you use public transportation?

   1 Own
   3 Other's
   5 Public Transportation
   7 Other _____

9. How many vehicles did your household take in evacuating?

   ____

10. How many vehicles were available to take in evacuating?

   ____ (GO TO Q.12)

NON-EVACUEES ONLY

11. What made you decide not to go anyplace else? (CODE UP TO 3 RESPONSES)

   05 Storm not severe/house adequate
   20 Officials said evacuation unnecessary
   30 Media said evacuation unnecessary
   35 Friend/relative said evacuation unnecessary
   45 Probabilities indicated low chance of hit
   55 Information indicated storm wouldn't hit
   60 No Officials said to evacuate
   65 Had no transportation
   70 Had no place to go
   75 Wanted to protect against looters
   80 Wanted to protect against storm
   85 Left unnecessarily in past
   90 Job required staying
   95 Other:_____

FOR EVERYONE:

12. *Did you hear from anyone in an official position -- civil defense, the mayor's office, the governor, police -- that you should evacuate to a safer place?*

1 Yes
-------- 5 No (GO TO Q.14)
-------- 9 Don't Know (GO TO Q.14)

13. Did they say that you should evacuate or that you must evacuate?

1 Should
5 Must
9 Don't Know

-->14. How well do you think the warning and evacuation process was handled in the Gloria threat?

11 Good/OK
22 Traffic a problem
33 Not enough information
55 Shouldn't have been told to evacuate
66 Shelters bad, crowded, etc.
77 Other: _____

14a. Do you think your home would be safe to stay in if a major hurricane were to strike this area directly?

1 No
3 Yes
5 Don't Know

15. Would you do anything differently if you were in the same situation again? *(CODE UP TO 3 RESPONSES)*

11 Would evacuate
22 Wouldn't evacuate
33 Would leave earlier
44 Would wait later to leave
55 Would go further away
66 Wouldn't go as far
77 Would go to public shelter
88 Wouldn't go to public shelter
90 No
95 Other _____

EVACUEES, SKIP TO Q.18

NON-EVACUEES ONLY

16. If you evacuate in a future hurricane, would you go to:

1 A Friend/Relative's Home
3 A Hotel/Motel
5 A Public Shelter
7 Other
9 Don't Know/Not Sure

16a. Where specifically would you go if you evacuated, someplace local or someplace out-of-town?

1 Local (same town/borough as residence)
5 Out-of-town (borough) (_____)
9 Don't Know

17. Would you or anyone in your household need special assistance from anyone outside the household in evacuating?

1 Yes, from government agency
3 Yes, from other
5 No
7 Other _____

17a. Do you have a car or other vehicle to use in evacuating?

1 Yes
3 No
5 Other

17b. If you evacuated, would you need to use public transportation?

1 Yes
3 No
5 Other
7 Don't Know

ASK OF ALL RESPONDENTS

The following questions are for statistical purposes only.

18. Which of the following structures do you live in?

1 High-rise (6 or more stories) Condo or Apartment
3 Detached Single Family Building
5 Mobile Home
7 Other
9 Don't Know/Refused

19. How far is your home from the water?

    1 Waterfront on beach
    3 Waterfront on Sound
    5 Other Waterfront
    2 Less than 1 block from beach
    4 Less than 1 block from bay
    6 Less than 1 block from water
    7 More than 1 block, less than 1 mile from water
    8 More than 1 mile from water
    9 Don't Know/Refused

20. Which of the following ranges describes your household income for a year?

    1 Less than $10,000
    3 $10,000 to $24,999
    5 $25,000 to $39,999
    7 $40,000 to $79,999
    8 over $80,000
    9 Don't Know/Refused

21. How old were you on your last birthday?

    1 Under 25
    3 25 to 39
    5 40 to 65
    7 Over 65
    9 Refused

Thank you, that completes our survey. Good Bye!

