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Summary of Biomass Trends and Conditions for Major Northwest Atlantic Fisheries Resources: A Graphical Approach

by

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INTRODUCTION

The Resource Assessment Division of the Northeast Fisheries Center annually updates the status of the major finfish and shellfish resources off the northeastern coast of the United States from Nova Scotia to Cape Hatteras. This information is presented on a species/stock basis in individual assessment reports available as Woods Hole Laboratory Reference Documents and is summarized in the annual Status of the Fishery Resources report prepared by the Resource Assessment Division. These reports are distributed to fishery managers and administrators, scientists, industry personnel, and the general public as requested and/or needed. In almost all cases, the assessment data are used in the fishery management process as the biological basis for management programs.

The large and increasing number of individual stocks assessed by the Division results in a substantial quantity of biological information to be assimilated by fishery managers. To help minimize the effort required to gain an appreciation of stock conditions, both currently and in an historical context, and to promote a more lucid understanding of stock levels at which management concerns might be considered, a graphical summary of stock status for the principal USA Northwest Atlantic fishery resources has been developed. This report describes the development of this summary and the information contained therein, as well as the expected utility of the graphical approach in evaluating assessment results.

METHODS

Assessment information on historical and current biomass levels was obtained from Woods Hole laboratory reference documents and/or published

scientific papers based on these reports. For each stock, the median biomass level was determined for the historically available time series. The median level was derived by ranking, from lowest to highest, all of the yearly biomass estimates and selecting that value which had an equal number of observations on both sides of it. The highest, lowest, and current levels of biomass for each stock were also identified. Table 1 presents these data for 29 separate stocks and for the total finfish and squid complex. Also listed in the table are the biomass indices utilized, the time series of data evaluated, the primary data sources and the current management status for each resource.

Graphic representation of biomass conditions was accomplished by relating the highest, lowest, and current levels for each stock to its median value. The range in biomass fluctuation is depicted as a multiple or fraction of the median by dividing the highest and lowest biomass values by the median, e.g. the range for Gulf of Maine haddock was determined from:

$$\frac{33.6 \text{ high}}{8.2 \text{ median}} = 4.1X \qquad \frac{2.0 \text{ low}}{8.2 \text{ median}} = 0.24 = 1/4.1X$$

Similarly, the current biomass value was divided by the median to assess the relation of the present stock size to both the median and range of observed stock levels, e.g. for Gulf of Maine haddock.

$$\frac{7.8 \quad 1981 \text{ value}}{8.2 \quad \text{median}} = 0.95X$$

The range for each stock is graphically depicted by a vertical line extending from the highest proportional level to the lowest, e.g., for Gulf of Maine haddock from 4.1X to 1/4.1X. The years in which the highest and lowest values occurred are also included on the chart and provide a temporal framework for gauging the rapidity of stock changes.

The current stock biomass level is indicated graphically by a horizontal bar across the range line, e.g., for Gulf of Maine haddock at 0.95X. Adjacent to the current biomass level is a symbol indicating the expected direction of biomass change in the near future based on current recruitment patterns and population growth rate.

Portions of the range have been marked with stippled and block shading to indicate the relative stock biomass levels at which the risk of recruitment overfishing appears heightened. The stippled zone represents a warning area, generally near the lowest stock sizes, at which recruitment failure might be expected to occur, although this may not as yet have occurred. The block zone indicates a danger area of stock sizes at which recruitment overfishing has previously been observed. For those stocks with only stippled shading, it should be realized that this warning region may encompass a presently unknown danger area. This is particularly true for warning regions extending below the lowest observed stock levels.

RESULTS AND DISCUSSION

Figure 1 is the graphical summary of the stock biomass data tabulated in Table 1. Individual finfish stocks are presented in a geographical sequence from the Gulf of Maine to the Mid-Atlantic. The first 17 stocks (Gulf of Maine haddock to summer flounder) include the major demersal finfish resources off the northeastern United States. The next 7 stocks (bluefish to *Illex*)

include the major pelagic stocks of fish in USA Atlantic waters, followed by total finfish and squids and the major invertebrate resources.

