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FWS/OBS-78/07
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PROBABILITY-OF-USE CRITERIA FOR
THE FAMILY SALMONIDAE

Instream Flow Information Paper No. 4

by

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as part of the Federal
Interagency Energy/Environment
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Office of Research and Development
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Cooperative Instream Flow Service Group
Western Energy and Land Use Team
Office of Biological Services
Fish and Wildlife Service
U.S. Department of the Interior

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on IPA Assignment from December 1976 - December 1977, to Cooperative
Instream Flow Service Group.

-- ADDENDUM --

It has come to our attention that there may be some undetected data bias in the curves for steelhead. The information we have received to date, suggests that the depth curves for steelhead fry and juveniles do not tail off at depths greater than 1.5 feet (juvenile curve) or 0.5 ft (fry curve). Additionally, the depth curve for spawning steelhead is probably appropriate for small streams only. For larger rivers, it is likely that this curve as well, does not tail off at depths greater than the indicated optimum depth. We hope to have the answers to some of these discrepancies by the time the next update of these curves is published.

PREFACE

This document gives probability-of-use criteria for the hydraulic parameters of depth, velocity, substrate, and temperature, for the family Salmonidae. It is intended as a companion document to Instream Flow Information Paper No. 3, Development and Evaluation of Weighted Criteria, Probability-of-Use Curves for Instream Flow Assessments: Fisheries, which describes the techniques used to construct and criteria used to evaluate each set. The user is urged to keep both volumes together for cross-reference.

Except for egg incubation, a curve set for each life stage consists of four curves; one each for velocity, depth, substrate, and temperature. The criteria selected for egg incubation is a function of the channel slope and sediment concentration. Incubation is usually represented by six curve sets, with different combinations of slope and sediment concentration. The user should select the curve set which most closely resembles the conditions at each study area.

A curve maintenance program has been developed by the Instream Flow Group to store a digitized file of these curves on magnetic tape. This program will be utilized by IFG to store new curves and update old ones. Updated versions of curves and curves for species not included in this

publication will be released by IFG periodically as new data becomes available. Any comments or questions involving these curves, or any additional data on the family Salmonidae, may be directed to:

Cooperative Instream Flow Service Group
 U.S. Fish and Wildlife Service
 Room 206, Federal Building
 Fort Collins, Colorado 80521

We extend our gratitude to those individuals who have submitted unpublished data on various species of fish. Without their cooperation the development of probability criteria would have been virtually impossible. Contributing individuals and organizations are listed below:

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 Montana Department of Fish and Game

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 Idaho Department of Fish and Game

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 Utah Cooperative Fishery Research Unit
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INSTREAM FLOW INFORMATION PAPERS ISSUED

The following list of substrate codes will be useful in the reading and interpretation of the probability curves for substrate.

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<u>SUBSTRATE</u>	<u>CODE NUMBER</u>
Plant detritus/ organic material	1
Mud/Soft Clay	2
Silt	3
Sand	4
Gravel	5
Cobble/Rubble	6
Boulder	7
Bedrock	8

NOTE: Gradations between code numbers refer to a rough proportion between one substrate type and another. For example, a 5.5 substrate code would indicate a gravel/cobble mixture with approximately equal portions of each particle size. A code of 4.8 would indicate a mix of approximately 80% gravel and 20% sand, whereas a code of 5.2 would mean 80% gravel and 20% cobble.

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COHO SALMON

Oncorhynchus kisutch

Catalog No.	10010 Spawning				Adult				Juvenile				10000 Fry				10021-10026 Egg Incubation			
	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
SPECIES: Coho																				
IFG EVALUATION	G	G	F	R									E	E	E	G	F	F	F	R
REFERENCE	1	1	1	1									15	15	15	5	9,10	9,10	10	5
	FA	FA	FA	RO									FA	FA	FA	RO	IN	IN	IN	PO
ANALYSIS			7	31											15	24	24	36	10	
			RO	RO											FA	IN	IN	IN	RO	
COMMENTS																	38	38	38	31
																	IN	IN	IN	PO
																	36	36		
																	IN	IN		

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

Reference: Refer to listed number in bibliography.

Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - indirect analysis

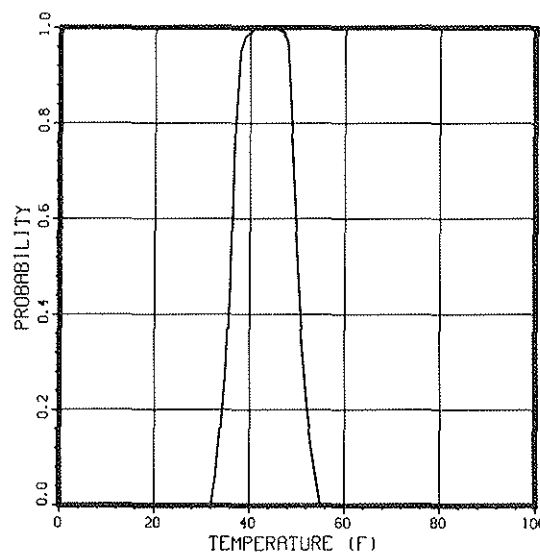
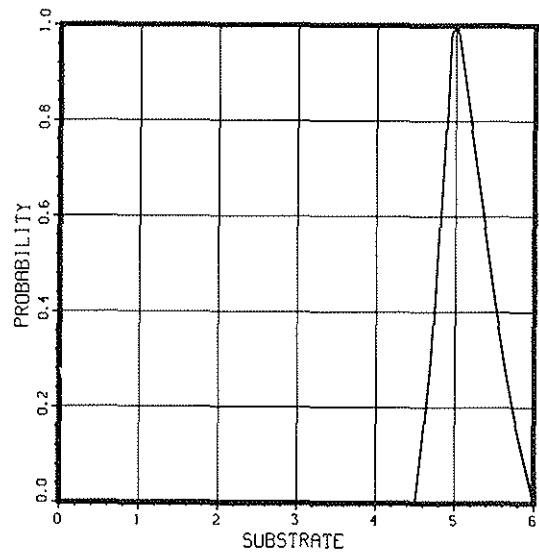
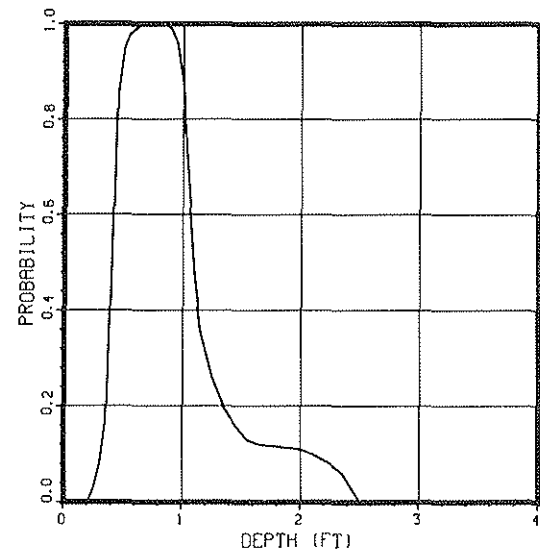
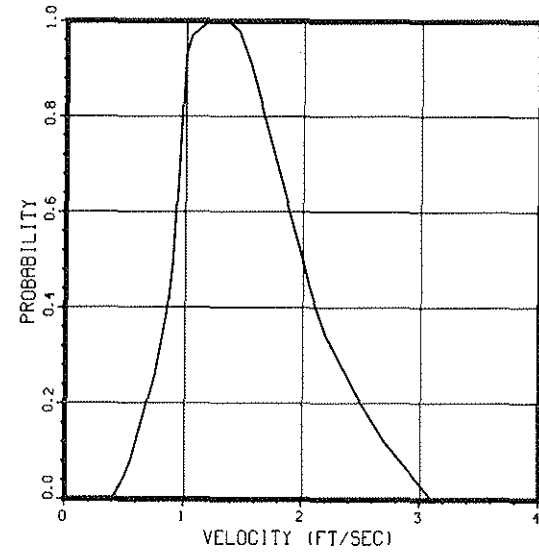
Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

COHO SALMON

10010

SPAWNING

78/01/24.

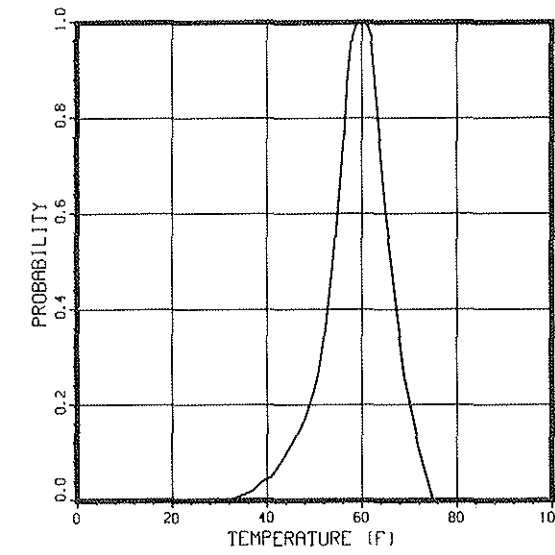
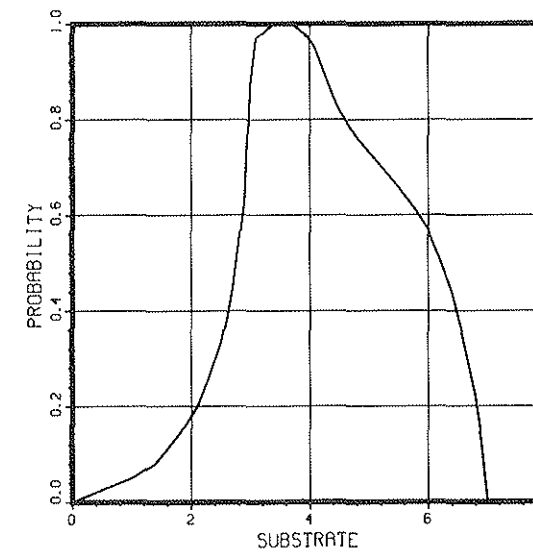
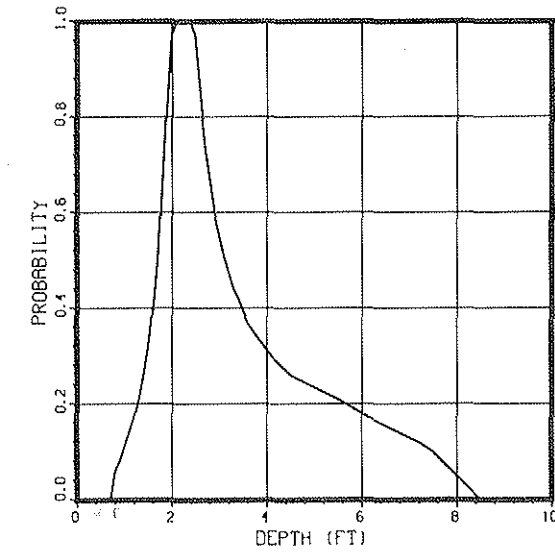
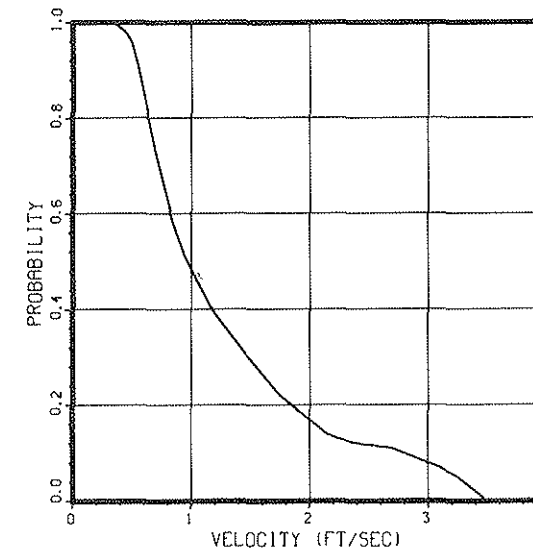


MOUNTAIN WHITEFISH

12000

FRY

78/01/24.

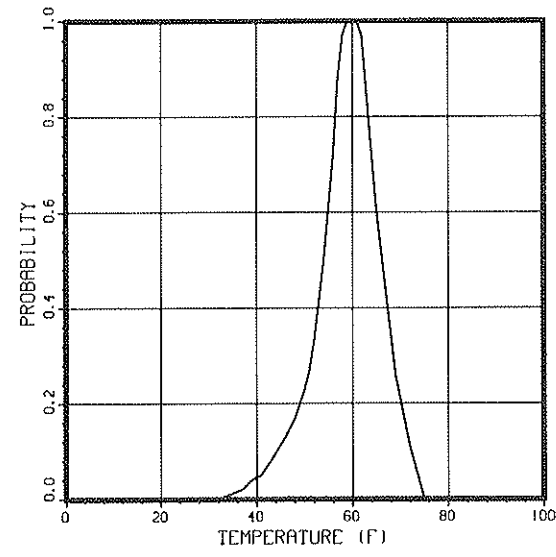
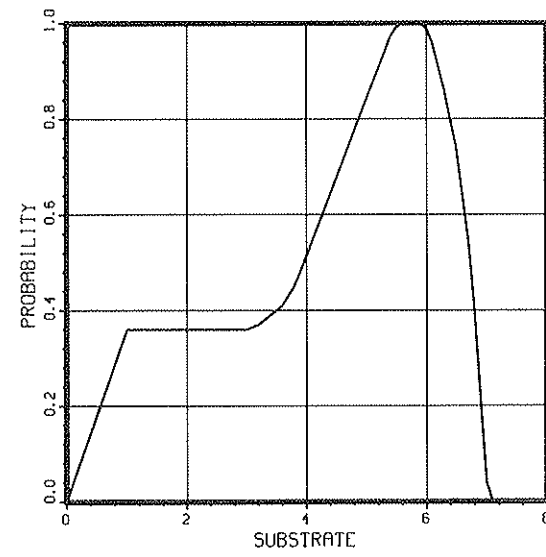
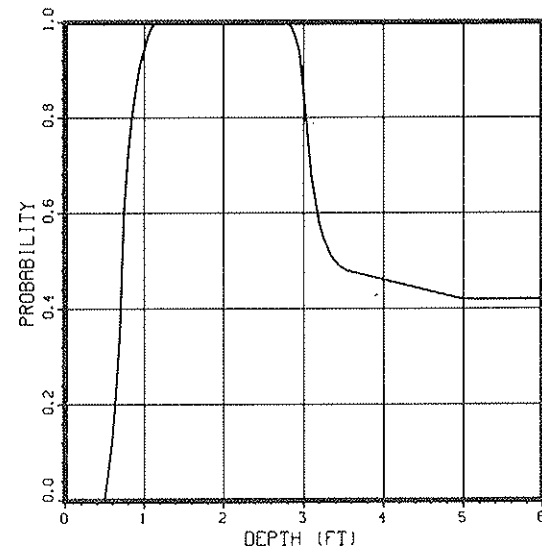
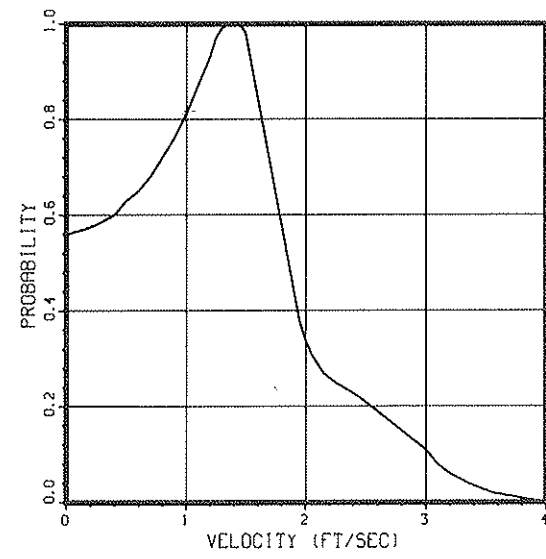


MOUNTAIN WHITEFISH

12001

JUVENILE

78/01/24.

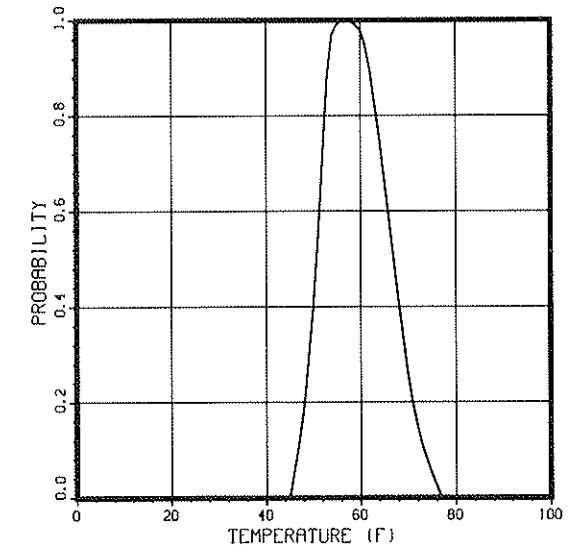
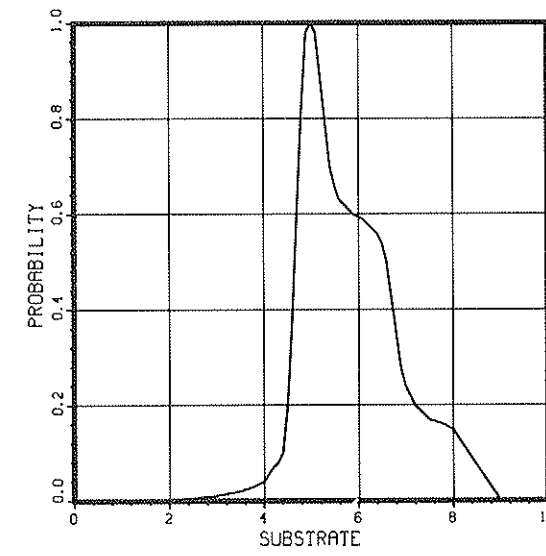
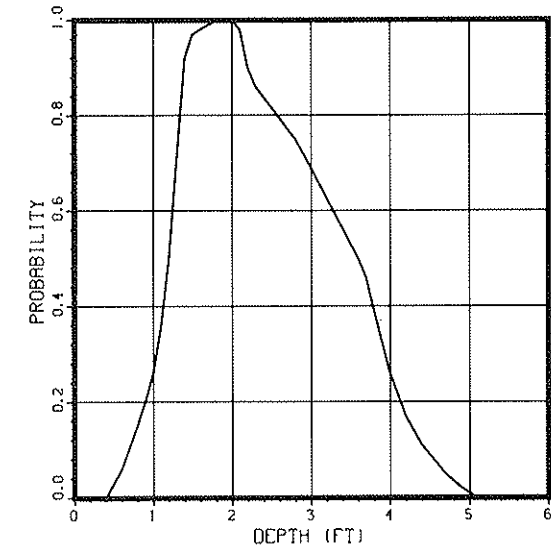
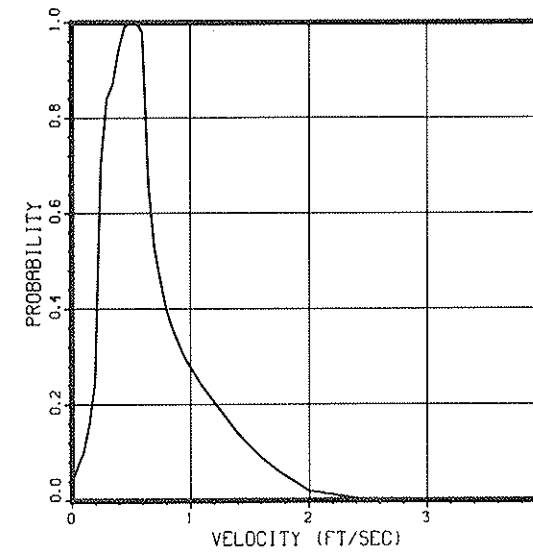


COHO SALMON

10000

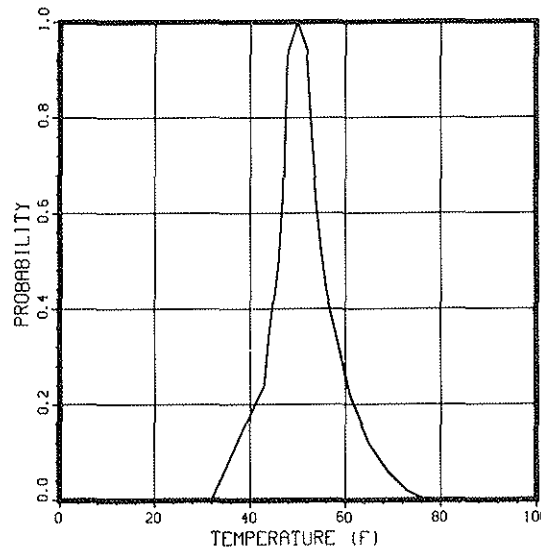
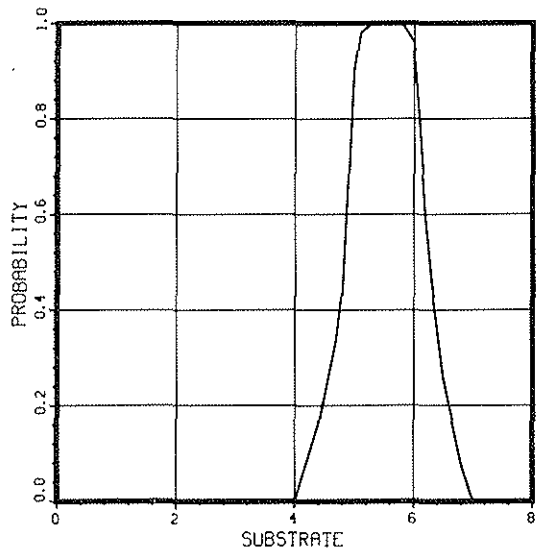
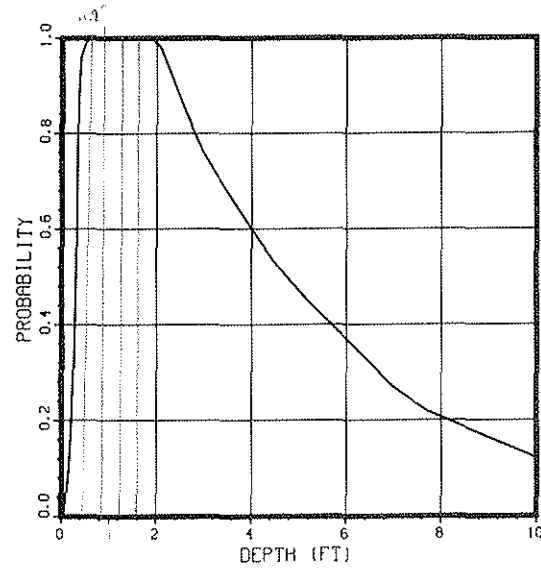
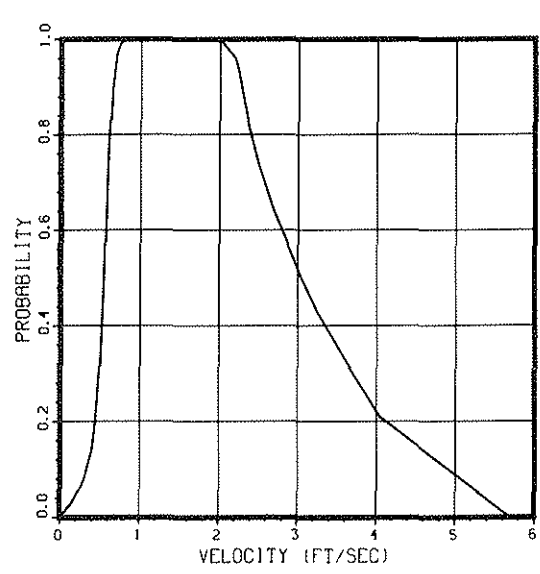
FRY

78/01/24.