Hurricane Evacuation Behavioral Assumptions for Rhode Island

Appendix to
Hurricane Evacuation Behavior in the Middle Atlantic and Northeast States

Prepared by

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For

U.S. ARMY CORPS OF ENGINEERS

October, 1988

Preface

This document is accompanied by a lengthier report titled *Hurricane Evacuation Behavior in the Middle Atlantic and Northeast States*, referred to hereafter as the "Main Report". That volume provides background information relevant to understanding the following discussion. In particular the Main Report describes methodology and data which form the basis for many of the recommendations included in this volume. On occasion this report will make reference to "MR-Fig. *x*", meaning a particular figure in the Main Report.

Sample survey results for two Rhode Island locations are reported in this document, but the reader should be aware that they are included as "tests" of the general response model's applicability to Rhode Island rather than to provide actual figures for evacuation planning. Even for the two sites themselves response in future hurricanes could be considerably different than that observed in Gloria.

Evacuation Rates Among Residents

The percentage of respondents in our sample who evacuated in Gloria varied considerably between interview sites. Sixty-one percent left from Warwick and 37% from Newport (MR-Fig. 8). This does not necessarily mean, however, that more should have left. Substantially more of the Warwick sample lived near water bodies (MR-Fig. 7).

More Warwick area respondents (51%) than Newport (39%) said they were told to evacuate (MR-Fig. 10). In both locations people hearing that they should leave were more than twice as likely to do so (84% vs. 38% in Warwick and 65% vs. 21% in Newport) (MR-Fig. 11). Respondents in Newport were more likely to interpret the evacuation notice as advisory than mandatory, but people in Warwick were about evenly divided (MR-Fig. 12). Overall all in the northern sampling region, people believing the notice to be mandatory were more likely to evacuate (MR-Fig. 13).

In Warwick 62% and in Newport 46% of those who *didn't* leave said they felt safe staying where they were (MR-Fig. 18). About half of all respondents in both locations perceived their houses to be safe in hurricanes (MR-Fig. 15).

Response in Gloria in both interview locations conforms to patterns predicted by the general response model. Table 1 summarizes the general guidelines for use in assigning evacuation rates to specific locations elsewhere in Rhode Island. The table varies response on the basis of four variables.

Severe Storm Evacuation Ordered in High/Mod. Risk Areas, and Mobile Homes			Weak Storm Evacuation Ordered in High Risk Areas Only, and Mobile Homes		
Risk Area					
High	*Mod*	*Low*	*High*	*Mod*	*Low*
Housing Other Than Mobile Homes					
90%	80%	30%	80%	40%	20%
Mobile Homes					
90%	85%	60%	90%	75%	55%

Note:

Figures will be lower if officials are not successful in communicating orders.

Table 1. Evacuation rates to be used for planning in Rhode Island.

Storm Severity

The table addresses two storm scenarios. The first is a strong storm, a category 3 or worse. The second storm is weaker. The difference obviously is that more people are at risk in the more severe storm, and evacuation will be greater from moderate-risk and low-risk locations.

Action by Officials

It is assumed that officials will tell people to leave from high-risk and moderate-risk locations and tell all mobile home dwellers in coastal counties to evacuate in the severe storm. In the weaker storm only mobile home residents and people who live in high-risk locations are told to leave.

It is also assumed that officials are successful at communicating the evacuation notices to residents. The Gloria data attests to the greater likelihood of people leaving if they believe officials have told them to. The only way to ensure that everyone will hear the notice is to have it disseminated door-to-door. If that is not possible, vehicles with loudspeakers are the second best method. If officials cannot disseminate the evacuation notices in either of those manners, evacuation rates will be 25% lower in high-risk areas and 50% lower in moderate-risk and low-risk areas.

Risk Area

High-risk areas refer primarily to barrier islands and other land areas exposed to the open ocean where wave battering and scour are major hazards in addition to flooding. Moderate-risk areas are subject to flooding in moderate to strong storms but do not experience significant battering and scour. Low-risk areas are subject only to wind and are adjacent to moderate-risk locations. Most of the

sample households in the two areas are located in high-risk to moderate-risk locations. More of the Warwick sample is probably high risk.

Housing

Table 1 distinguishes between mobile homes and other housing. Neither of the survey locations contained a large percentage of mobile homes, but they should be considered separately for planning. Evacuation will be greater from mobile homes than from other housing, all other factors being the same.