Several general but important relationships are rapidly and easily discernible from the graphical summary:

1. For almost all stocks, the upper bound on biomass is generally no larger than 4-5X the median while the lower bound may be proportionally much lower, often as low as 1/10 to 1/20 of the median. This pattern suggests that biological and ecological factors probably constrain the upper limit of stock biomass while exploitation can have a marked effect in reducing stock levels to their lowest bounds.

2. The range in variability of biomass appears to be as large in demersal stocks as it is in pelagic species. For example, Georges Bank haddock and Southern New England yellowtail flounder exhibit as much variability as bluefish and Georges Bank herring. However, the factors affecting this variability may be quite different. Relatively short-lived species like Illex are apt to be more affected by environmental conditions causing large variations in biomass then longer-lived species like haddock where biomass variations are also influenced by the number of age groups in the stock. When fishing activity reduces the number of age groups in a stock as happened to Georges Bank haddock in the late 1960's, large variations in biomass primarily reflect recruitment success, the situation normally observed in short-lived species. The extreme variation in Illex biomass, however (10X to 1/14X), is probably also a function of availability since this species often migrates out of the geographical range covered by assessment surveys.

3. Currently, more stocks appear to be increasing in biomass than decreasing. This is probably a result of the substantial reduction in foreign fishery effort during the past six years. The increase in biomass of total

finfish and squids since 1975 tends to support this inference. Under more normal circumstances, however, there would probably be as many stocks decreasing in biomass as increasing. The differences among stocks in the time (years) at which maximum and minimum biomass levels were observed suggests such an expected pattern of biomass changes.

4. For stocks harvested together in a single fishery (e.g., Georges Bank haddock and cod in the mixed trawl fishery), the relation of current biomass and the expected directionality of biomass change with respect to the median and the warning and danger zones appears quite different among stocks. This overview suggests that simultaneous increases in biomass of all components in the mixed fishery is unlikely due to the differential fishing mortalities generated by the common fishery on each component stock.

As presented, the graphical depiction of biomass conditions for the major USA Northwest Atlantic fishery resources represents a preliminary attempt to provide an easily understood but comprehensive overview of resource patterns in a holistic context. Effort is continuing to improve and refine this presentation so that it may be of maximum benefit to fishery managers in rapidly identifying current stock levels from an historical perspective, in clearly evaluating expected future changes in stock sizes, and in assessing current and anticipated biomass conditions in relation to stock levels at which average recruitment may be significantly jeopardized.

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Table 1. Summary of current and historical biomass conditions for major Northwest Atlantic fisheries resources.