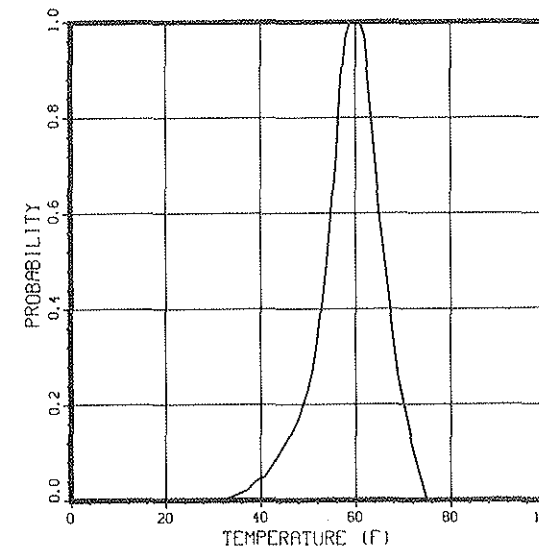
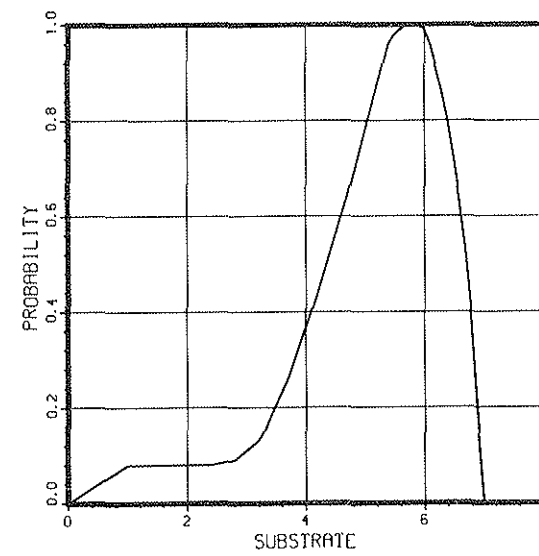
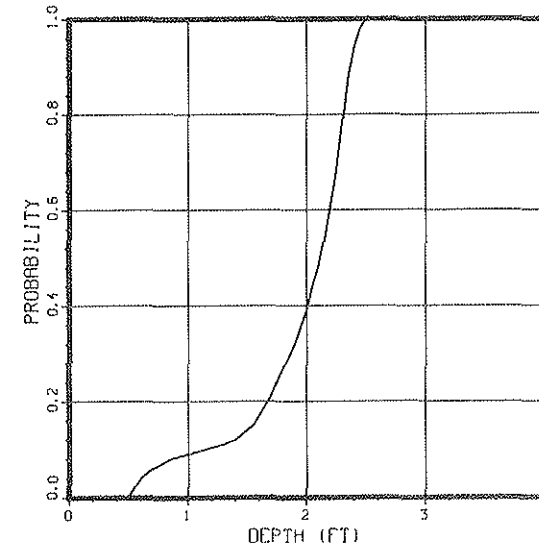
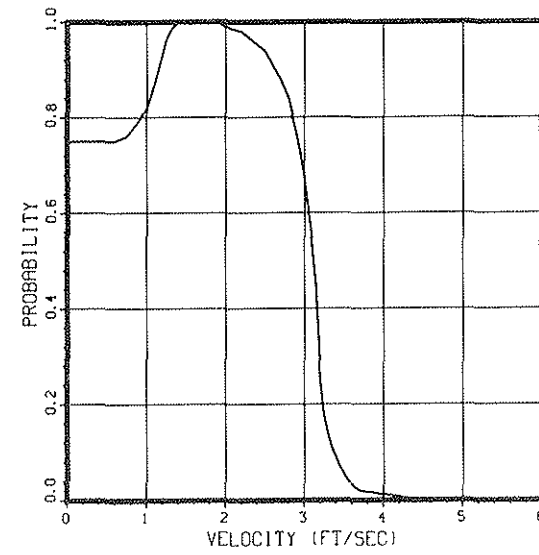
COHO SALMON (CLEAR WATER, S=.001)

10021 INCUBATION 78/01/24.



MOUNTAIN WHITEFISH

12002 ADULT 78/01/24.

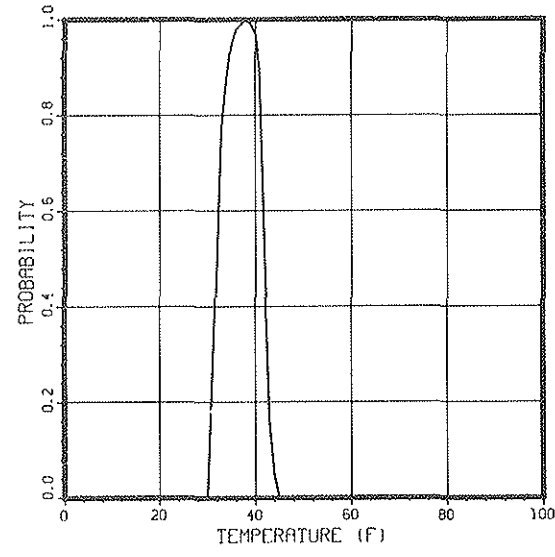
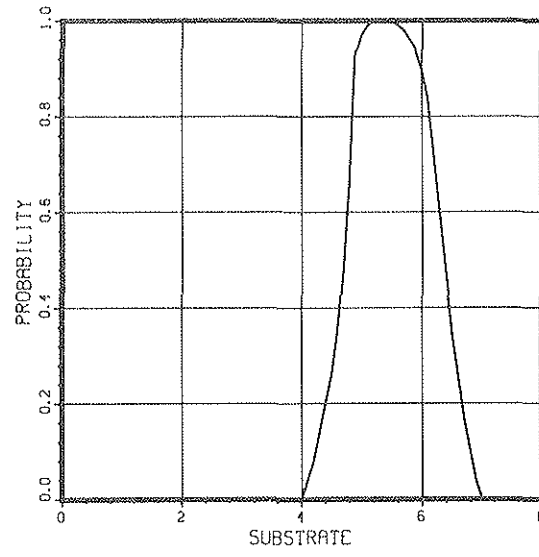
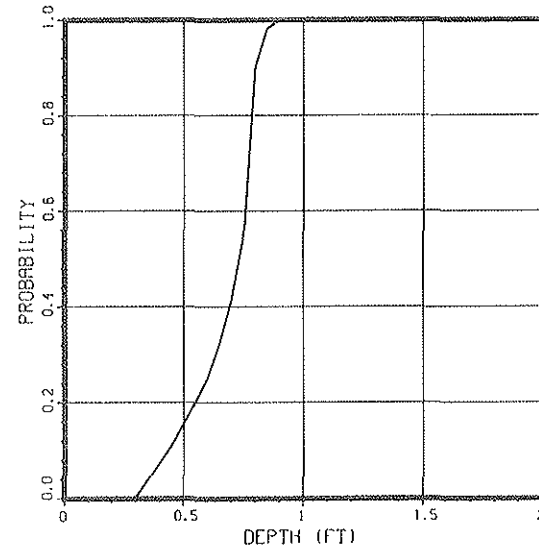
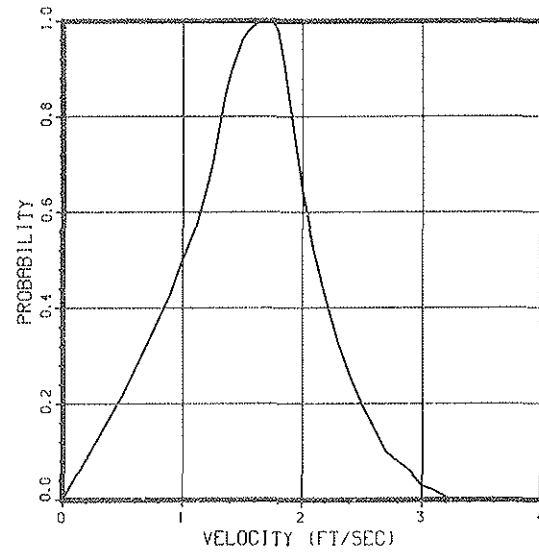


MOUNTAIN WHITEFISH

12010

SPAWNING

78/01/24.

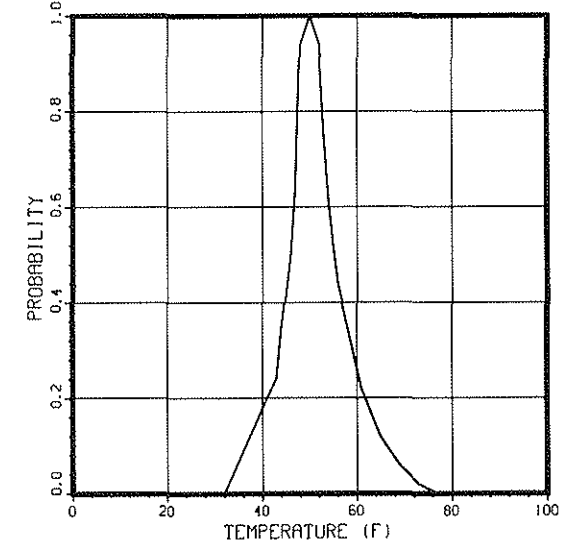
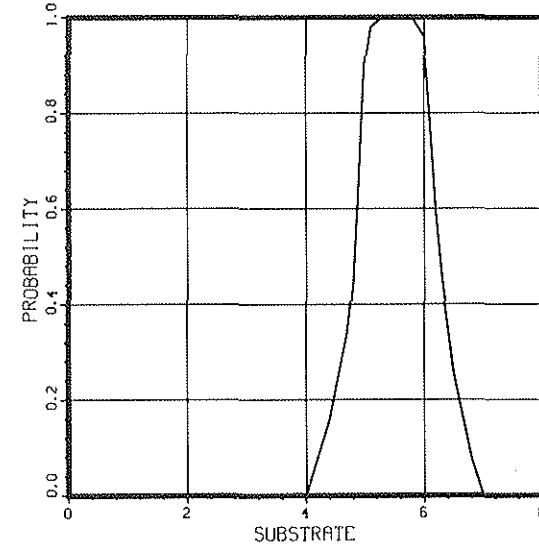
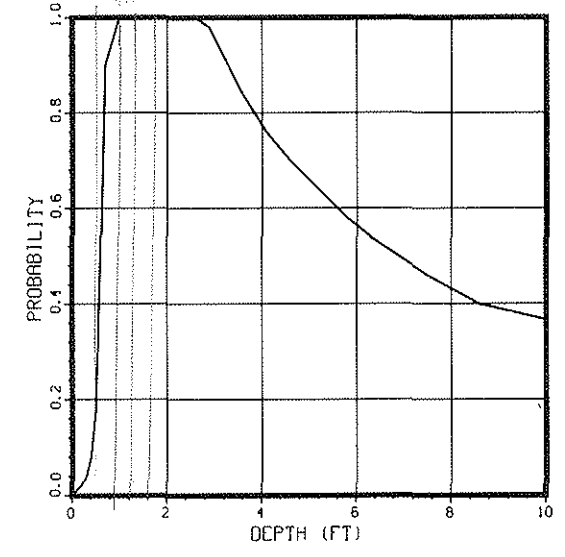
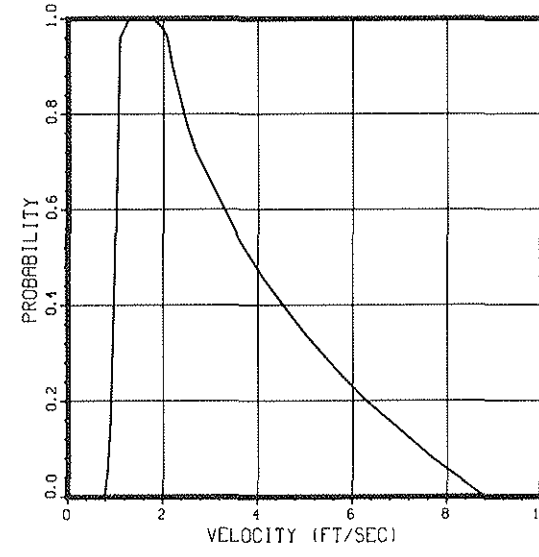


COHO SALMON (TURBID WATER, S=.001)

10022

INCUBATION

78/01/24.

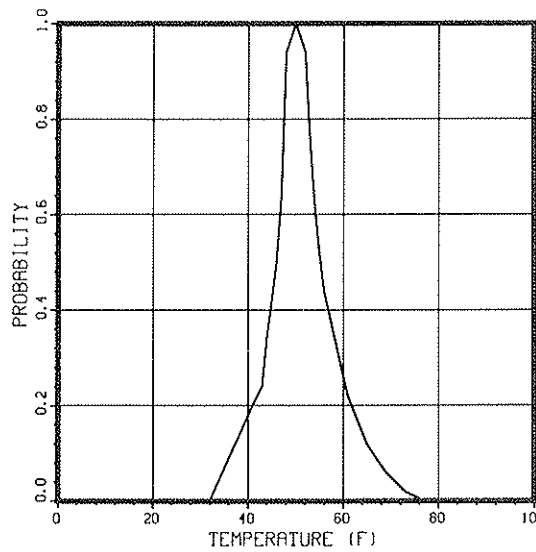
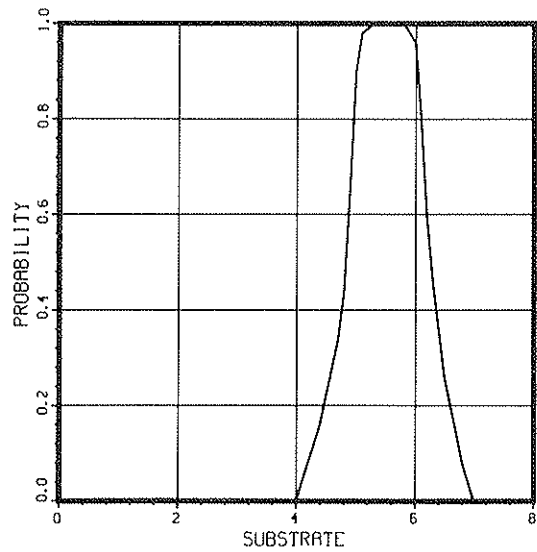
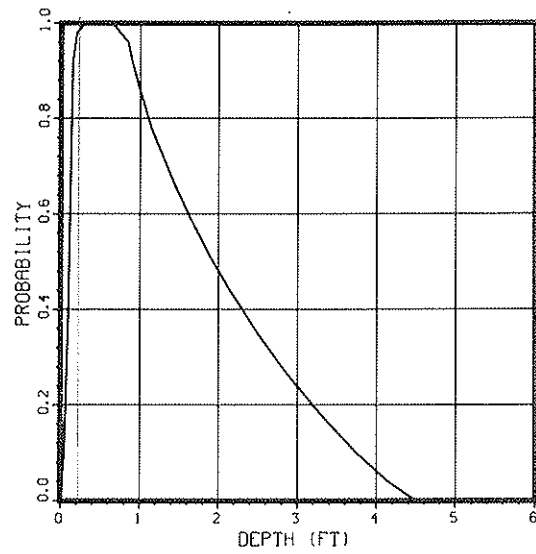
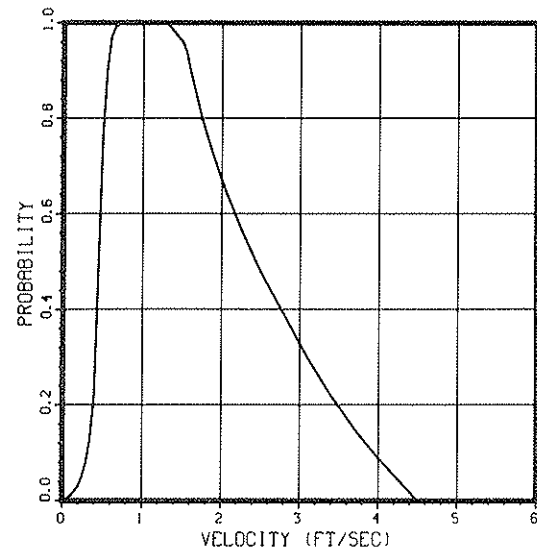


COHO SALMON (CLEAR WATER, S=.0025)

10023

INCUBATION

78/01/24.



MOUNTAIN WHITEFISH

Prosopium williamsoni

Catalog No.	12010 Spawning				12002 Adult				12001 Juvenile				12000 Fry				Egg Incubation				
	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	
SPECIES: Mountain Whitefish																					
IFG EVALUATION	F	F	F	F	G	E	G	F	G	G	E	F	G	G	G	F					
REFERENCE	33	6	6	6	12	12	12	12	12	12	12	12	12	12	12	12					
	FA	RO	RO	RO	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA	FA					
	34	33	33		16	16	16	26	16	16	26	16	16	16	26						
ANALYSIS	RO	FA	FA		FA	FA	FA	PO	FA	FA	FA	PO	FA	FA	FA	PO					
	34	34			6			31				31				31					
COMMENTS						1															

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
 G - Good
 F - Fair
 R - Reconnaissance Grade

Analysis: FA - frequency analysis
 RO - range and optimum
 PO - Parameter overlap
 IH - indirect analysis

Reference: Refer to listed number in bibliography.
 Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

Comments - Mountain Whitefish

1. Despite the large sample size, the optimum could not be tested beyond 2.5 ft in depth due (probably) to lack of habitat in the greater depth ranges. Optimum line continued by observations from Brown (1952).