Evacuation Timing By Residents

With so few evacuees in the two samples, it's difficult to make very confident statements about the exact time evacuees left. The matter is further complicated by the fact that interviewees were being asked to recall fairly precise information from something that occurred two years previously.

Evacuation timing, however, will vary greatly from storm to storm, and little can be generalized from Gloria. For planning purposes three different sets of assumptions depicted in Figure 1 should be analyzed. The three curves in Figure 1 reflect three different rates at which evacuees leave, reflecting in turn three different levels of urgency.

The left-most curve represents response when forecasts are early and residents are told to evacuate with plenty of warning. That scenario should probably be called optimistic. The middle curve is probably more typical. Warning is not quite so early in relation to landfall. Finally, the right-hand curve will pertain when a storm accelerates, intensifies, or changes course unexpectedly. People will leave very promptly if it is made clear to them that they must. All three curves should be used for planning because all three will occur eventually.

Fewer than 20% of eventual evacuees will leave before being told to leave. When told, however, people will leave as promptly as they believe they must. Given the luxury of time, most people will not evacuate late at night and will wait until morning if they haven't left by 11 pm or midnight. People <u>will</u> leave in the middle of the night if officials make it clear that circumstances make it imperative that they do so. People from high-risk locations (barrier islands) tend to leave earlier than other evacuees.

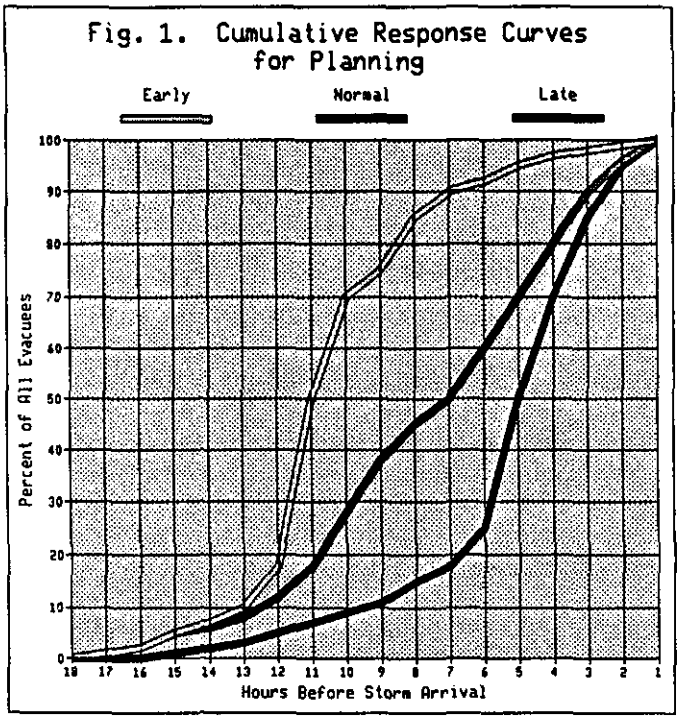
Fig. 1. Cumulative Response Curves for Planning
Early
Normal
Late
Percent of All Evacuees
100
90
80
70
60
50
40
30
20
10
0
18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Hours Before Storm Arrival

Demand for Public Shelters by Residents

Very few evacuees in either survey area used public shelters: 8% of the Warwick evacuees said they went to public shelters compared to 3% of the Newport evacuees (MR-Fig. 25). Due to the sample sizes, however, both figures are subject to enough uncertainty to prevent the conclusion that there were overall differences in shelter use among all evacuees from the two areas. Such figures are normal for high-risk locations. Residents of beach communities and waterfront locations usually have higher incomes and choose not to stay at public shelters and can afford motels if arrangements can't be made with friends and relatives. They also tend to leave earlier and go farther.

Late night evacuation tends to maximize shelter use, primarily because it is occurring with a sense of urgency, leaving no time to make alternative arrangements with friends, relatives, and motels or leaving too little time to travel the distance necessary to go out-of-town, particularly at night.