Stock	Biomass Median	Biomass Maximum	Biomass Minimum	Current value	Biomass units	Index	Primary data source	Current Fishery Management Status
Gulf of Maine Haddock	8.2 (1963-1981)	33.6 (1963)	2.0 (1972)	7.8 (1981)	kg/tow (0+)	Autumn survey	Clark et al. 1982 Woods Hole Lab. Ref. 82-32	Managed under Fishery Management Plan (FMP)
Gulf of Maine Cod	9.4 (1963-1980)	14.1 (1964)	4.2 (1976)	13.1 (1980)	kg/tow (0+)	Autumn survey	Serchuk et al. 1982 Woods Hole Lab. Ref. 82-33	Managed under FMP
Gulf of Maine Silver hake	75 (1955-1981)	194 (1955)	16 (1971)	30 (1981)	10^{-3}tons (2+)	VPA	Almeida and Anderson 1981 Woods Hole Lab. Ref. 81-36	Managed under Preliminary Fishery Management Plan (PMP)
Gulf of Maine American plaice	4.3 (1963-1981)	11.1 (1980)	2.2 (1972)	10.0 (1981)	kg/tow (0+)	Autumn survey	Serchuk 1982 Unpublished data	No USA management FMP in preparation (ADF Plan)
Gulf of Maine Witch flounder	2.5 (1963-1980)	4.5 (1966)	1.0 (1976)	2.5 (1980)	kg/tow (0+)	Autumn survey	Clark 1982 Unpublished data	No USA management FMP in preparation (ADF Plan)
Pollock	4.8 (1968-1981)	6.8 (1967)	2.7 (1969)	6.3 (1981)	kg/tow (0+)	Spring survey	Clark et al. 1981 Woods Hole Lab. Ref. 81-32	No USA management FMP in preparation (ADF Plan)
Redfish	23.5 (1963-1981)	54.6 (1964)	12.2 (1981)	12.2 (1981)	kg/tow (0+)	Autumn survey	Mayo 1980 J. Northw. Atl. Fish. Sci. 1:21-37	No USA management FMP in preparation (ADF Plan)
Georges Bank Haddock	153 (1935-1960)	427 (1965)	14 (1973)	67 (1982)	10^{-3}tons (2+)	VPA	Clark et al. 1982 Woods Hole Lab. Ref. 82-32	Managed under FMP
Georges Bank Cod	8.7 (1963-1981)	21.5 (1978)	4.9 (1969)	17.5 (1981)	kg/tow (0+)	Autumn survey	Serchuk et al. 1982 Woods Hole Lab. Ref. 82-33	Managed under FMP
Georges Bank Yellowtail flounder	4.9 (1963-1981)	10.6 (1964)	1.2 (1976)	2.3 (1981)	kg/tow (0+)	Autumn survey	Clark et al. 1981 Woods Hole Lab. Ref. 81-10	Managed under FMP
Georges Bank Silver hake	143 (1955-1981)	595 (1964)	26 (1978)	32 (1981)	10^{-3} tons (2+)	VPA	Almeida and Anderson 1981 Woods Hole Lab. Ref. 81-36	Managed under FMP
Georges Bank Red hake	0.8 (1970-1982)	2.4 (1971)	0.1 (1982)	0.1 (1982)	kg/tow (0+)	Spring survey	Almeida and Anderson 1981 Woods Hole Lab. Ref. 81-37	Managed under FMP
So. New England Yellowtail flounder	9.2 (1963-1981)	20.1 (1972)	0.7 (1975)	3.8 (1981)	kg/tow (0+)	Autumn survey	Clark et al. 1981 Woods Hole Lab. Ref. 81-10	Managed under FMP
So. New England-Mid-Atlantic Silver hake	93 (1955-1981)	375 (1965)	57 (1958)	61 (1981)	10^{-3} tons (2+)	VPA	Almeida and Anderson 1981 Woods Hole Lab. Ref. 81-36	Managed under FMP
So. New England-Mid-Atlantic Red hake	94 (1963-1981)	174 (1965)	30 (1977)	38 (1981)	10^{-3}tons (2+)	VPA	Almeida and Anderson 1981 Woods Hole Lab. Ref. 81-37	Managed under FMP
So. New England-Mid-Atlantic Scup	6.2 (1968-1981)	12.4 (1979)	1.1 (1969)	3.2 (1981)	kg/tow (0+)	Spring survey	Mayo 1982 Woods Hole Lab. Ref. 82-	No USA management FMP planned
Summer flounder	0.3 (1968-1980)	1.0 (1976)	0.05 (1970)	0.4 (1980)	kg/tow (0+)	Spring survey	Fogarty 1981 Woods Hole Lab. Ref. 81-25	No USA management FMP in preparation

Table 1. Cont.