BROOK TROUT

11402

ADULT

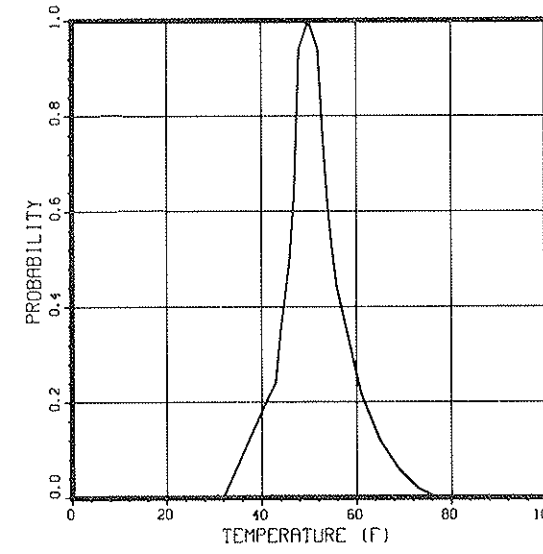
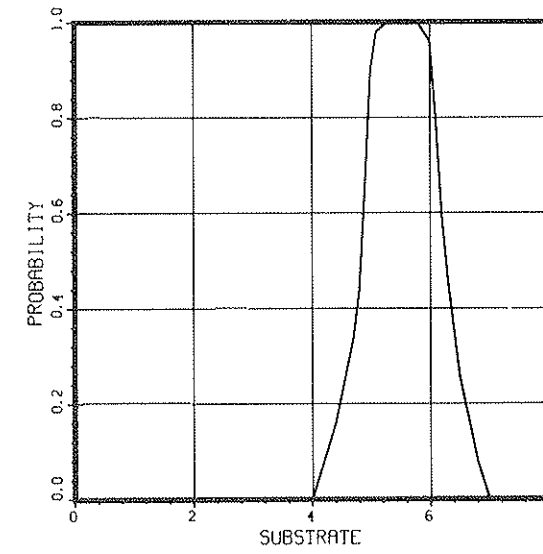
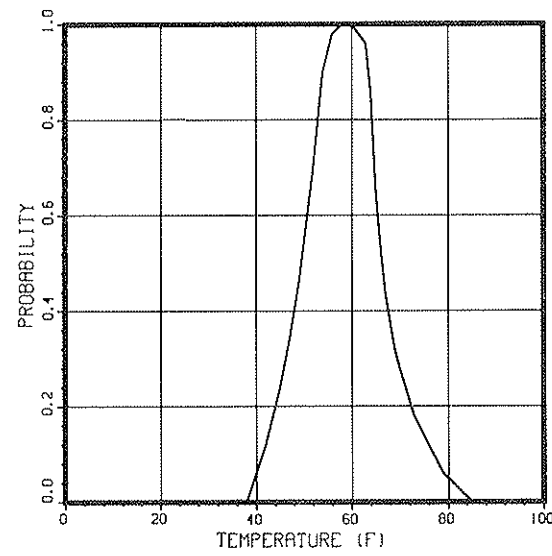
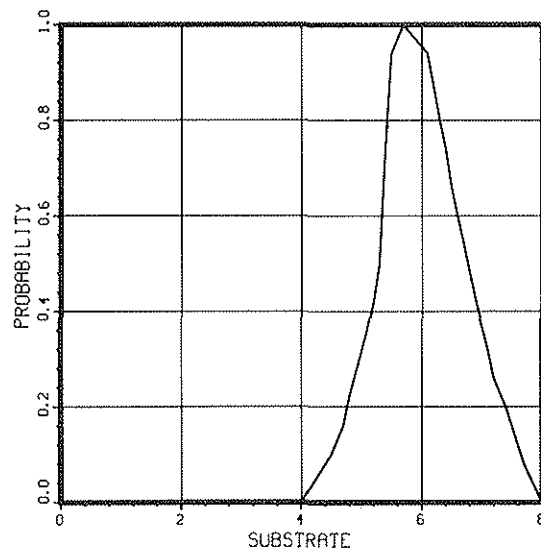
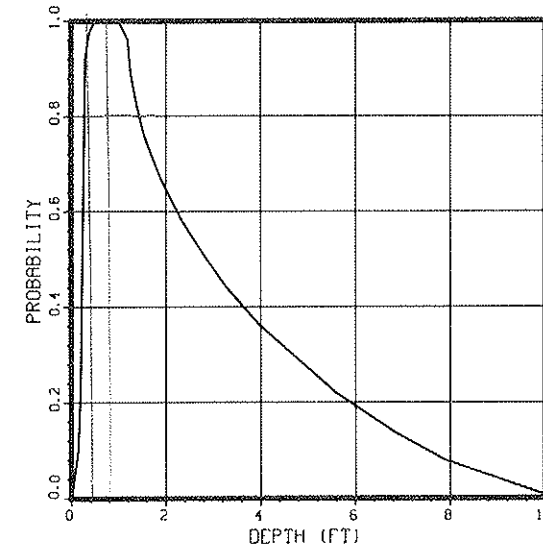
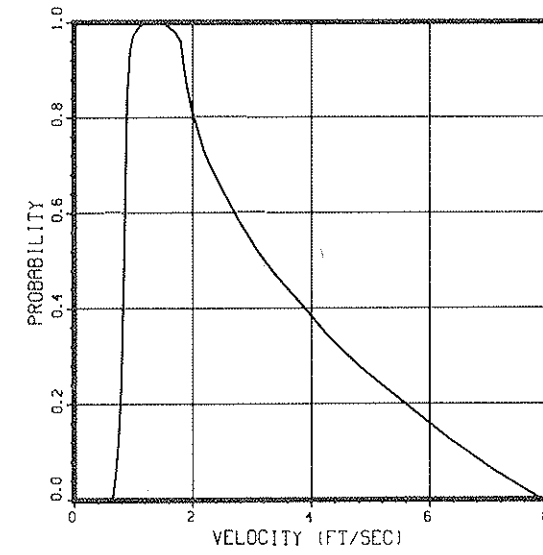
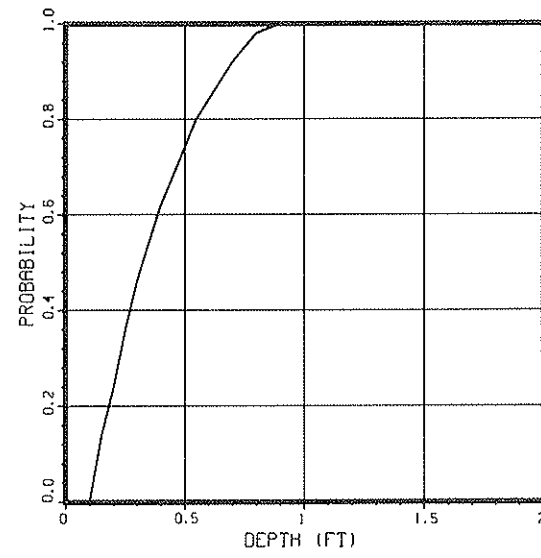
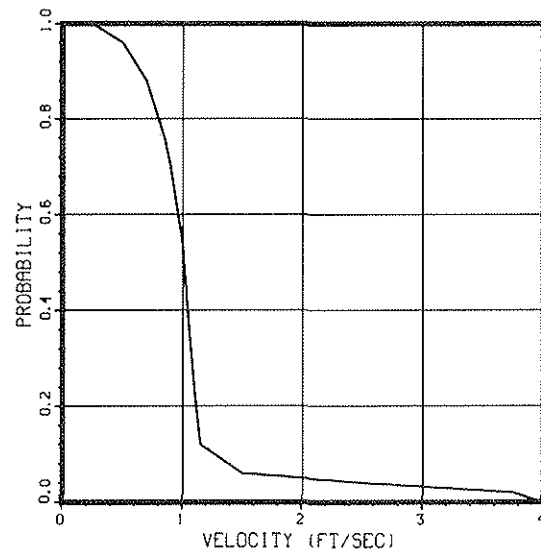
78/01/24.

COHO SALMON (TURBID WATER, S=.0025)

10024

INCUBATION

78/01/24.

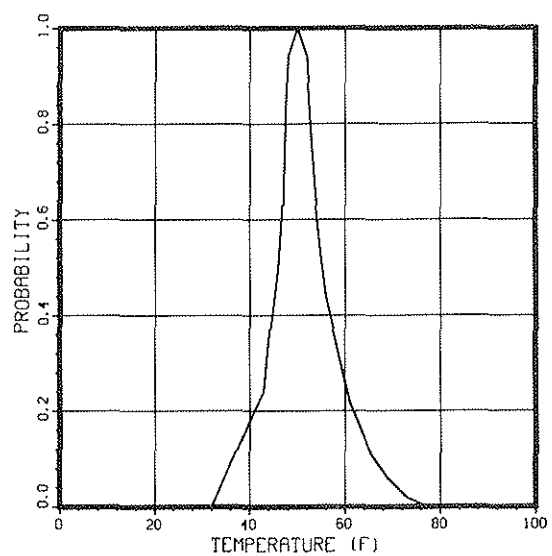
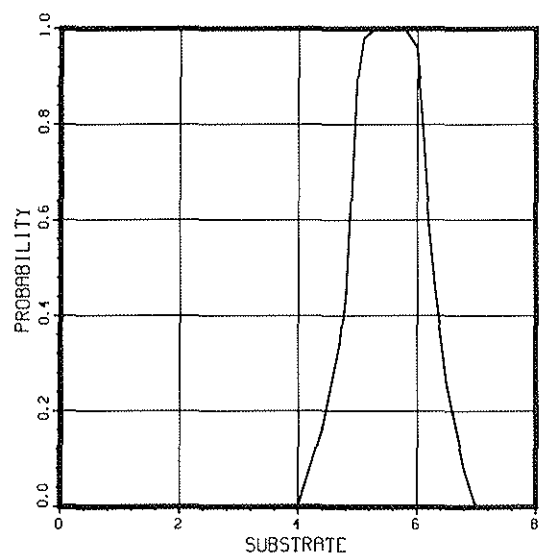
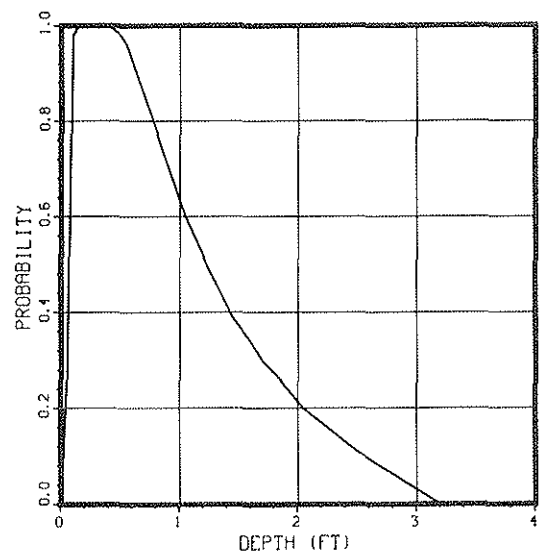
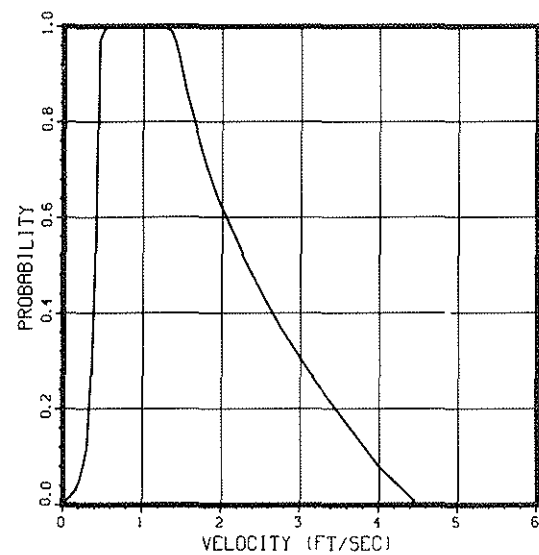


COHO SALMON (CLEAR WATER, S=.004)

10025

INCUBATION

78/01/24.

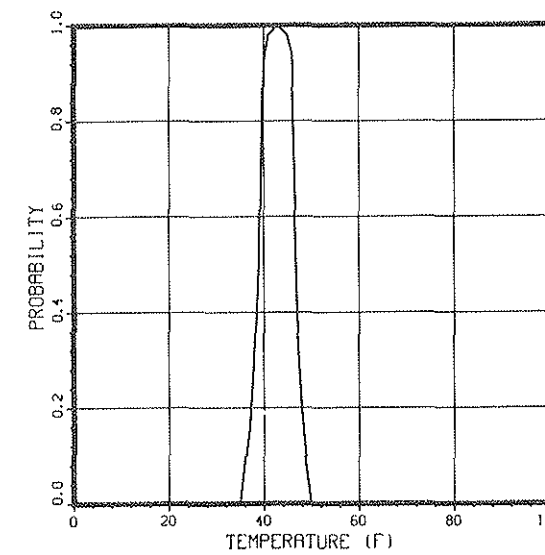
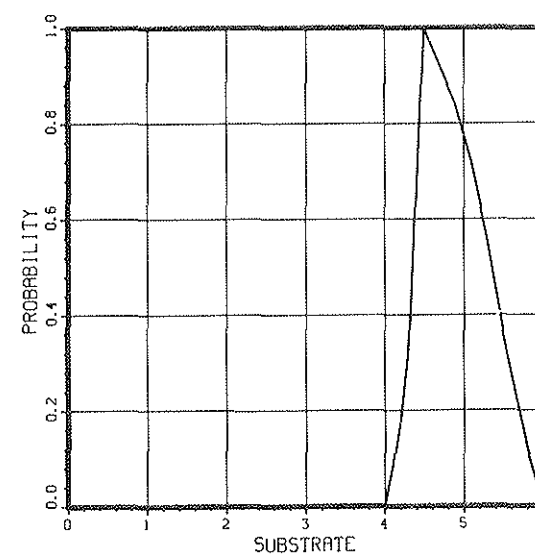
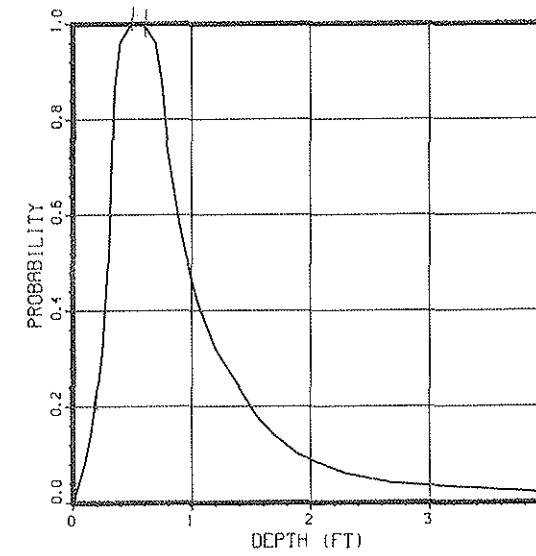
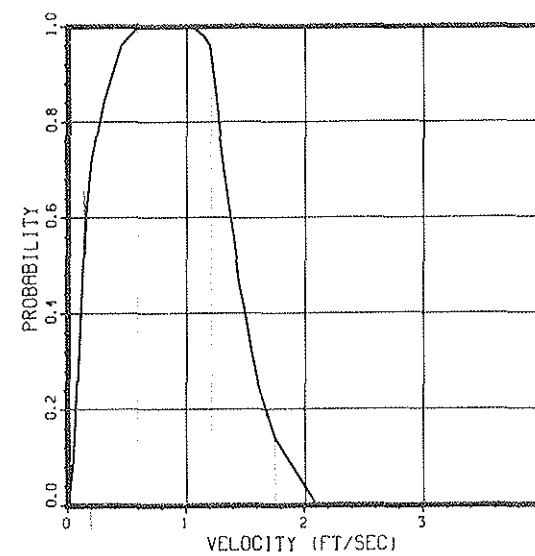


BROOK TROUT

11410

SPAWNING

78/01/24.



BROOK TROUT
Salvelinus fontinalis

COHO SALMON (TURBID WATER, S=.004)

10026

INCUBATION

78/01/24.

Catalog No.	011430				011402				Juvenile				Fry				Egg Incubation			
	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
SPECIES:	Brook Trout																			
IFG EVALUATION	G	G	G	F	R	R	R	F												
REFERENCE	22	22	20	12	12	12	2													
	FA	FA	RO	RO	FA	FA	RO	RO												
ANALYSIS	29	29	22	22	35	35	22													
	FA	FA	RO	RO	FA	FA	RO													
COMMENTS	1	1			2	2														

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

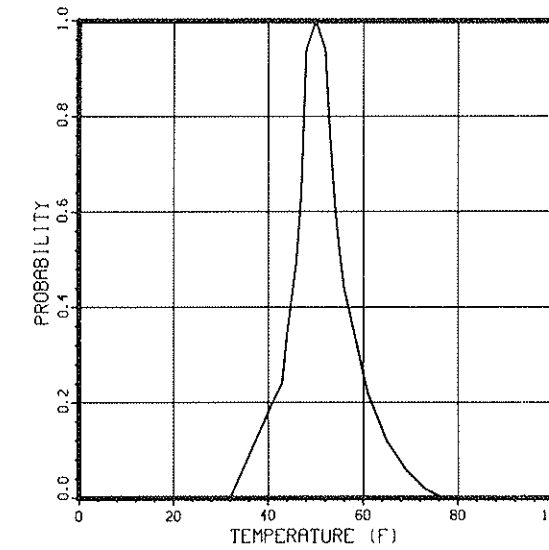
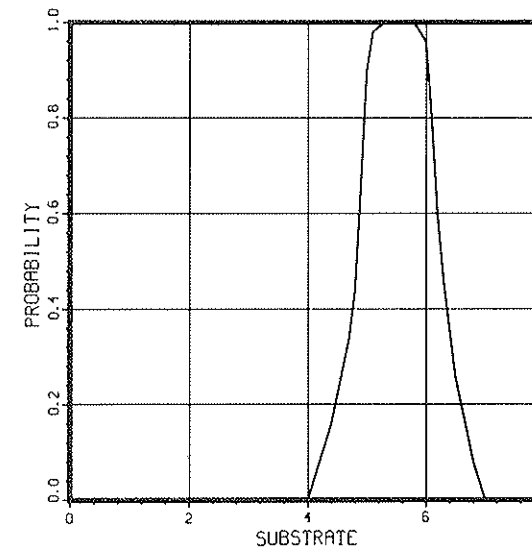
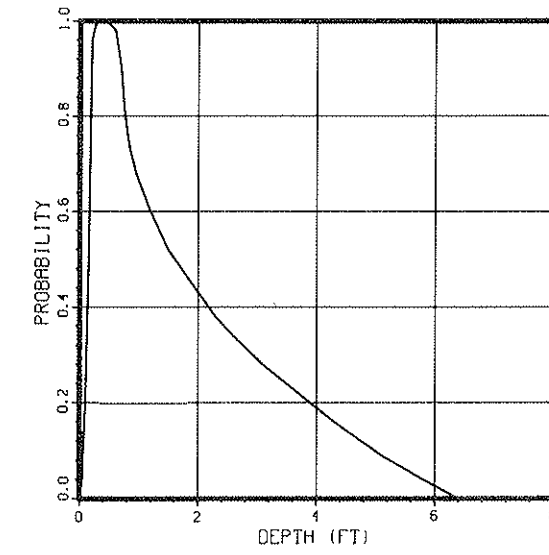
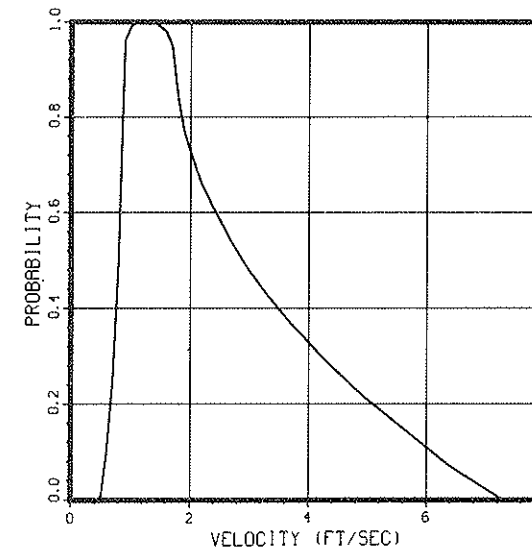
Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - indirect analysis

Reference: Refer to listed number in bibliography.

Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

Comments - Brook Trout Curves

1. Data from Reiser & Heschel (1977) were taken in small streams for 7 to 9" brook trout. Hunter's (1973) data came from a wider range of conditions and was given double weighting in the frequency analysis. These curves represent a composite of large and small spawners and would be skewed to the left for small spawners alone.
2. The depths and velocities in Stewart's study were measured the year prior to his population sampling. Therefore, there is no way of knowing that the flow conditions measured were those actually inhabited by the fish.