Hypothetical shelter use among non-evacuees was greater than actual use among evacuees (36% in Warwick and 22% in Newport) (MR-Fig. 27). These hypothetical responses are typical of the overestimation normally observed when comparing intended to actual shelter use. It does, however, tend to reinforce the notion that dependence upon public shelters will be greater in Warwick. It's likely that *if* the stayers in Gloria had evacuated, 15% in Warwick and 10% in Newport would have attempted to go to public shelters.

Table 2, showing guidelines for projecting normal shelter demand, reflects these patterns. Late, urgent evacuations, which will roughly double normal shelter demand, are not a function of location. It should also be noted that emergency

	Risk Area		
	High	*Mod*	*Low*
Income			
High	5%	5%	10%
Med.	10%	15%	15%
Low	-	30%	30%

Note:

Figures will be higher if officials encourage use of public shelters.

Figures will be lower for developments with on-site shelters (e.g., clubhouses).

Figures will be lower where churches and other organizations shelter members.

Table 2. Evacuees going to public shelters: planning assumptions for Rhode Island.

management officials in some communities encourage shelter use more than others, and such policies should be taken into account in planning, because officials can take actions which either increase or decrease shelter use. Other factors to note are that retirees living in "retirement areas" are more likely to use public shelters than other groups, some communities have churches and other organizations which reduce "public" shelter use by being more active than normal in providing their own shelters, and some housing developments and mobile home parks provide onsite shelter which will alleviate demand for public shelter.

Evacuation Out-of-Town by Residents

Few of the people evacuating from either survey area went out-of-town: 31% in Warwick and 21% in Newport (MR-Fig. 30). Almost everyone in both locations said they required 30 minutes or less to reach their destinations, however, suggesting that evacuees travelled very short distances (MR-Fig. 31).

Differences are usually accounted for primarily by income (low income residents don't go as far), evacuation timing (late night, urgent evacuees don't go as far), and risk area (evacuees from high-risk beach areas go farther). Table 3 reflects these generalizations. Note too, that emergency management officials can influence this response. In some locations agencies have policies to discourage evacuees from staying in the local area. Communities which aggressively provide and publicize public shelters will have fewer evacuees leaving the local area.

Very Strong Storm, Early Evacuation			Weak Storm Typical Timing		
Risk Area			Risk Area		
High	*Mod*	*Low*	*High*	*Mod*	*Low*
65%	40%	10%	40%	30%	20%

Note:

Figures will be lower for low income and elderly retired evacuees.

Figures will be lower for last minute evacuations.

Figures will be higher if officials encourage evacuees to leave area.

Table 3. Percent of evacuees leaving local area: planning assumptions for Rhode Island.

Vehicle Use by Residents

The average number of vehicles used per evacuating household in Gloria was greater for Warwick (1.5) than Newport (1.2) (MR-Fig. 37). About 10% in both locations used no vehicles at all, probably walking short distances to friends or to shelters or riding with someone else (MR-Fig. 36).

Normally 65% to 75% of the vehicles available to a household are used in evacuations, and both Rhode Island survey locations fell within or near that range in Gloria (71% and 76%). **For planning purposes it would be reasonable to assume that approximately 70% to 75% of available vehicles will be used in most evacuations.**

No one in either sample said they required assistance from public agencies in evacuating (MR-Fig. 41), and no one said they used public transportation (MR-Fig. 38). Of those respondents who did *not* evacuate in Gloria, no one in Warwick but 8% in Newport said they would have needed agency assistance if they had evacuated (MR Fig. 42). Normally, however, even in communities where agencies prepare lists of people and addresses needing evacuation assistance, it is common to find that those people have already been provided for by friends and relatives when public vehicles arrive to collect them. About 5% of the stayers in both sites said they would use public transportation if they evacuated (MR-Fig. 40). Five percent of the stayers in Warwick and 11% in Newport said they had no cars of their own available (MR-Fig. 39).

APPENDIX C

Transportation Analysis Support Documentation

April 1995

RHODE ISLAND HURRICANE EVACUATION STUDY
Transportation Analysis Support Documentation

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