Stock	Biomass Median	Biomass Maximum	Biomass Minimum	Current value	Biomass units	Index	Primary data source	Current Fishery Management Status
Bluefish	0.7 (1967-1981)	1.5 (1974)	0.01 (1968)	0.6 (1981)	kg/tow (0+)	Autumn survey	Anderson 1980 Woods Hole Lab. Ref. 80-30	No USA management FMP developed
Gulf of Maine Herring	103 (1965-1981)	175 (1968)	34 (1973)	83 (1981)	10^{-3}tons (4+)	VPA	Fogarty & Anthony 1982 Woods Hole Lab. Ref.82-34	Managed under FMP through mid-1982.
Georges Bank Herring	342 (1961-1977)	1143 (1967)	Near 0 (1981)	Near 0 (1981)	10^{-3}tons (4+)	VPA	Anthony & Waring 1980 Rapp P-v. Reun. Con. int. Mer 172:72-111.	Managed under FMP through mid-1982.
Atlantic mackerel	915 (1962-1981)	2827 (1970)	567 (1962)	780 (1981)	10^{-3}tons (1+)	VPA	Anderson 1981 Woods Hole Lab. Ref. 81-38	Managed under FMP
Butterfish	5.5 (1968-1982)	20.6 (1980)	2.9 (1975)	5.2 (1982)	kg/tow (0+)	Autumn survey	Waring & Anderson 1981 Woods Hole Lab. Ref. 81-27	Managed under FMP
Loligo squid	28.3 (1968-1981)	51.4 (1976)	14.1 (1971)	24.3 (1981)	10^{-3}tons (0+)	Autumn survey	Lange 1982 Woods Hole Lab. Ref. 82-27	Managed under FMP
Illex squid	5.4 (1968-1981)	68.6 (1981)	0.4 (1969)	68.6 (1981)	10^{-3}tons (0+)	Autumn survey	Lange 1982 Woods Hole Lab. Ref. 82-27	Managed under FMP
Total Finfish and Squids Gulf of Maine-Cape Hatteras	3416 (1965-1981)	8012 (1968)	1934 (1975)	3358 (1981)	10^{-3}tons	VPAs and Surveys	Clark and Brown 1979 Inv. Pesq. 43:107-122	No USA management as a unit.
Georges Bank Sea scallops	1.2 (1975-1982)	2.5 (1978)	0.6 (1982)	0.6 (1982)	kg/tow (meat) ($\geq$70 mm)	Scallop survey	Serchuk et al. 1982 Woods Hole Lab. Ref. 82-06	Managed under FMP
Mid-Atlantic Sea scallops	0.3 (1975-1982)	0.7 (1978)	0.18 (1981)	0.2 (1982)	kg/tow (meat) ($\geq$70 mm)	Scallop survey	Serchuk et al. 1982 Woods Hole Lab. Ref. 82-06	Managed under FMP
Mid-Atlantic Surf Clam	2.5 (1965-1982)	4.3 (1982)	0.5 (1977)	4.3 (1982)	kg/tow (meat) (0+)	Surf clam survey	Murawski & Serchuk 1981 Woods Hole Lab. Ref. 81-33	Managed under FMP
Offshore American Lobster	0.8 (1963-1981)	1.3 (1964)	0.5 (1970)	0.9 (1981)	kg/tow (0+)	Autumn survey	Fogarty et al. 1982 ICES C.M. 1982/K:14	FMP prepared
Gulf of Maine Northern Shrimp	5.8 (1972-1981)	45.8 (1968)	1.6 (1977)	3.0 (1981)	kg/tow (0+)	Maine summer survey	Clark 1982 ICES C.M. 1982/K:13	Managed by States under ASMFC

Figure 1. Graphical summary of biomass patterns for major Northwest Atlantic finfish and shellfish resources.