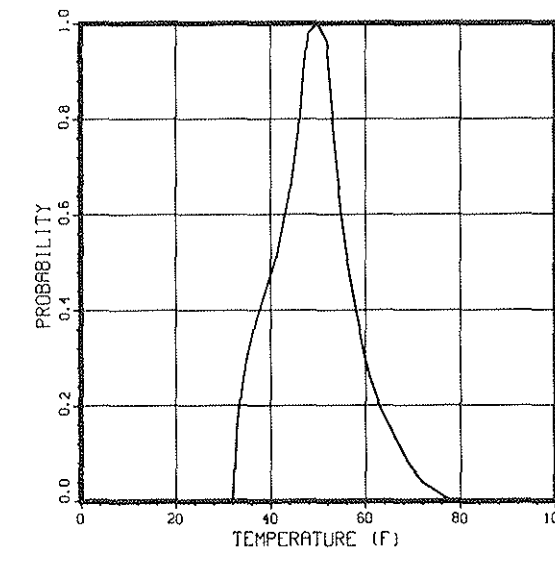
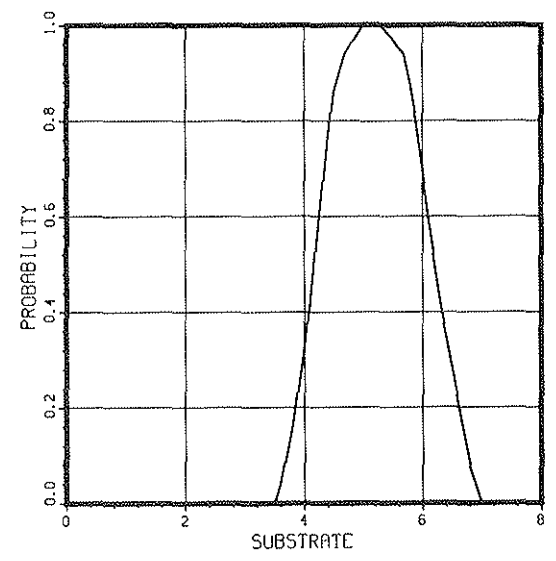
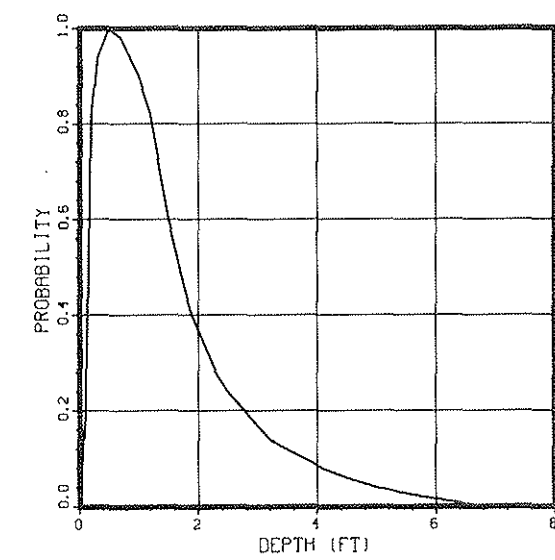
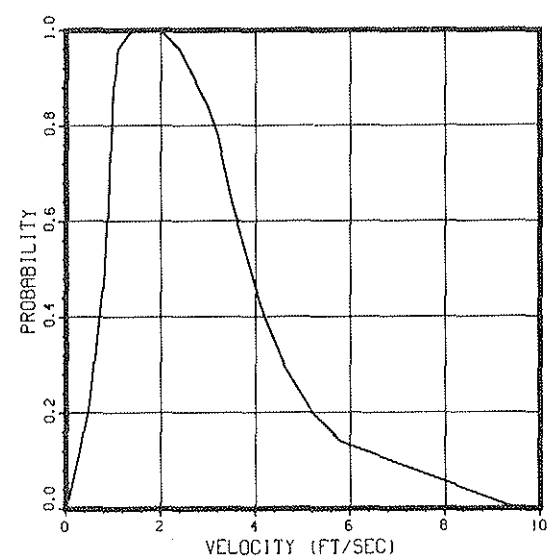
SOCKEYE SALMON
Oncorhynchus nerka

BROWN TROUT (TURBID WATER, S=.004)
11326 INCUBATION 78/01/24.

Catalog No.	10310				Adult				Juvenile				Fry				Egg Incubation			
SPECIES:	Spawning																			
Sockeye	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
IFG EVALUATION	F	F	F	R																
REFERENCE	7	7	21	31																
	RO	RO	RO	RO																
	21	21	7																	
	RO	RO	RO																	
ANALYSIS																				
COMMENTS																				

Key to IFG Evaluation Matrix

<p>IFG Evaluation: E - Excellent G - Good F - Fair R - Reconnaissance Grade</p> <p>Analysis: FA - frequency analysis RO - range and optimum PO - Parameter overlap IN - indirect analysis</p>	<p>Reference: Refer to listed number in bibliography.</p> <p>Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).</p>
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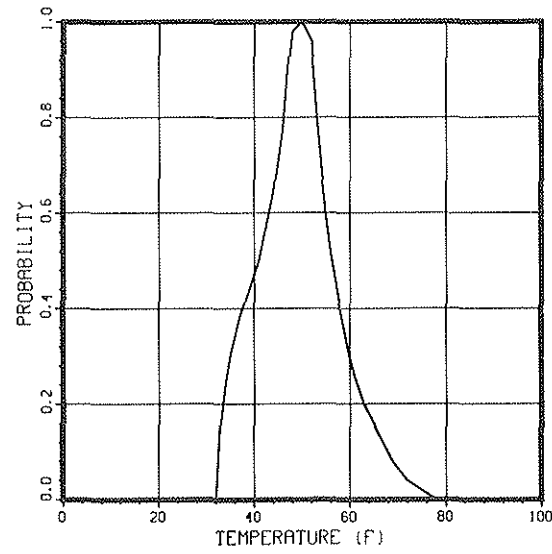
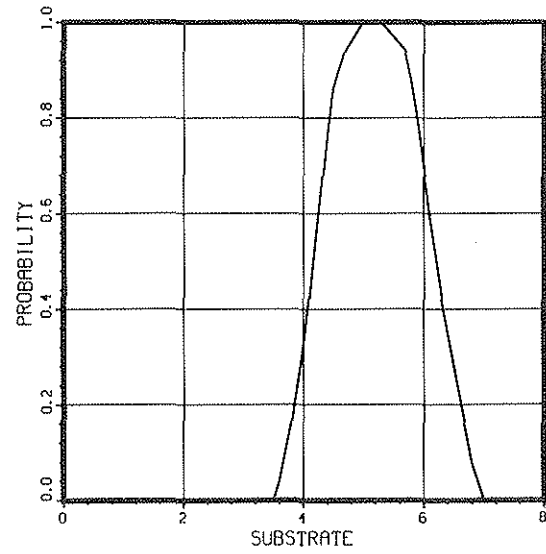
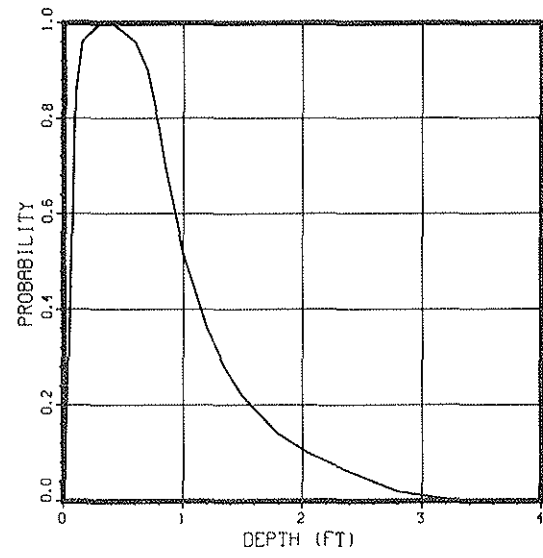
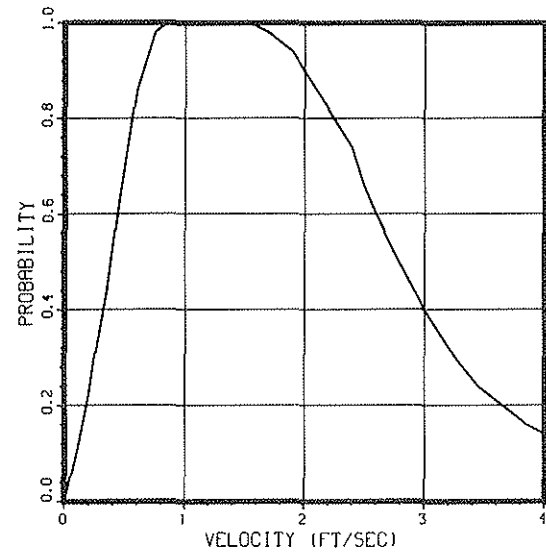


BROWN TROUT (CLEAR WATER, S=.004)

11325

INCUBATION

78/01/24.

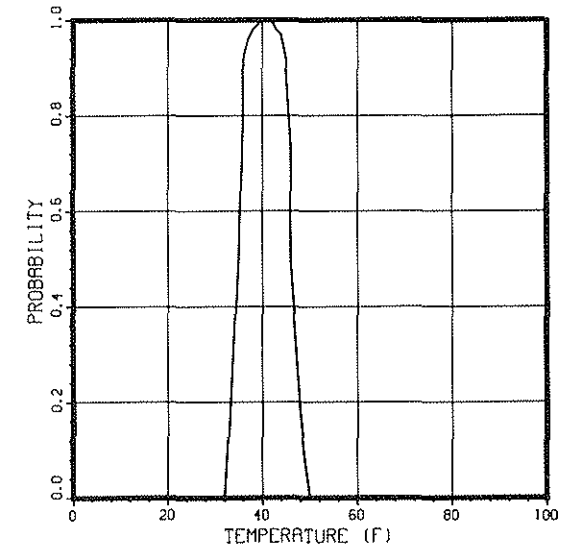
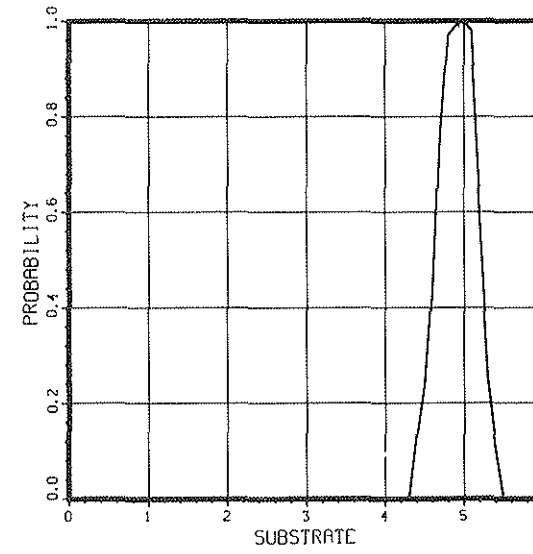
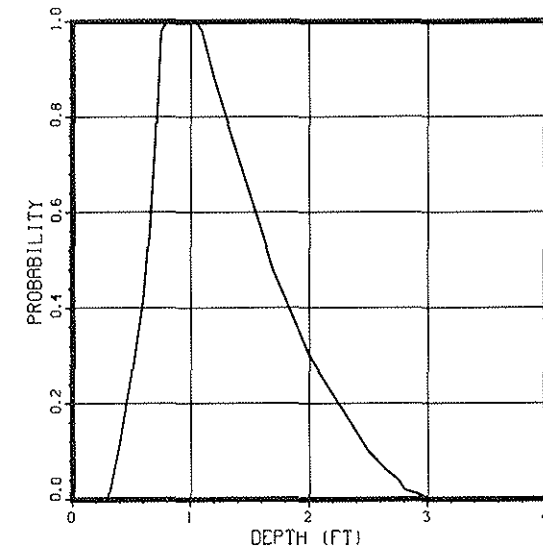
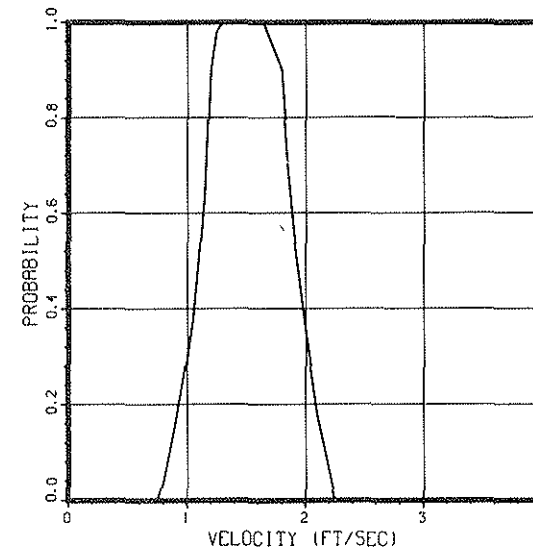


SOCKEYE SALMON

10310

SPAWNING

78/01/24.



KOKANEE
Oncorhynchus nerka

Catalog No.	10210 Spawning				Adult				Juvenile				Fry				Egg Incubation			
	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
SPECIES:	Kokanee																			
IFG EVALUATION	G	G	F	F																
REFERENCE	22	22	21	22																
	FA	FA	RO	PO																
ANALYSIS																				
COMMENTS																				

Key to IFG Evaluation Matrix

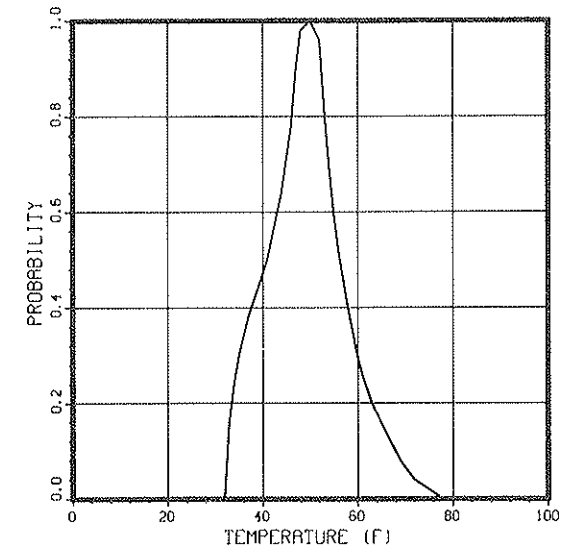
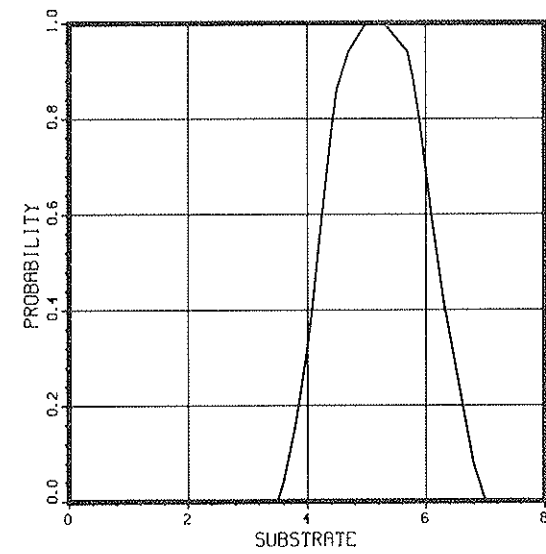
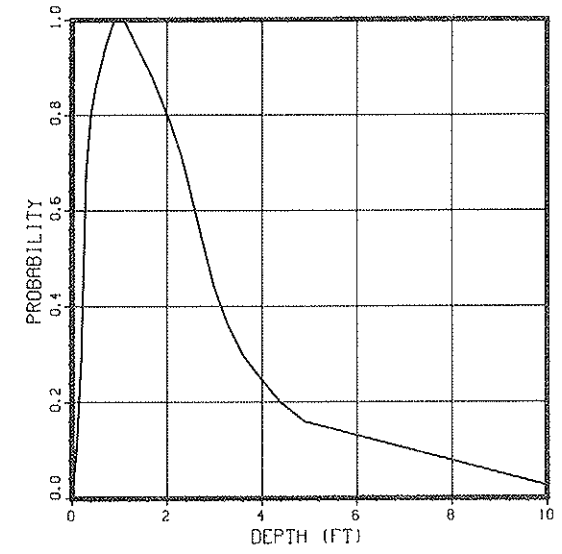
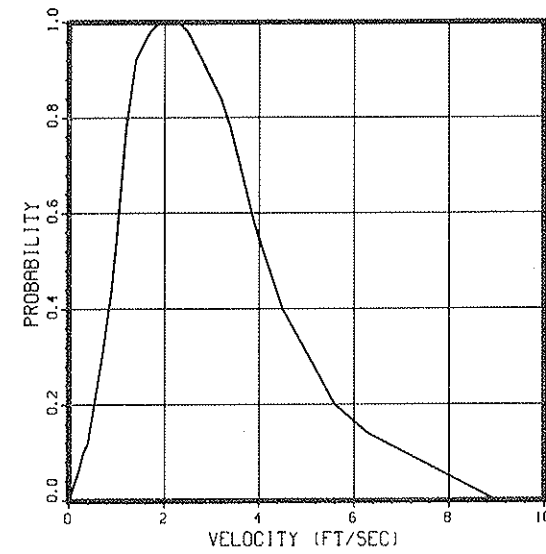
IFG Evaluation: E - Excellent
 G - Good
 F - Fair
 R - Reconnaissance Grade

Analysis: FA - frequency analysis
 RO - range and optimum
 PO - Parameter overlap
 IM - Indirect analysis

Reference: Refer to listed number in bibliography.

Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

BROWN TROUT (TURBID WATER, S=.0025)
 11324 INCUBATION 78/01/24.

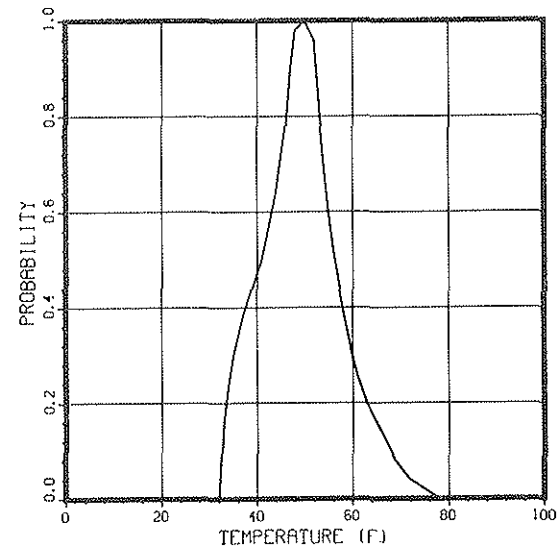
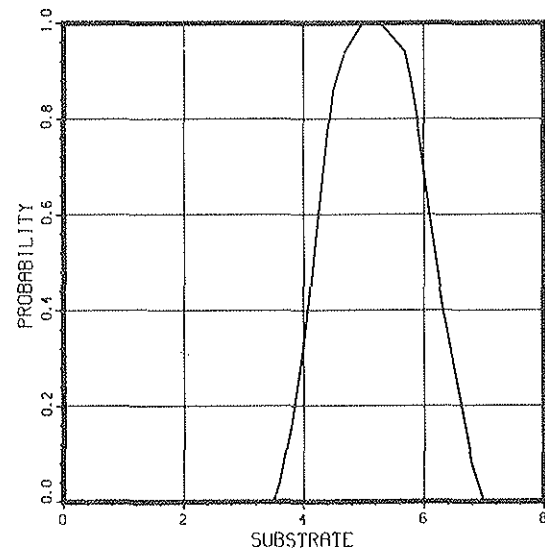
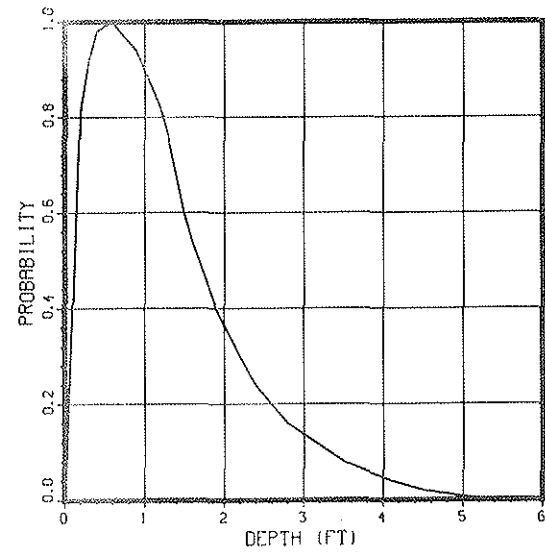
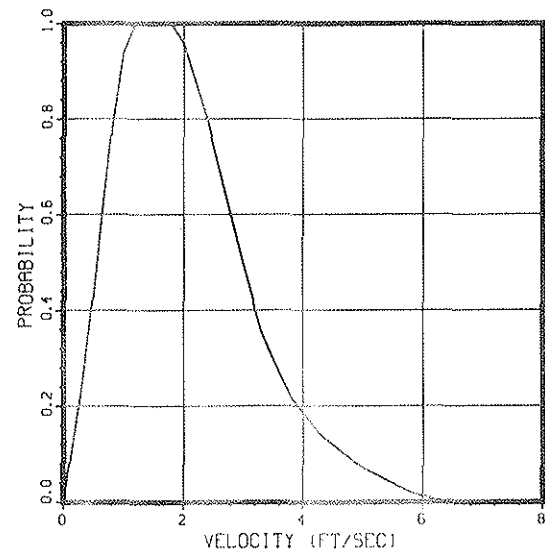


BROWN TROUT (CLEAR WATER, S=.0025)

11323

INCUBATION

78/01/24.

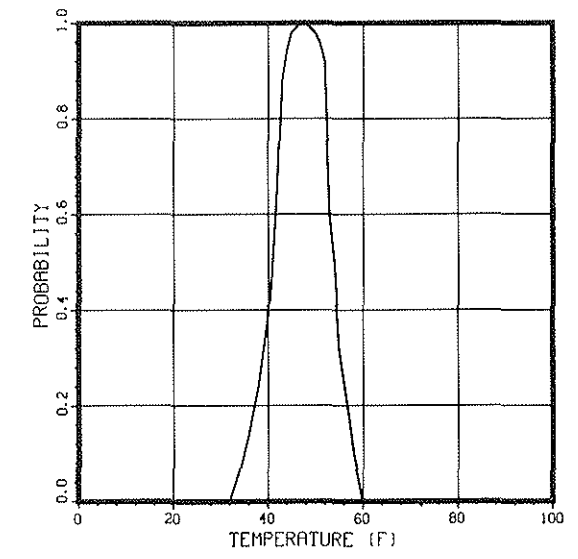
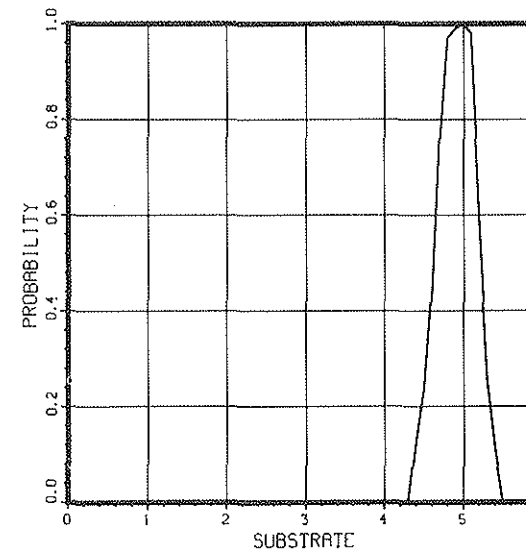
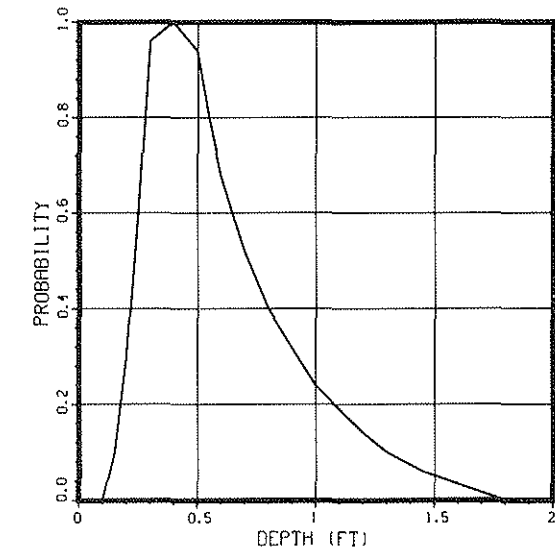
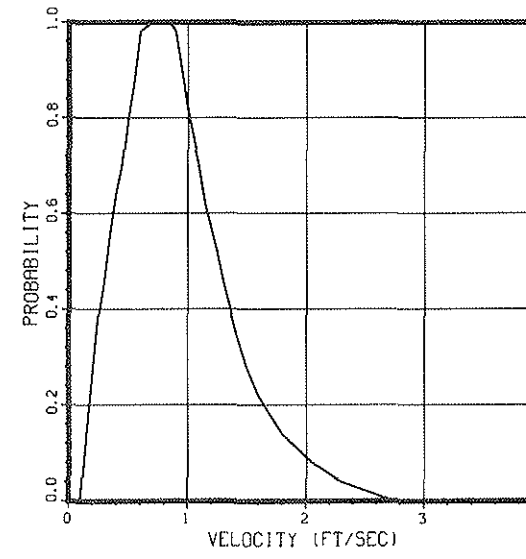


KOKANEE SALMON

10210

SPAWNING

78/01/24.



CHINOOK SALMON

Oncorhynchus tshawytscha

Catalog No.	10111 Spring Spawning				10112 Fall Spawning Adult				10101 Juvenile				Fry				10121-10126 Egg Incubation			
SPECIES:	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
IFG EVALUATION	E	E	G	F	G	G	F	F	G	G	E	G					F	F	F	
REFERENCE	1	1	1	1	1	1	1	1	14	14	15	5					1	1	36	
ANALYSIS	FA	FA	FA	PO	FA	FA	FA	RO	FA	FA	FA	FA					IN	IN	IN	
	32	32			23	23			15	15		15					9,24	9,24	38	
COMMENTS																				

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - indirect analysis

Reference: Refer to listed number in bibliography.

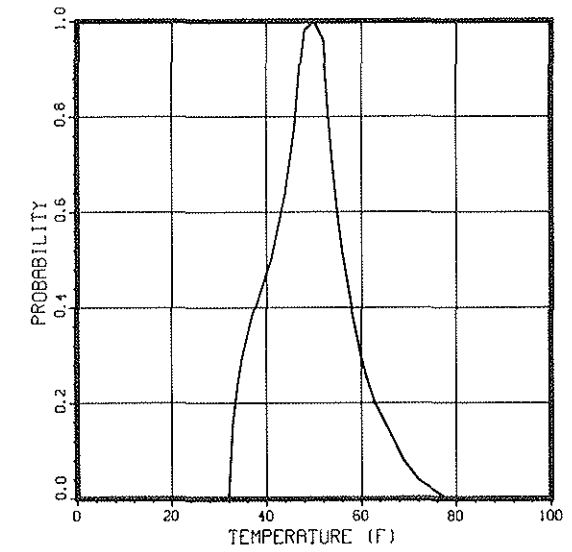
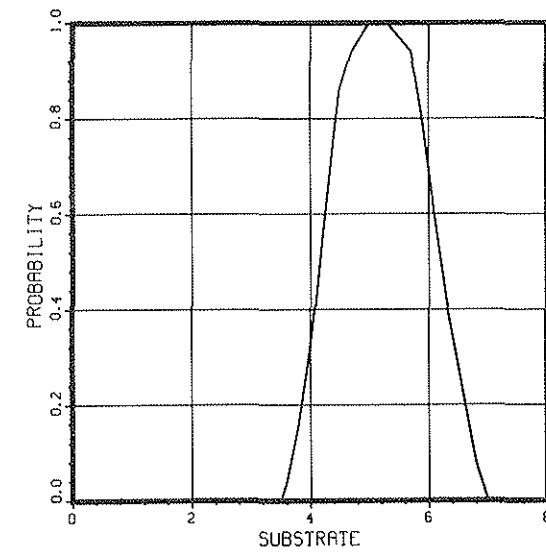
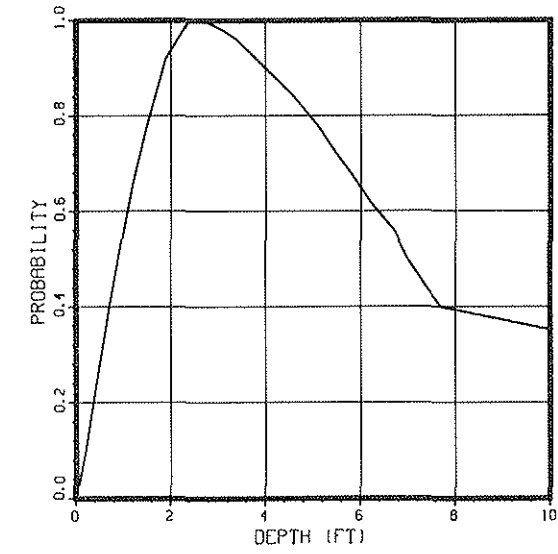
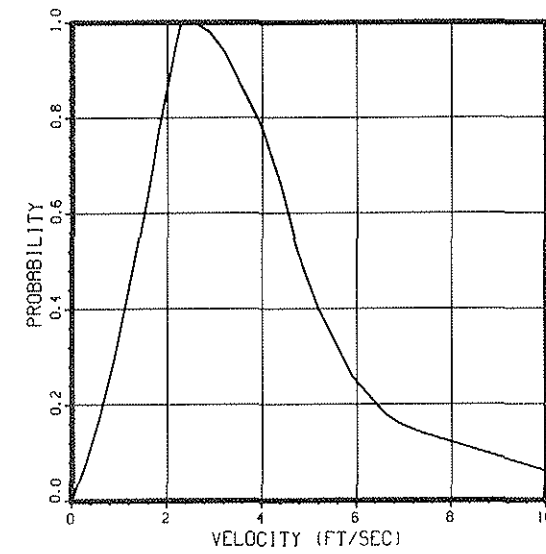
Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

BROWN TROUT (TURBID WATER, S=.001)

11322

INCUBATION

78/01/24.

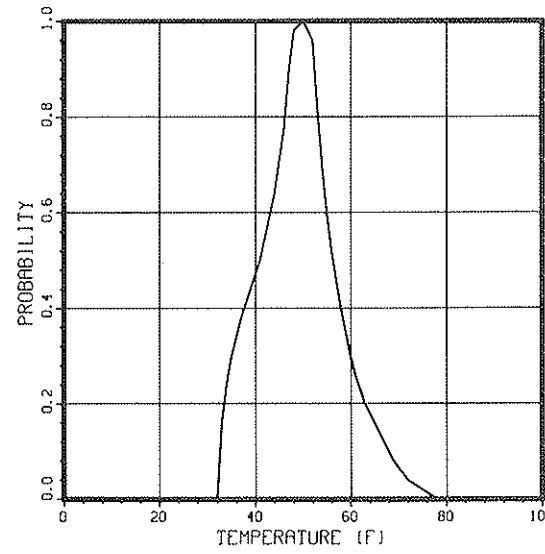
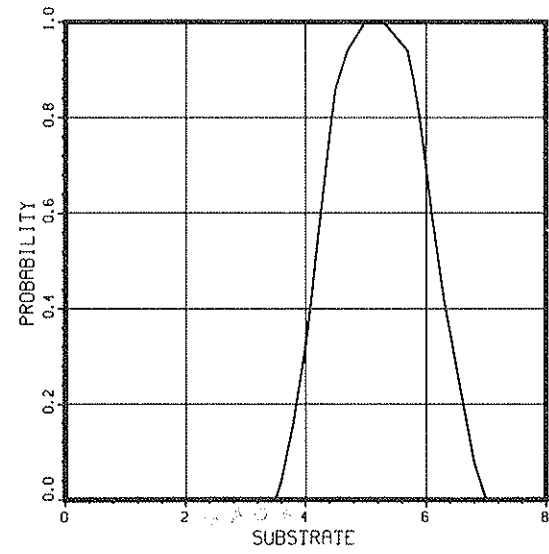
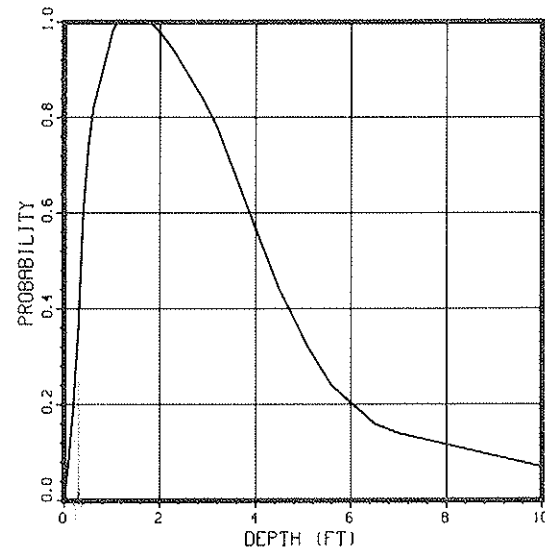
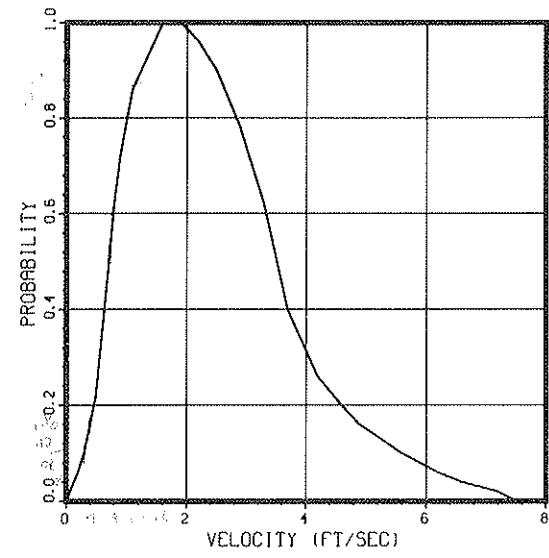


BROWN TROUT (CLEAR WATER, S=.001)

11321

INCUBATION

78/01/24.

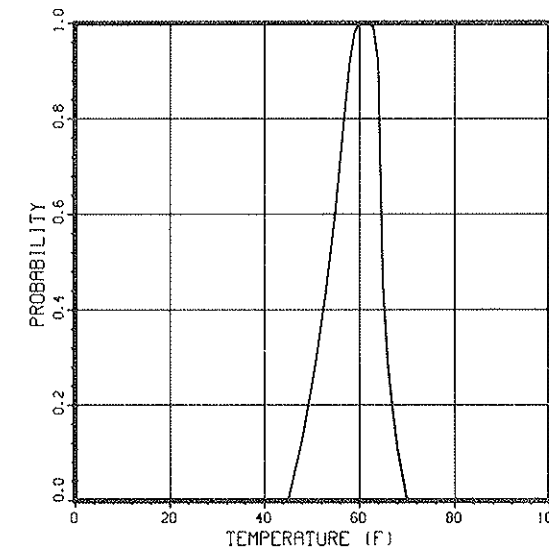
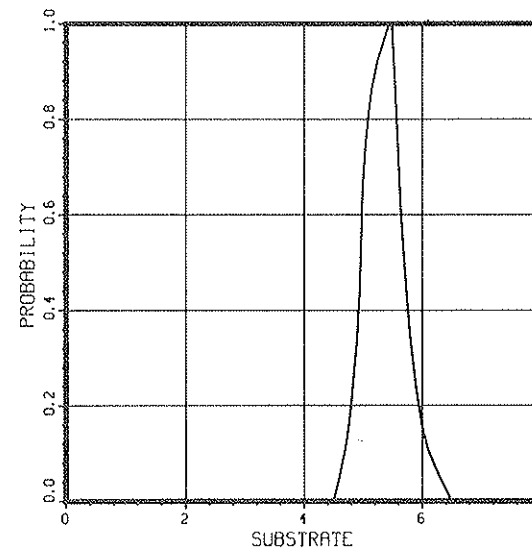
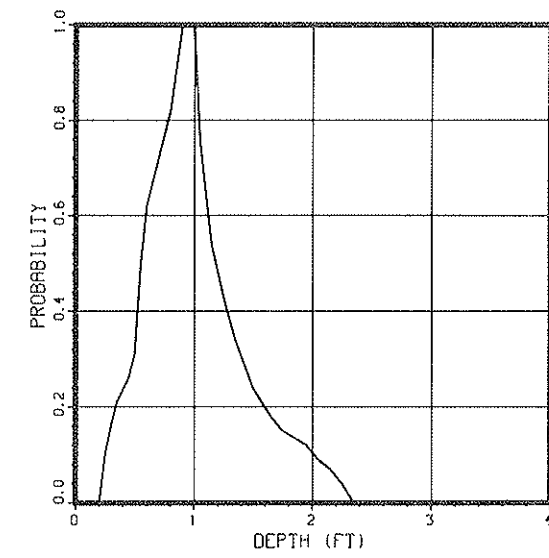
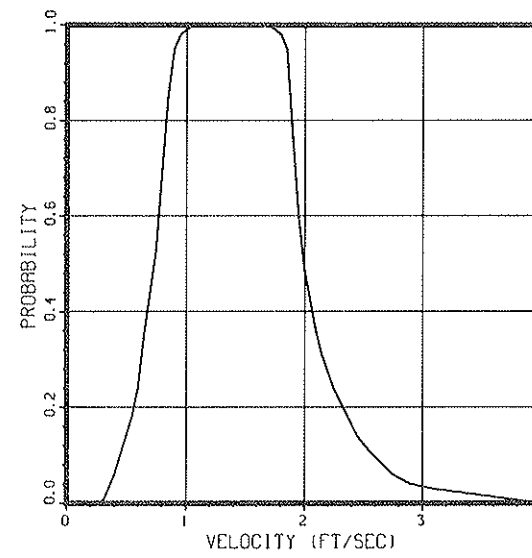


SPRING CHINOOK

10111

SPAWNING

78/01/24.

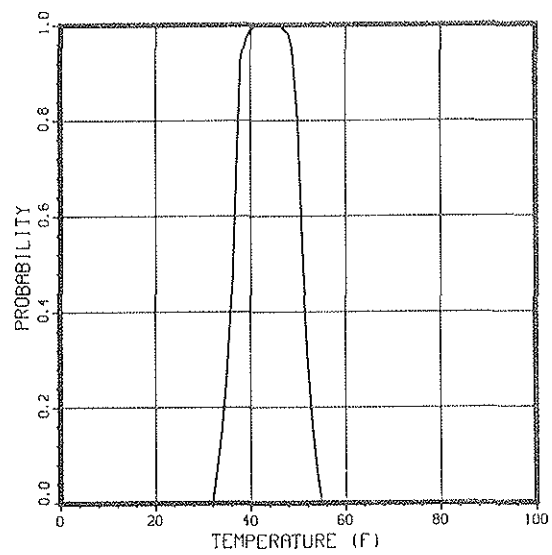
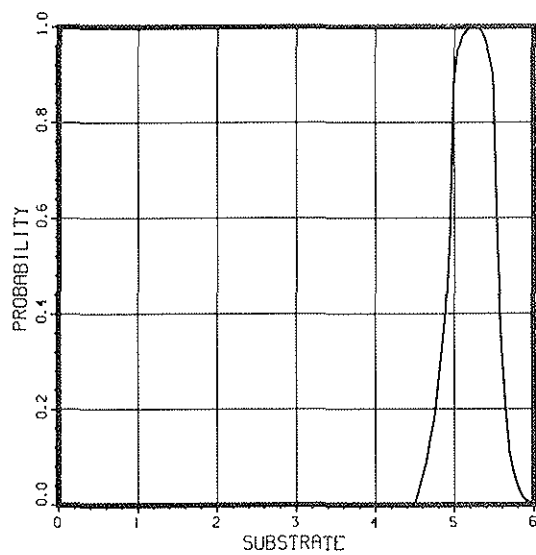
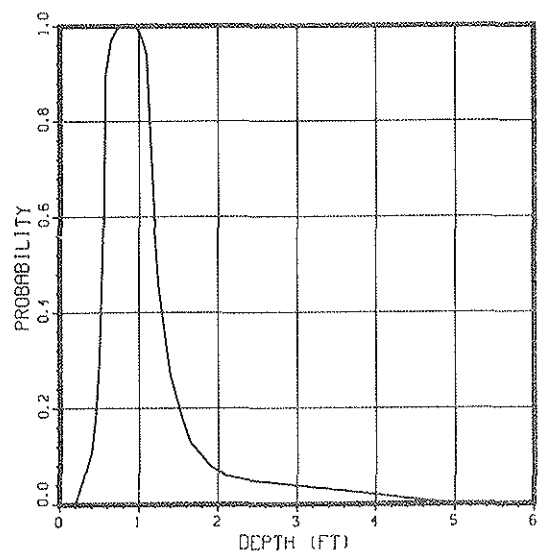
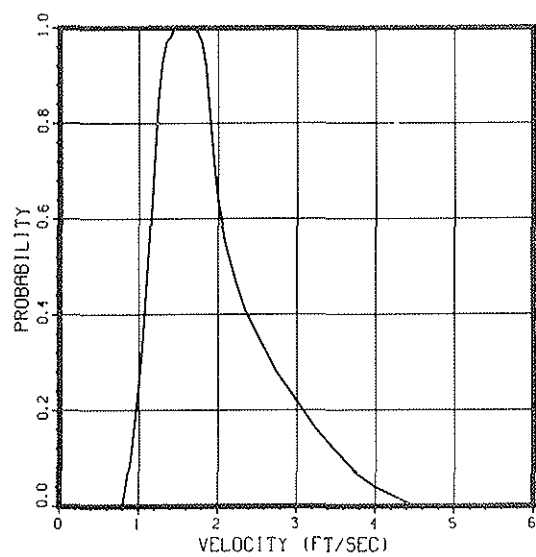


FALL CHINOOK

10112

SPAWNING

78/01/24.

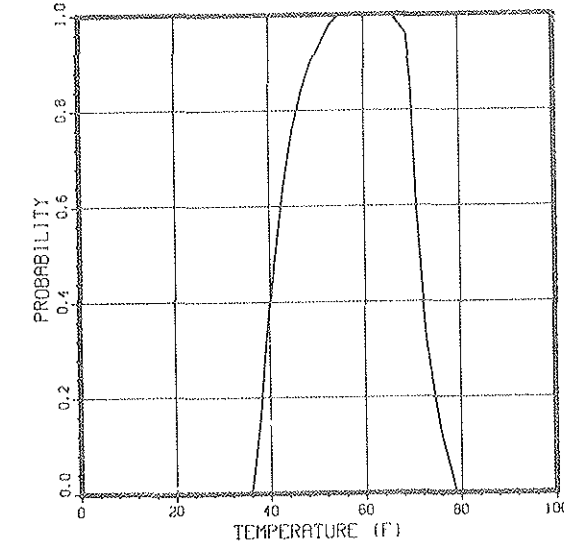
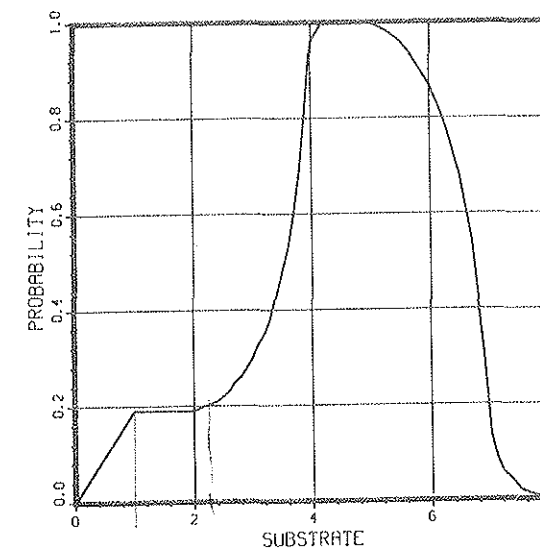
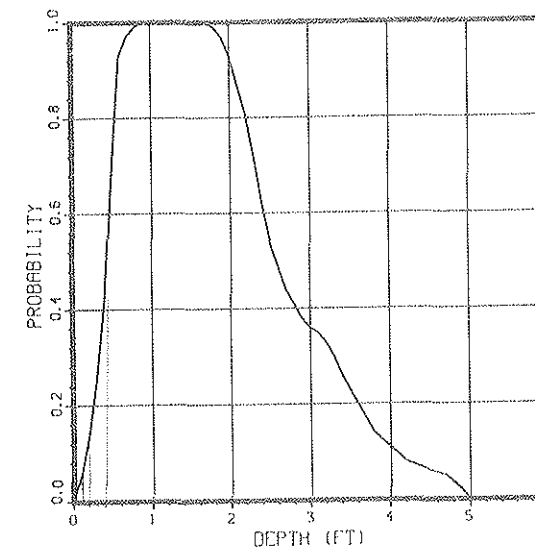
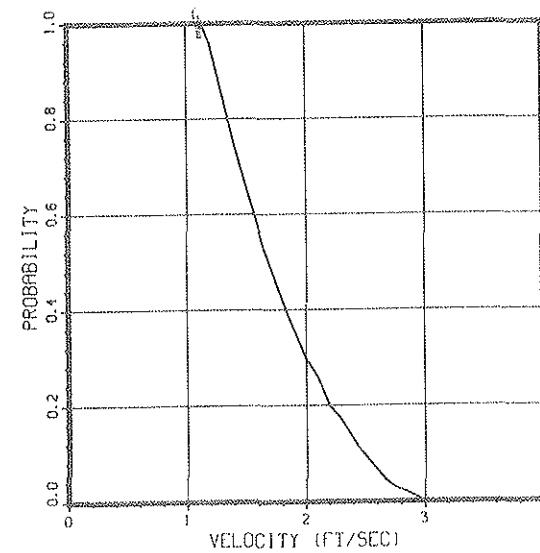


BROWN TROUT

11300

FRY

78/01/24.