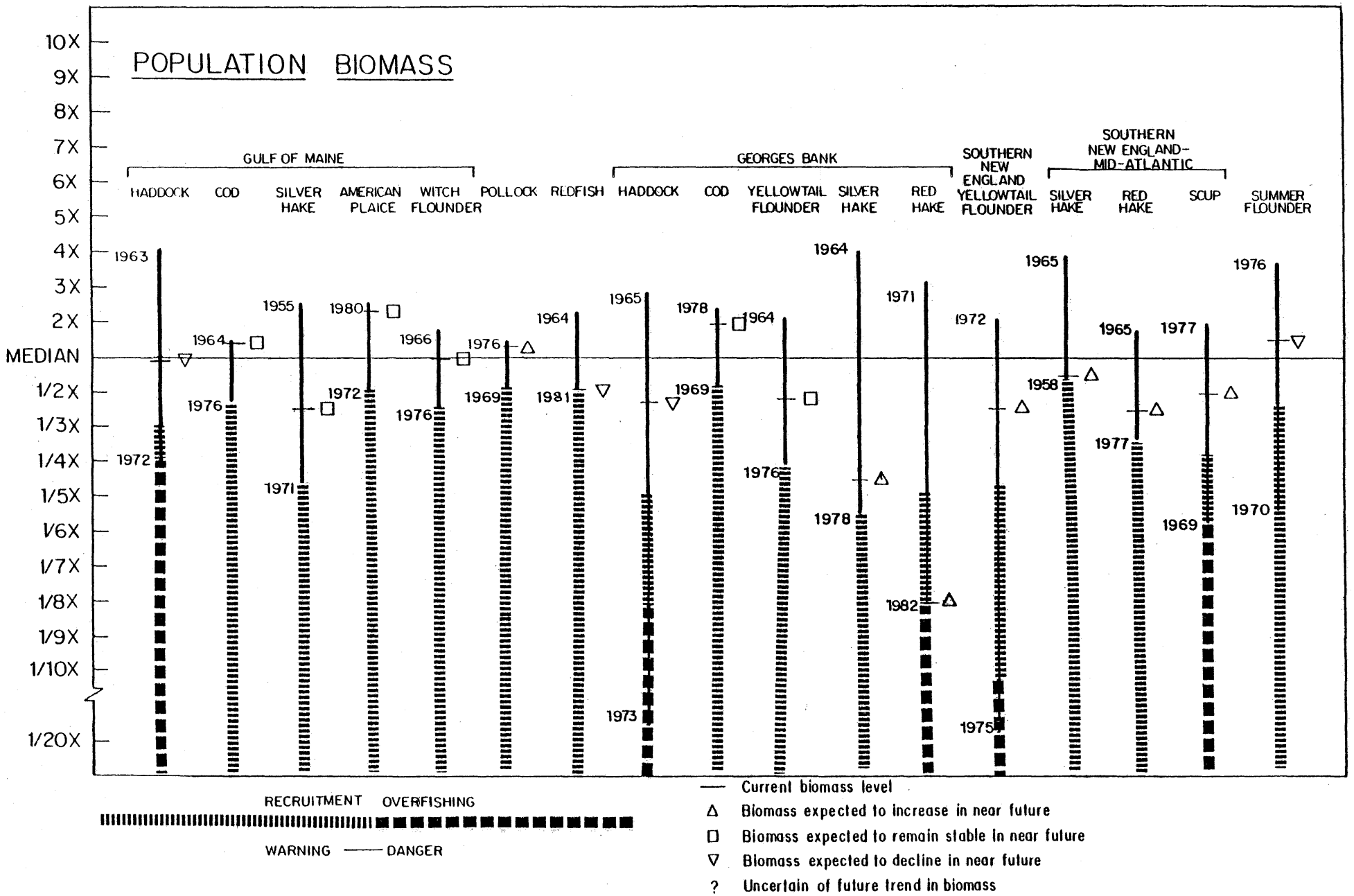
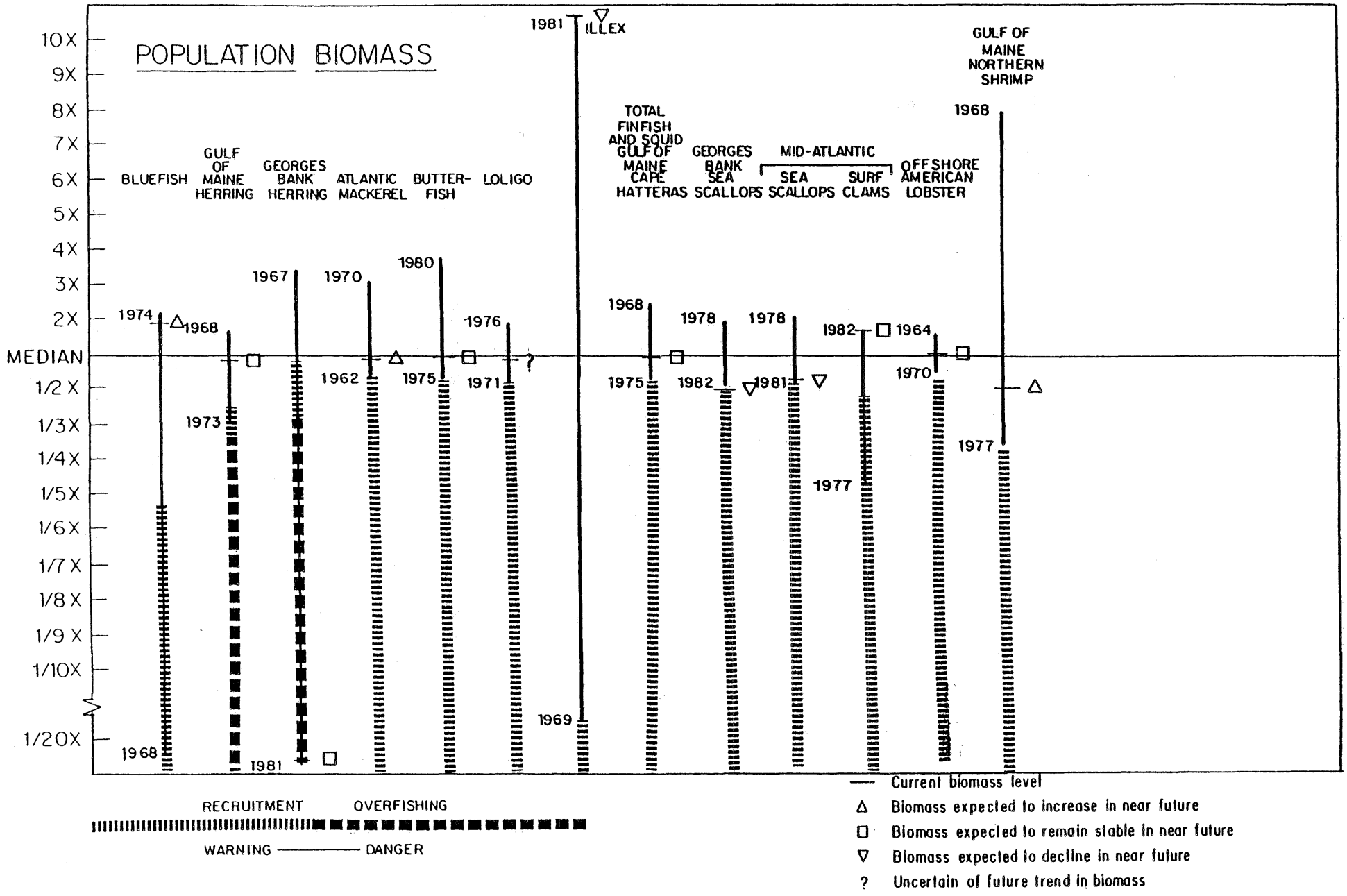
Figure 1. (continued). Graphical summary of biomass patterns for major Northwest Atlantic finfish and shellfish resources.