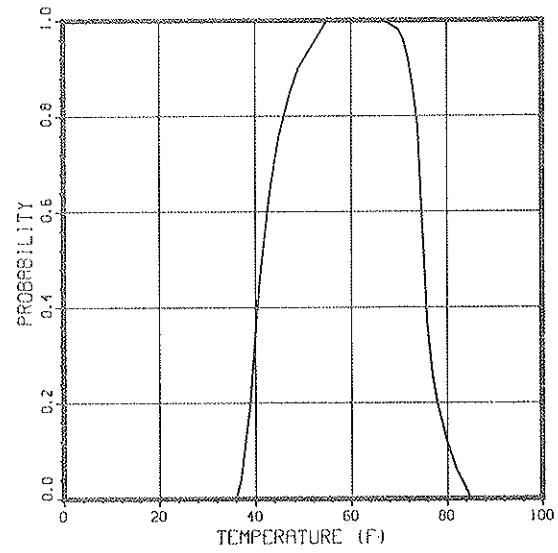
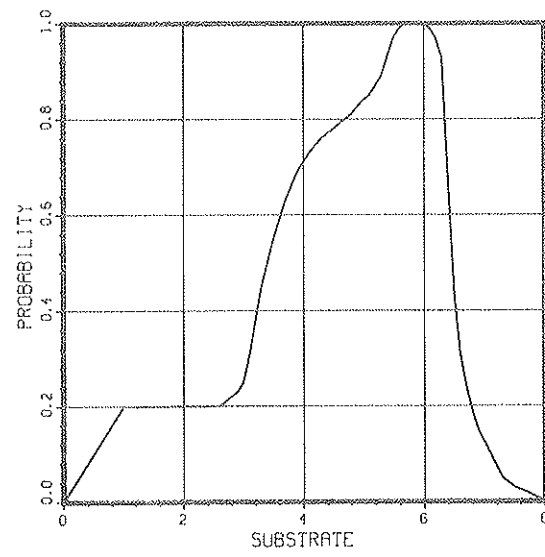
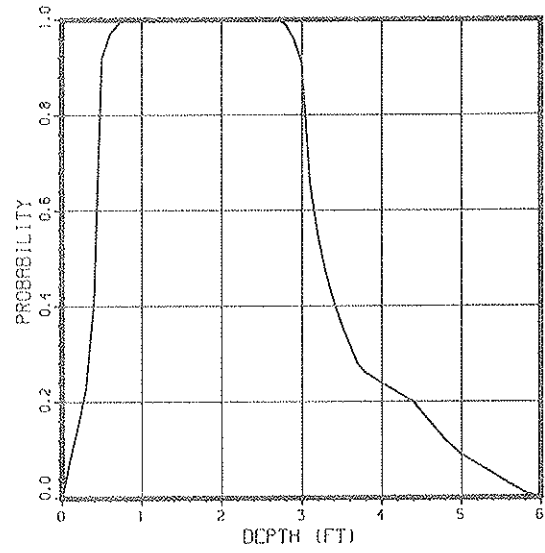
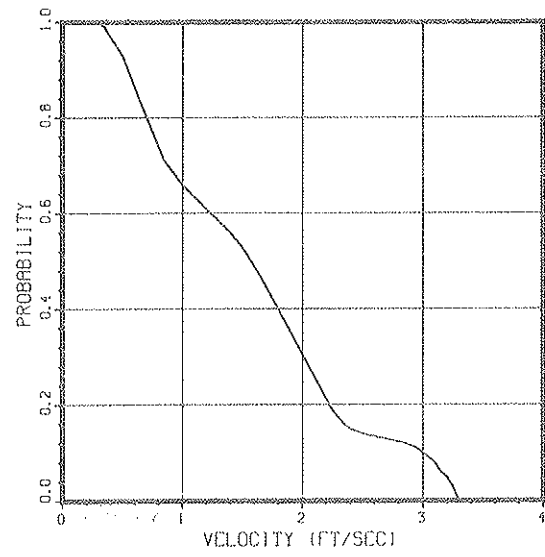


BROWN TROUT

11301

JUVENILE

78/01/24.

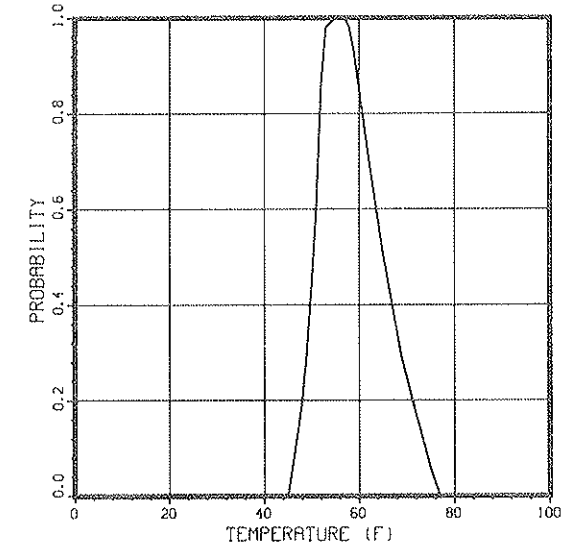
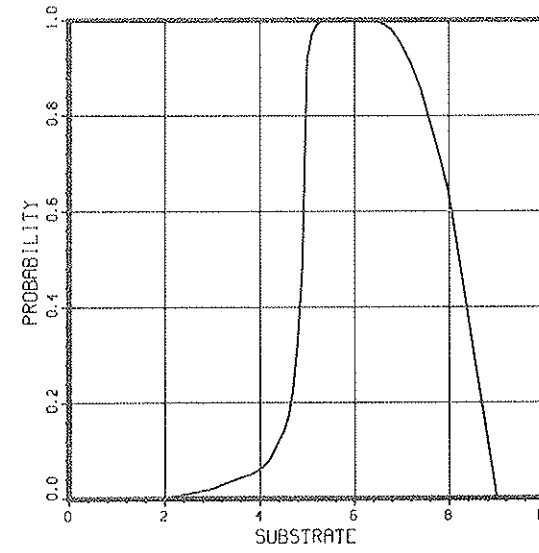
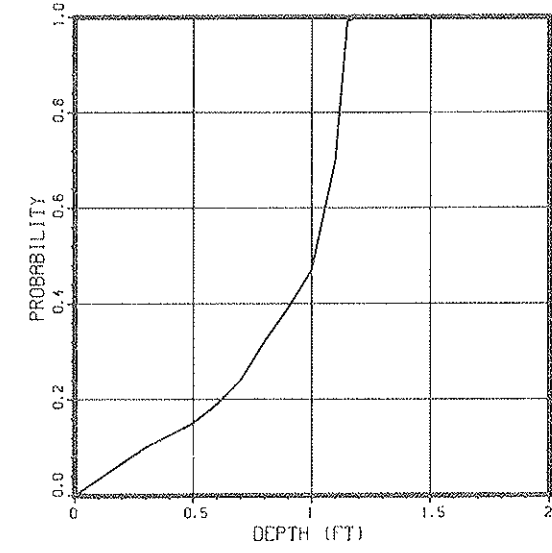
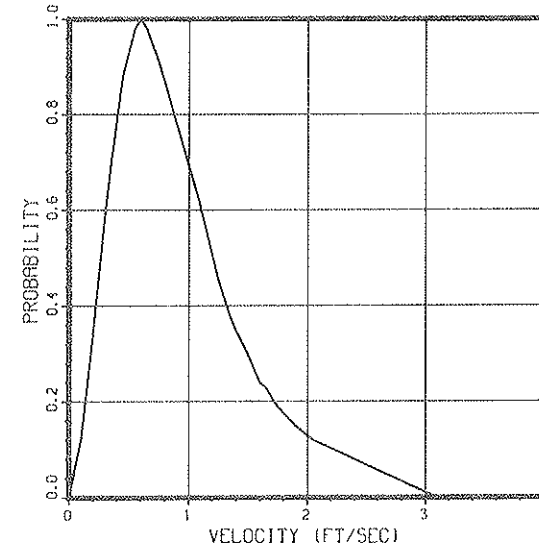


CHINOOK SALMON

10101

JUVENILE

78/01/24.

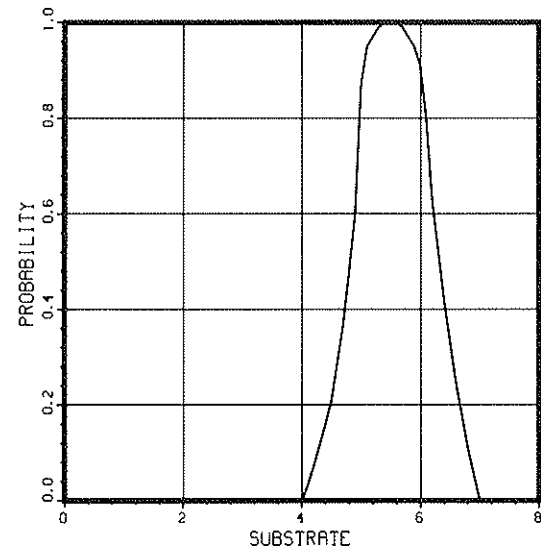
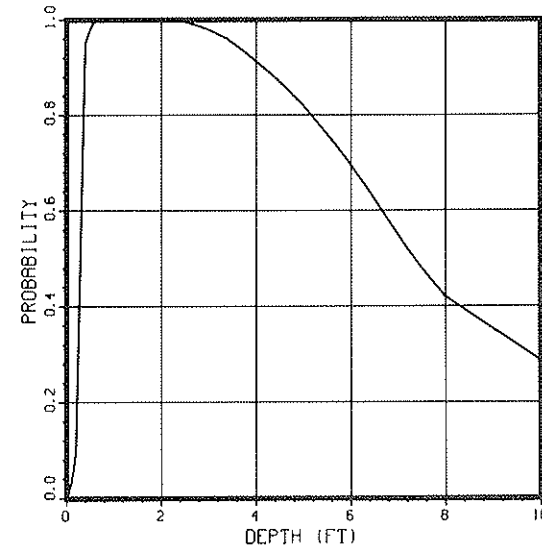
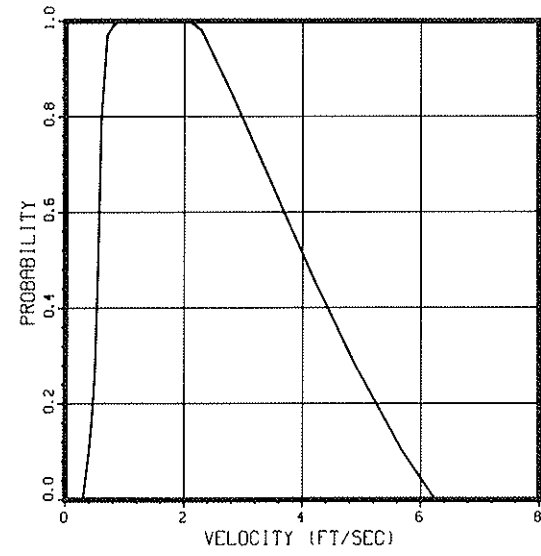


CHINOOK SALMON (CLEAR WATER, S=.001)

10121

INCUBATION

78/01/24.

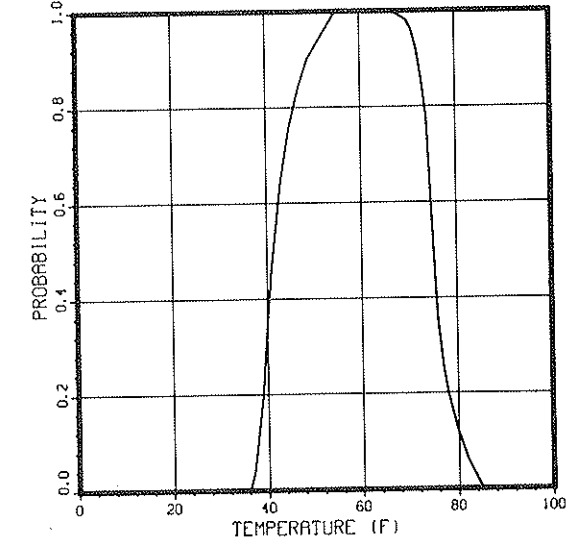
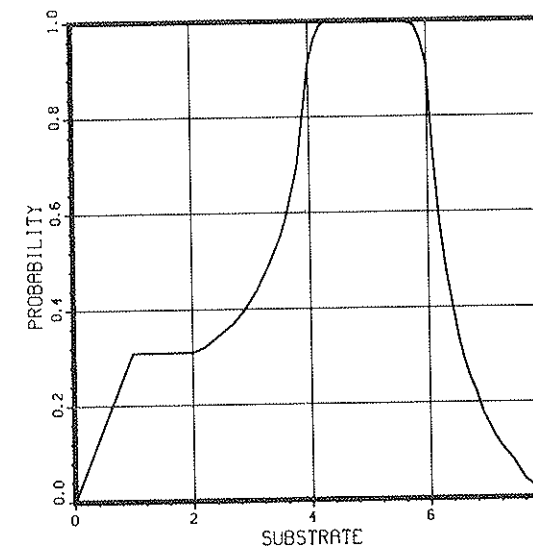
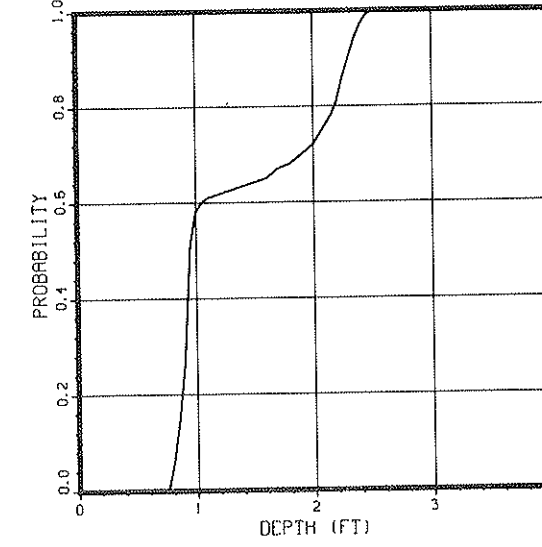
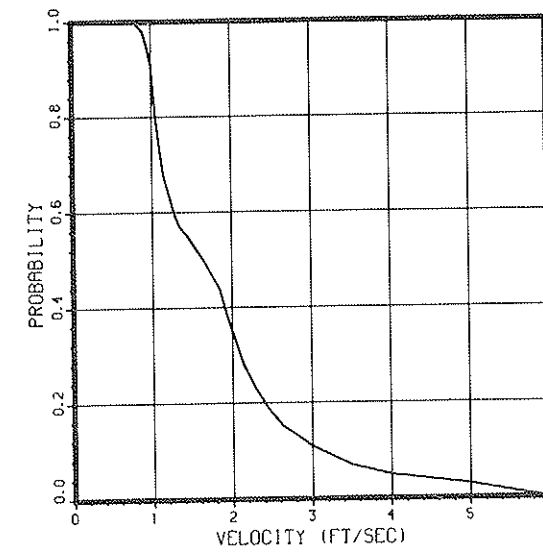


BROWN TROUT

11302

ADULTS

78/01/24.

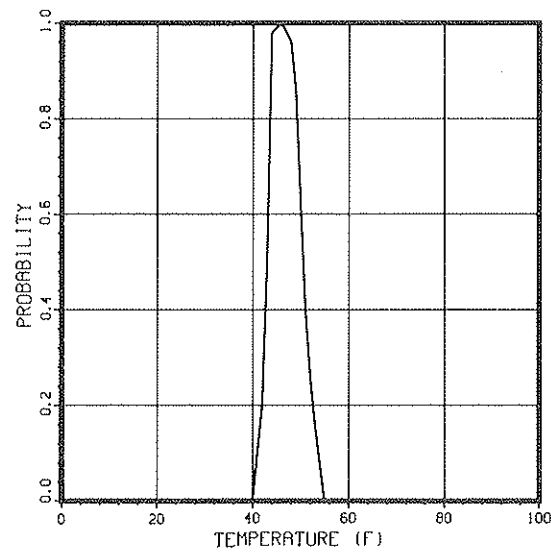
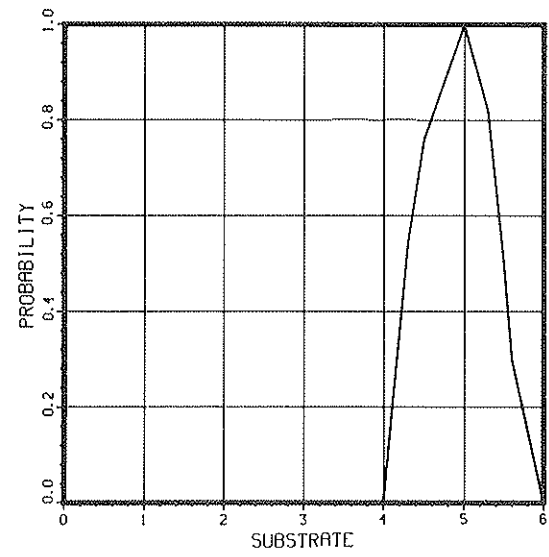
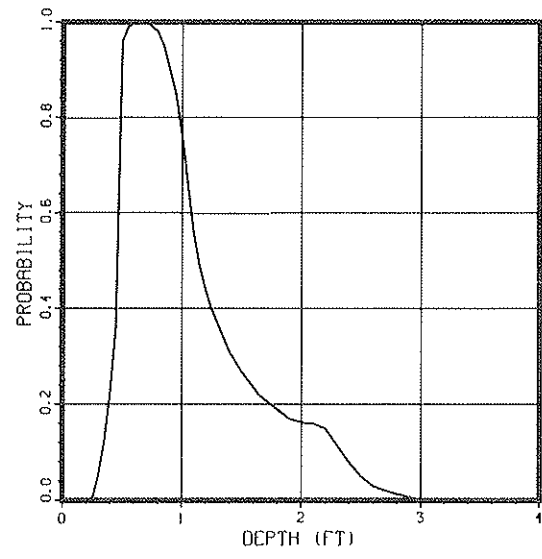
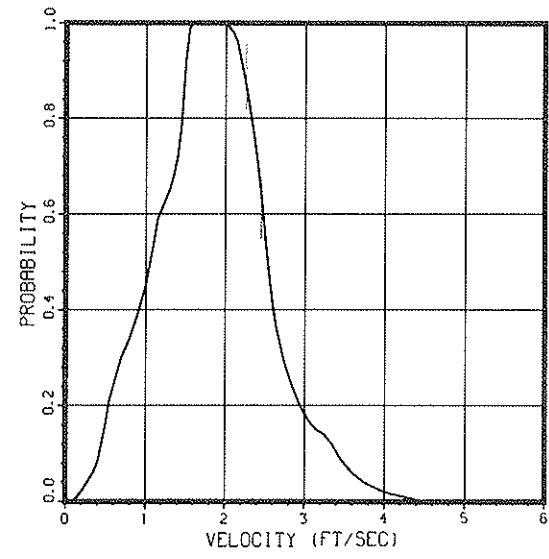


BROWN TROUT

11310

SPAWNING

78/01/24.

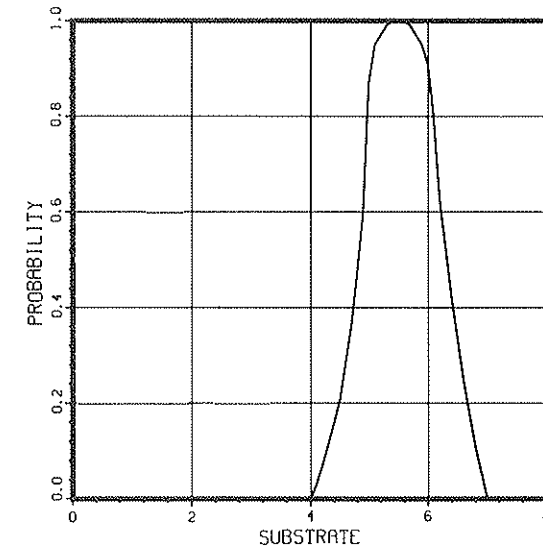
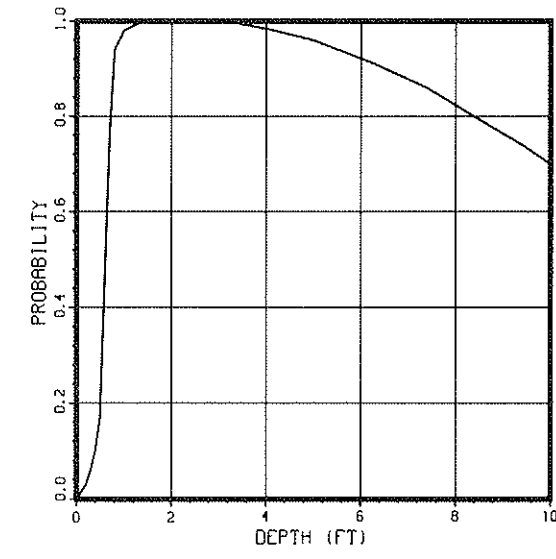
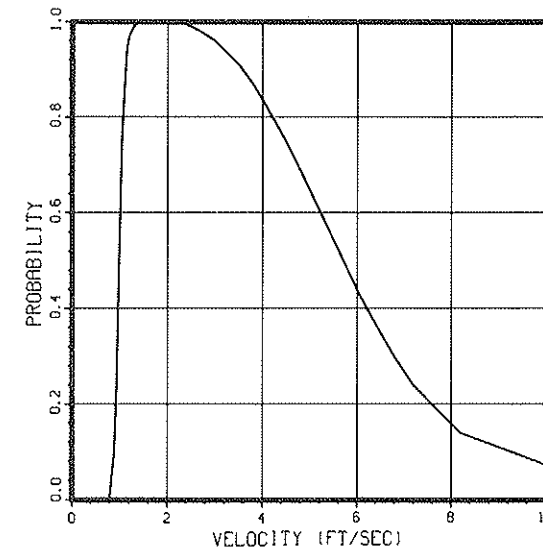


CHINOOK SALMON (TURBID WATER, S=.001)

10122

INCUBATION

78/01/24.

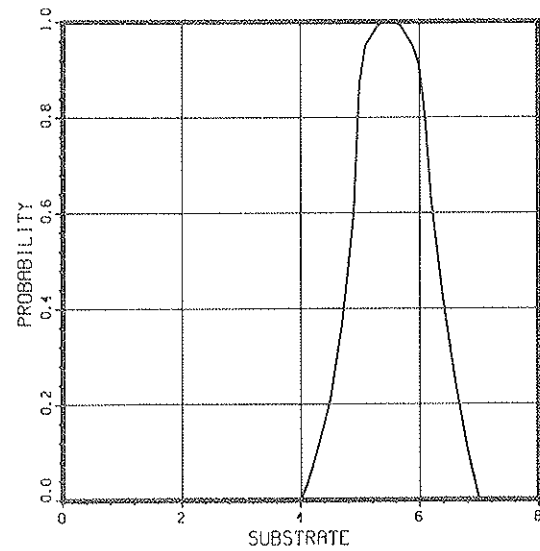
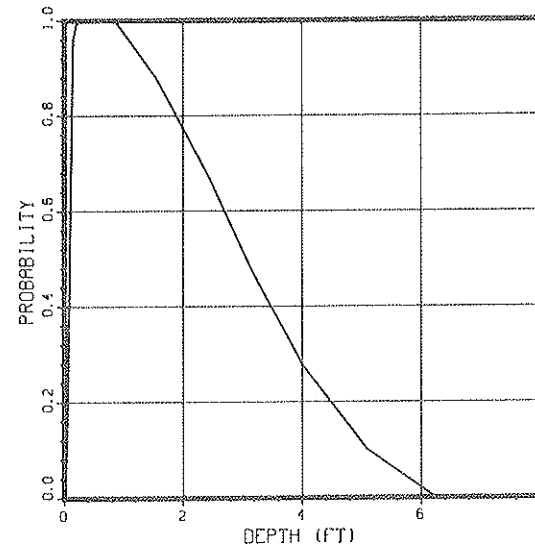
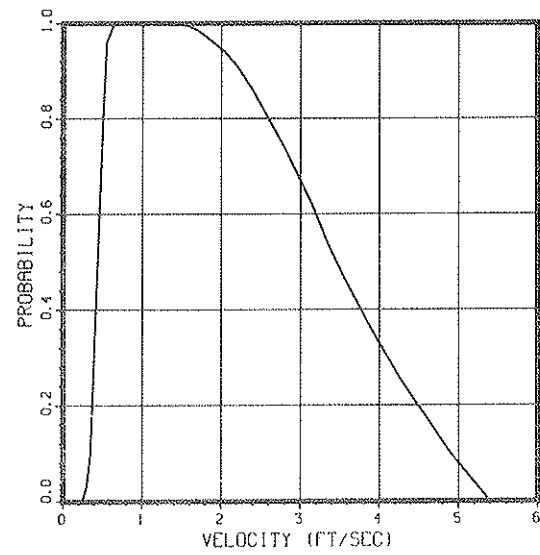


CHINOOK SALMON (CLEAR WATER, S=.0025)

10123

INCUBATION

78/01/24.



BROWN TROUT

Salmo trutta

Catalog No.	11310				11302				11301				11300				11321-11326				
	Spawning		Adult		Juvenile		Fry		Egg		Incubation										
SPECIES:	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	
Brown Trout																					
IFG EVALUATION	E	E	G	G	G	E	G	F	F	E	G	F	G	G	G	F	F	G	F		
REFERENCE	29	29	29	20	12	12	12	2	12	12	12	2	12	12	12	2	9	9	11	2	
	FA	FA	FA	RO	FA	FA	FA	RO	FA	FA	FA	RO	FA	FA	FA	RO	IN	IN	IN	IN	
	33	33	33	31	16	16	16	13	16	16	16	13	16	16	16	8	11	11	29	8	
	FA	FA	FA	RO	FA	FA	FA	RO	FA	FA	FA	RO	FA	FA	FA	RO	IN	IN	IN	IN	
ANALYSIS					3			31				31				13	25	25	36	30	
					RO			PO				PO				RP	IN	IN	IN	IN	
								8				8					36	36			
								RO				RO				IN	IN				
COMMENTS									1			2									3

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - indirect analysis

Reference: Refer to listed number in bibliography.

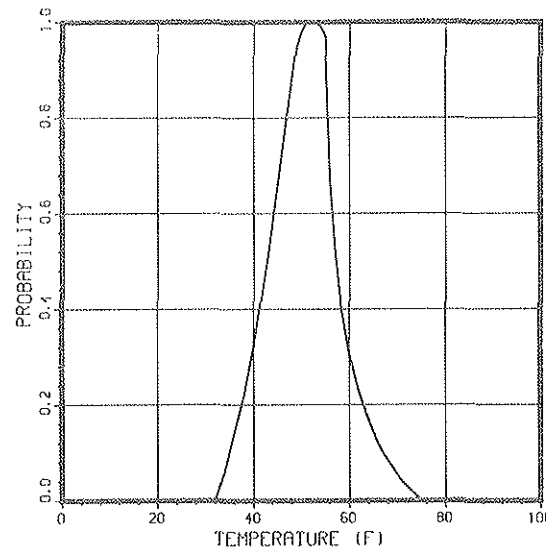
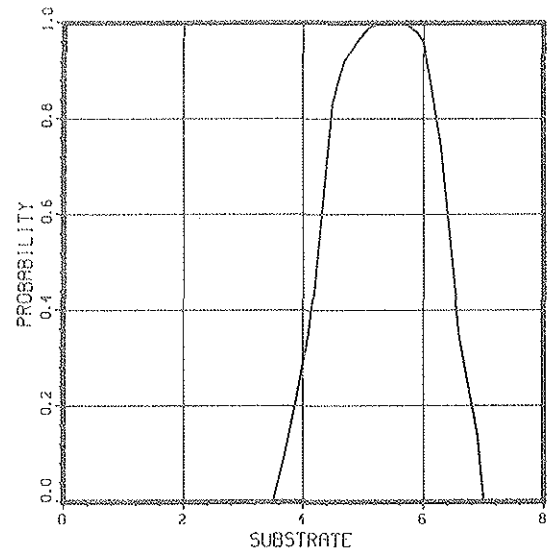
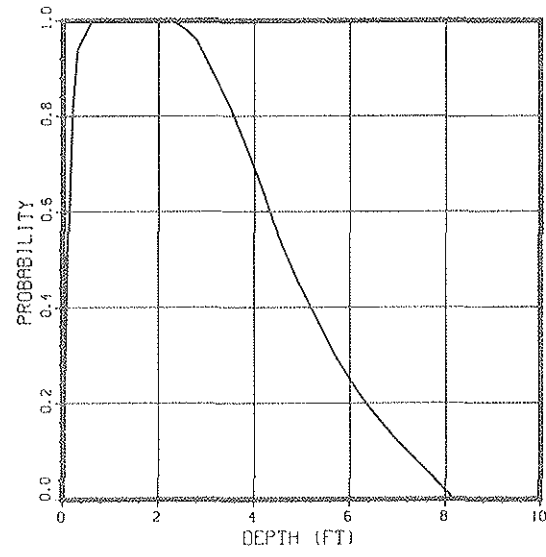
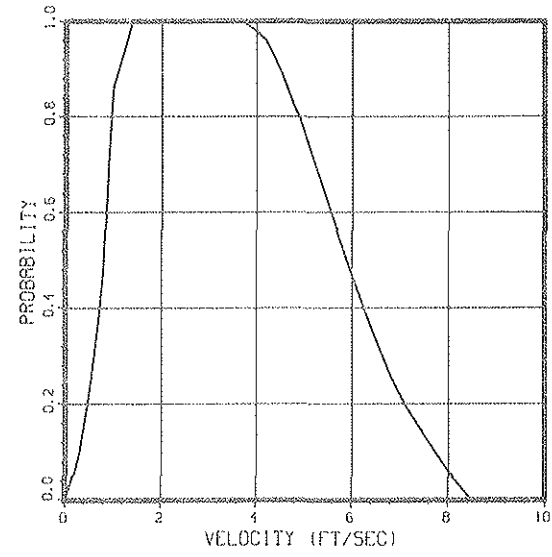
Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

Comments - Brown Trout Curves

- The note for Wesche's data was from .5 to 1.25 feet in depth. Cochnauer's data showed no difference between 1.0 and 3.0 feet. Gosse, et. al., showed a very distinct peak at 2.9 to 3.1 feet. The optimum on this curve incorporates these differences, which may be due to availability of different conditions rather than differential preferences.
- At the time of year that these collections were made, young of the year brown trout were fairly large. For fry recently emerged from the redds, this curve would be compacted toward the zero velocity axis somewhat.
- Survival rates were calculated from time-to-hatching data, based on a standard hatching time of 4 to 6 weeks. It was assumed that an extended incubation period would increase the probability of egg mortality. This assumption applies only to the lower temperature limb of the curve.

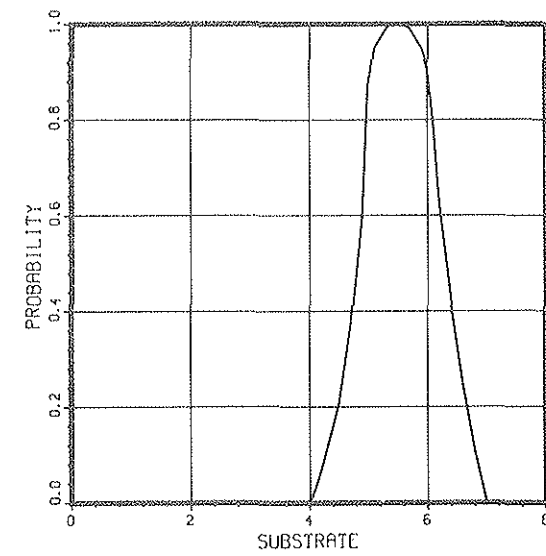
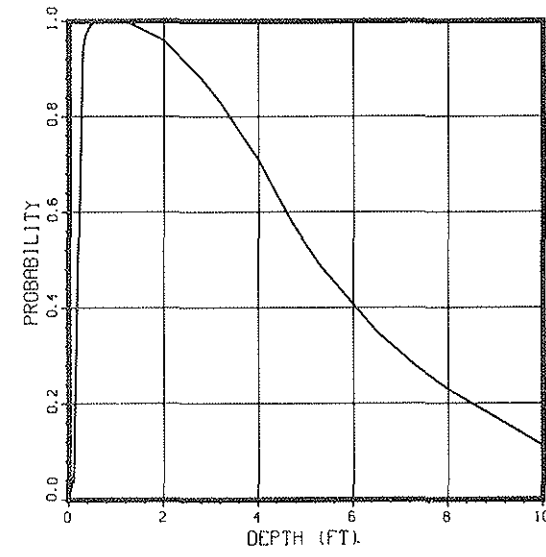
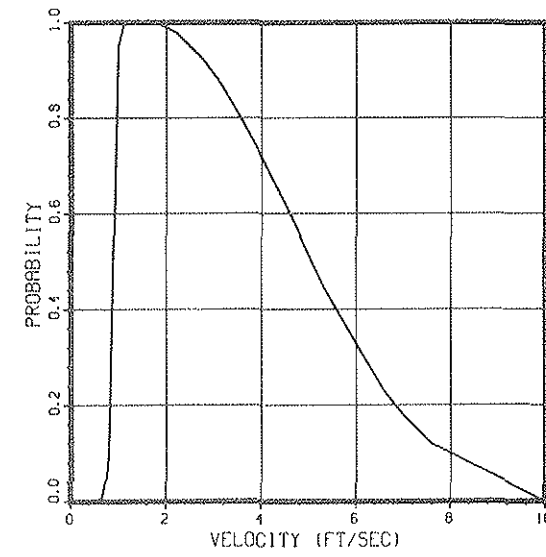
WINTER STEELHEAD (TURBID WATER, S=.004)

11026 INCUBATION 78/01/24.



CHINOOK SALMON (TURBID WATER, S=.0025)

10124 INCUBATION 78/01/24.



CHINOOK SALMON (CLEAR WATER, S=.004)

10125

INCUBATION

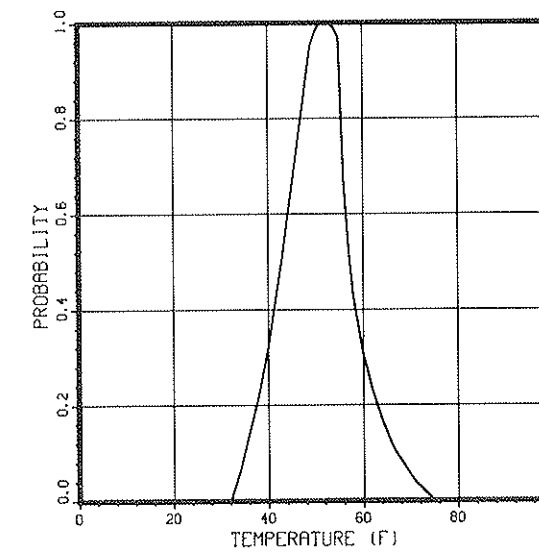
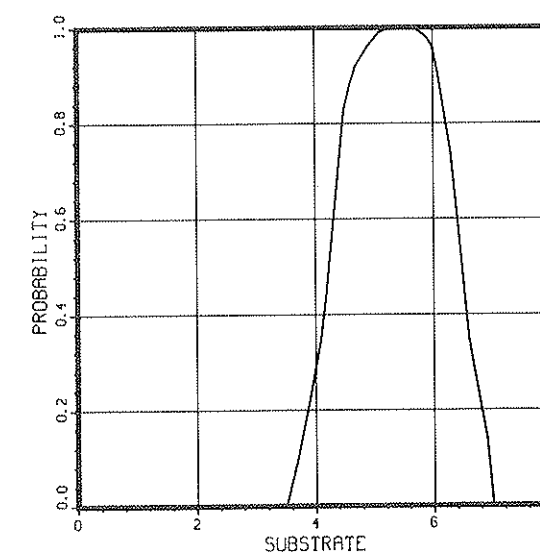
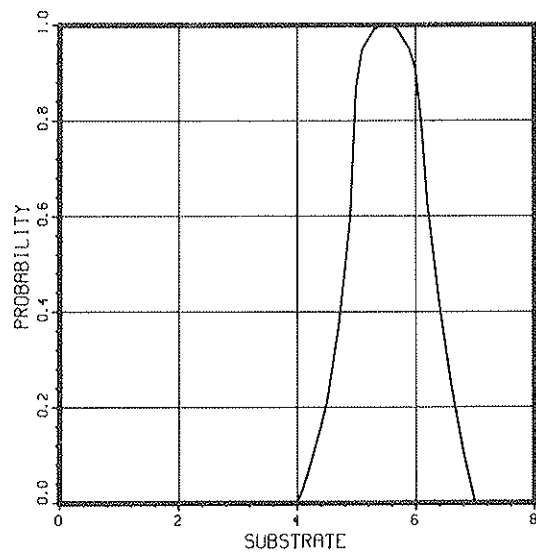
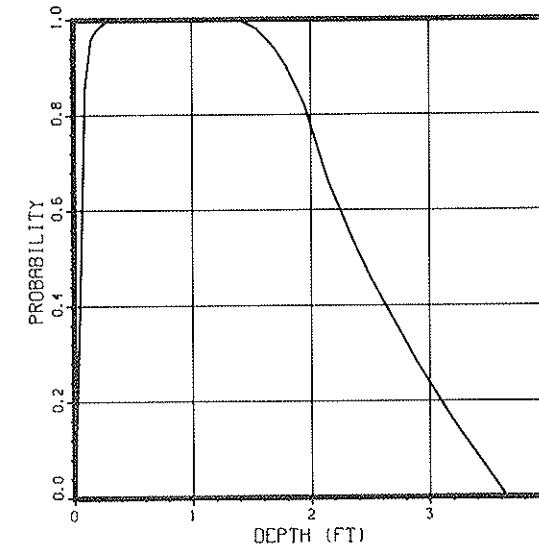
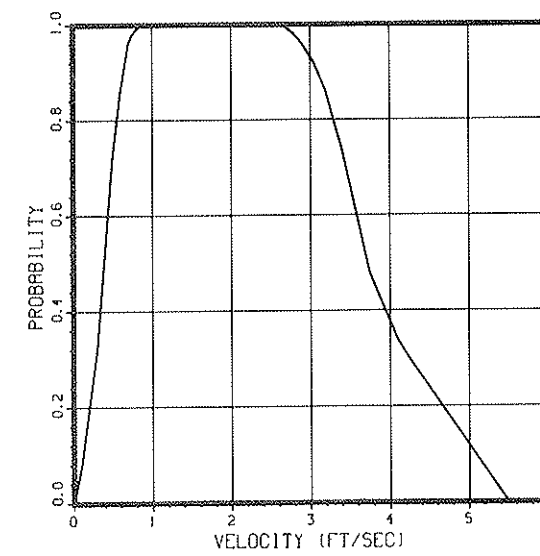
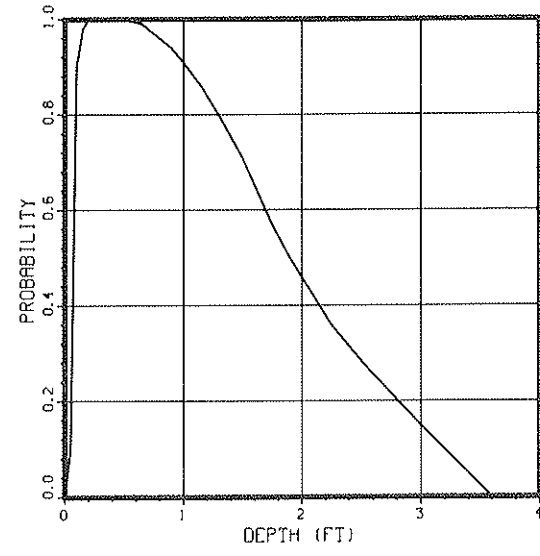
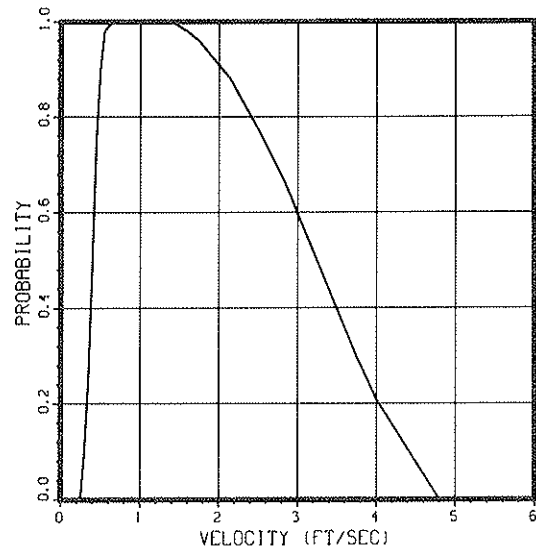
78/01/24.

WINTER STEELHEAD (CLEAR WATER, S=.004)

11025

INCUBATION

78/01/24.

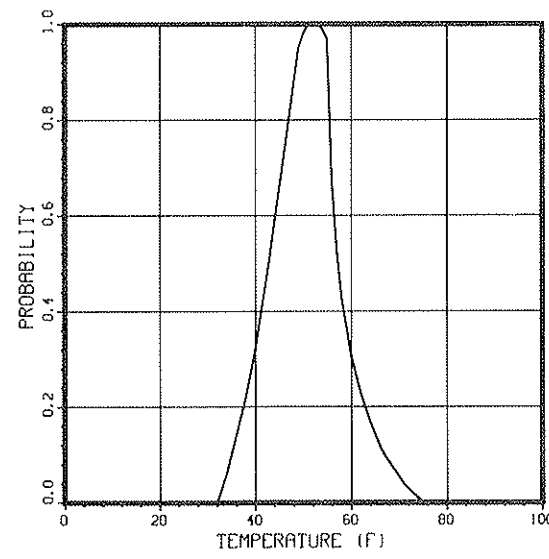
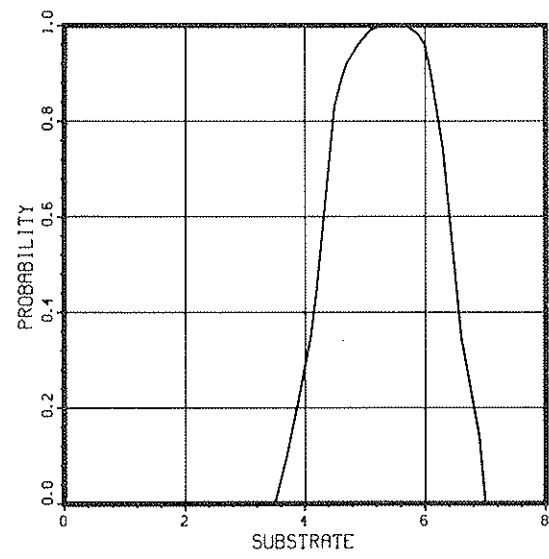
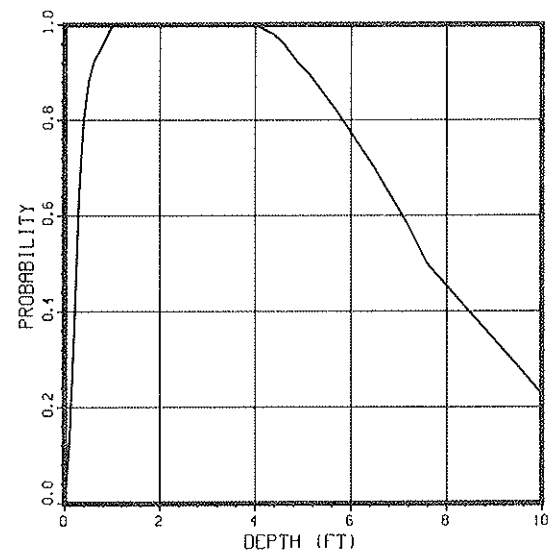
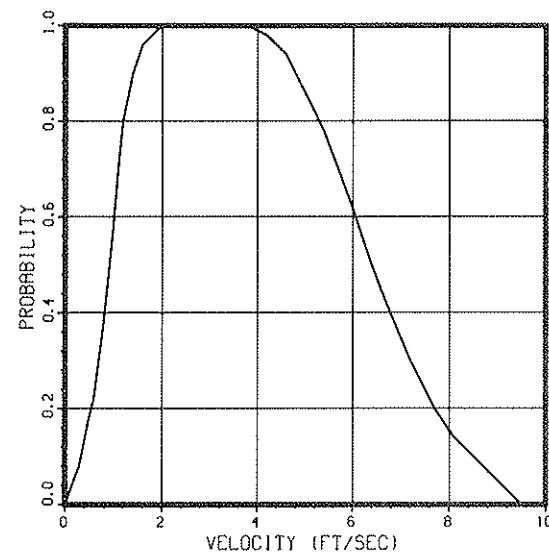


WINTER STEELHEAD (TURBID WATER, S=.0025)

11024

INCUBATION

78/01/24.

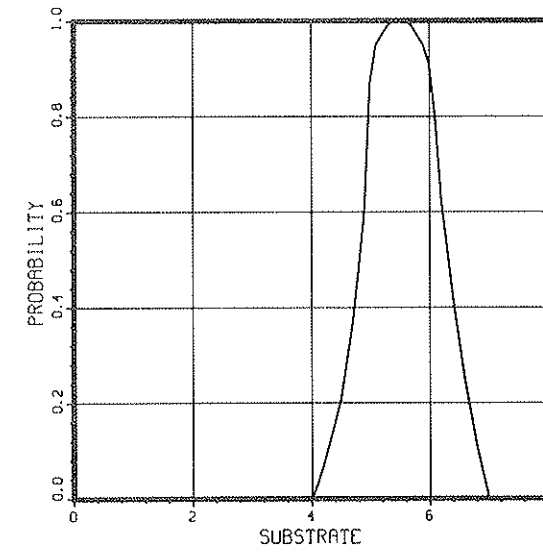
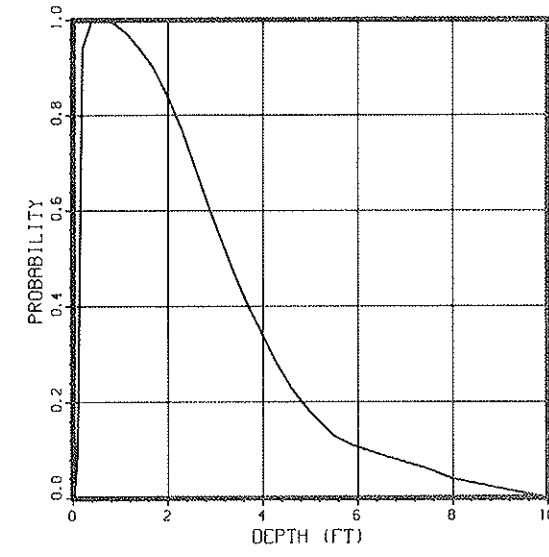
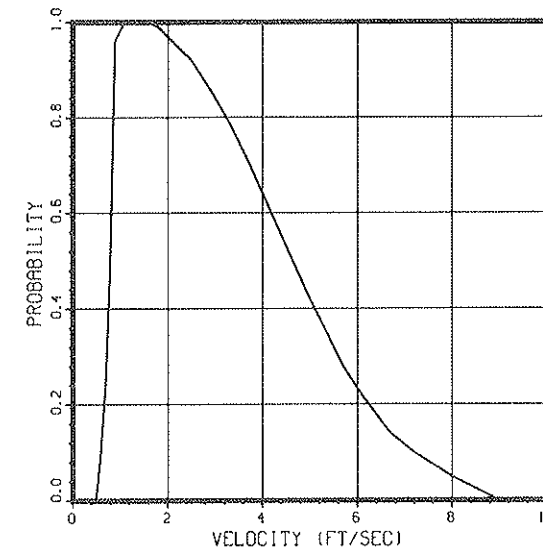


CHINOOK SALMON (TURBID WATER, S=.004)

10126

INCUBATION

78/01/24.



CUTTHROAT TROUT

Salmo clarki

SPECIES: Cutthroat trout	11210 Spawning				11202 Adult				11201 Juvenile				11200 Fry				11223-11226 Egg Incubation			
	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
IFG EVALUATION	F	F	F	F	F	F	F	R	G	G	G	R	F	F	G	R	F	F	F	R
REFERENCE	22 FA	22 FA	20 RO	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	15 FA	9 IN	9 IN	11 IN		
ANALYSIS			31 RO													25 IN	25 IN	36 IN		
																36 IN	36 IN			
COMMENTS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - indirect analysis

Reference: Refer to listed number in bibliography.

Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

Comments - Cutthroat Trout

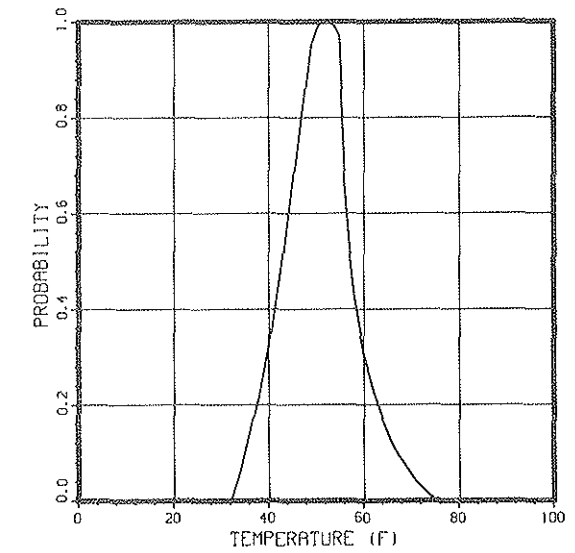
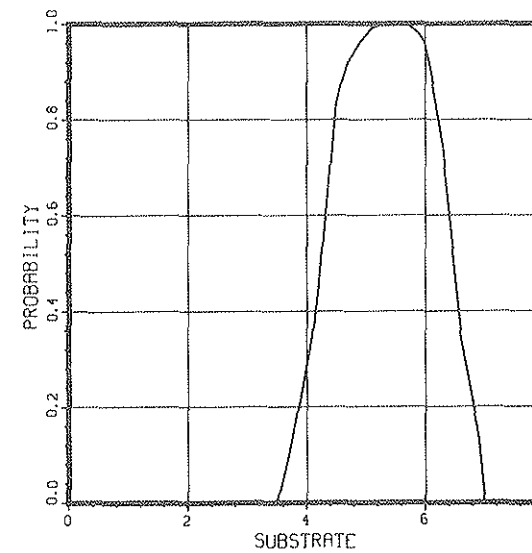
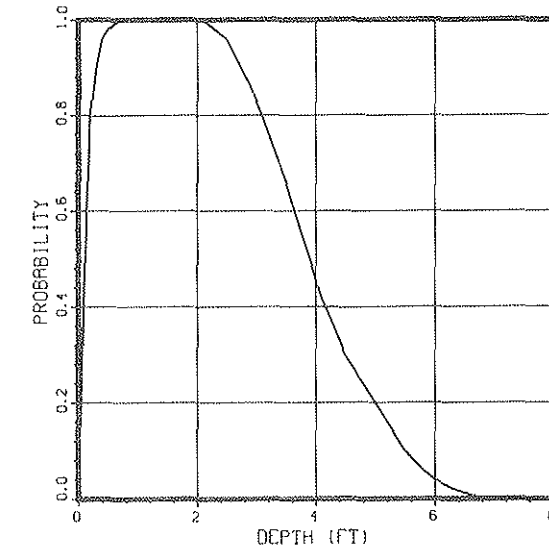
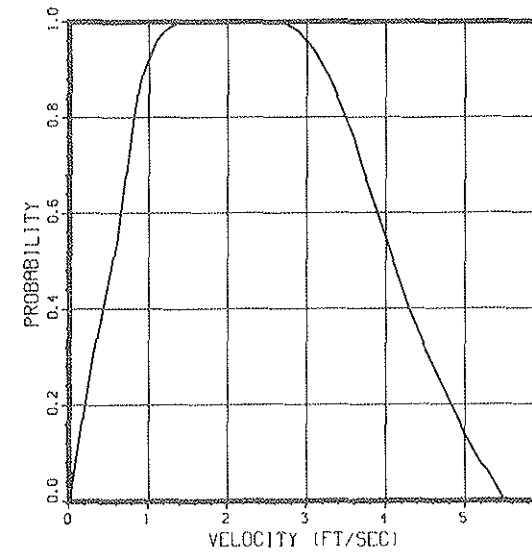
1. These curves represent the composite cutthroat trout. There are so many races and sub-species of cutthroat trout that the criteria for any single race may deviate somewhat from these criteria.
2. Assumed same as rainbow trout.

WINTER STEELHEAD (CLEAR WATER, S=.0025)

11023

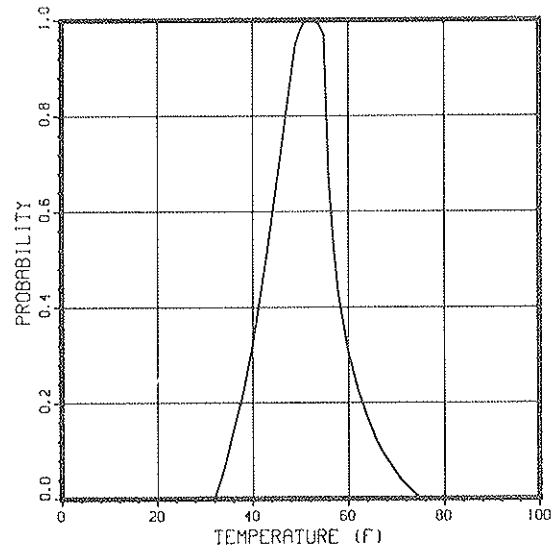
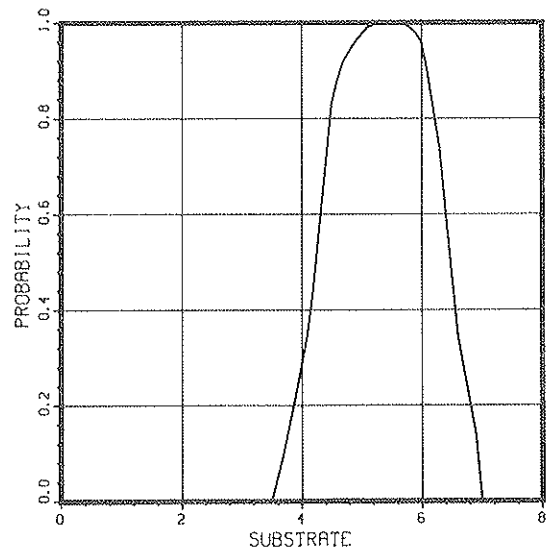
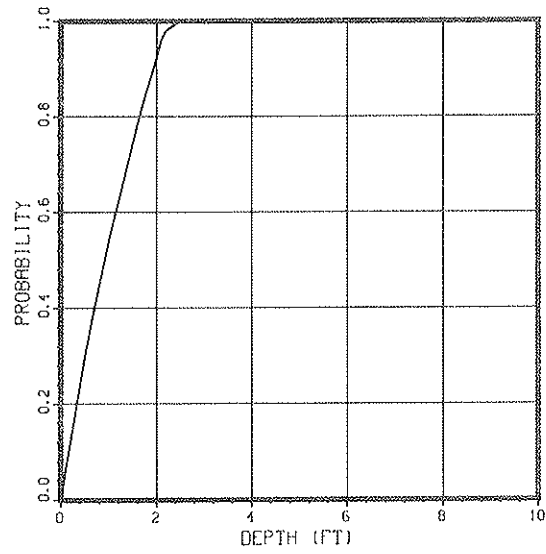
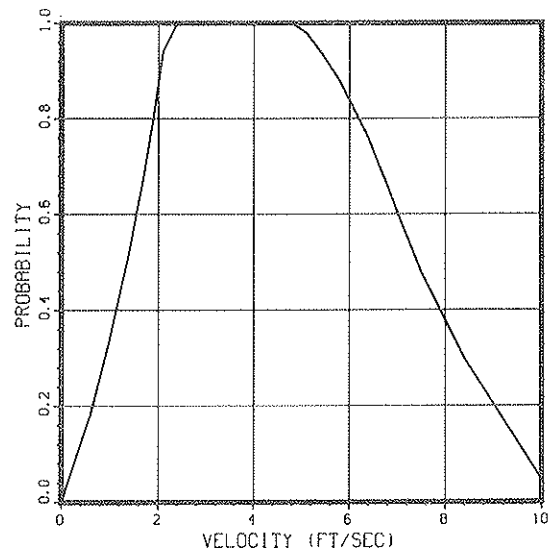
INCUBATION

78/01/24.



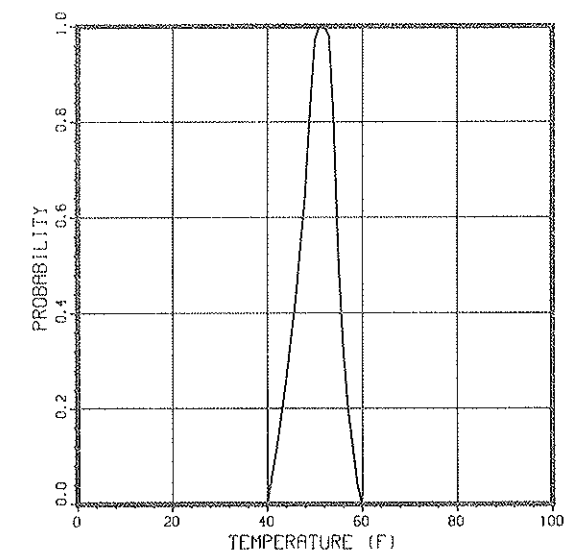
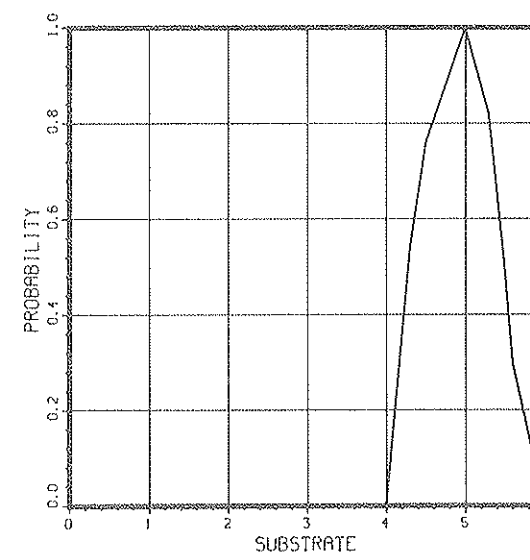
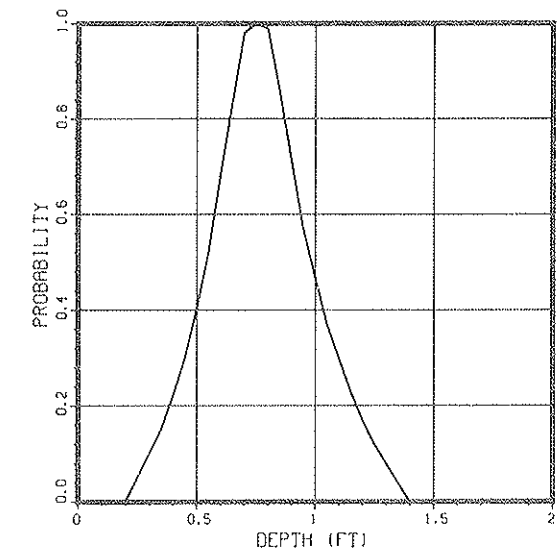
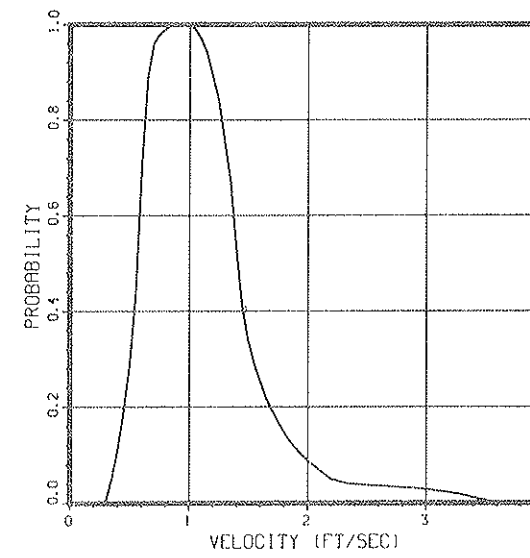
WINTER STEELHEAD (TURBID WATER, S=.001)

11022 INCUBATION 78/01/24.



CUTTHROAT TROUT

11210 SPAWNING 78/01/24.

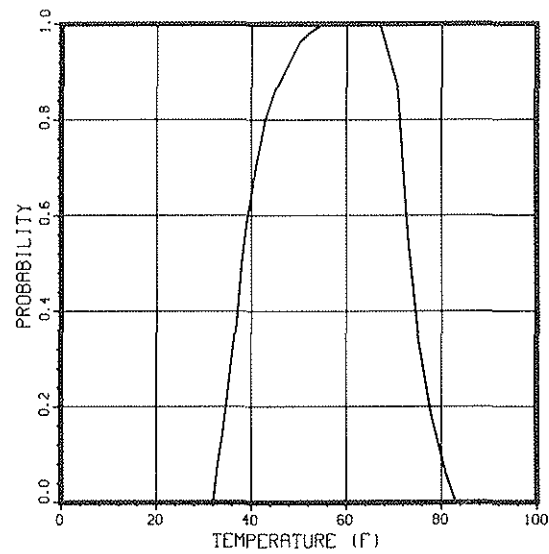
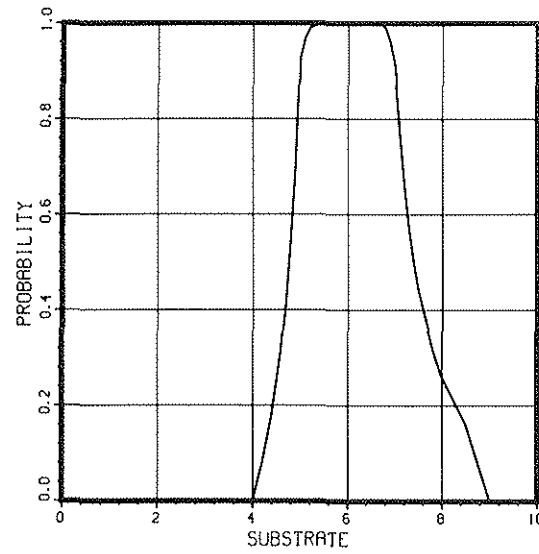
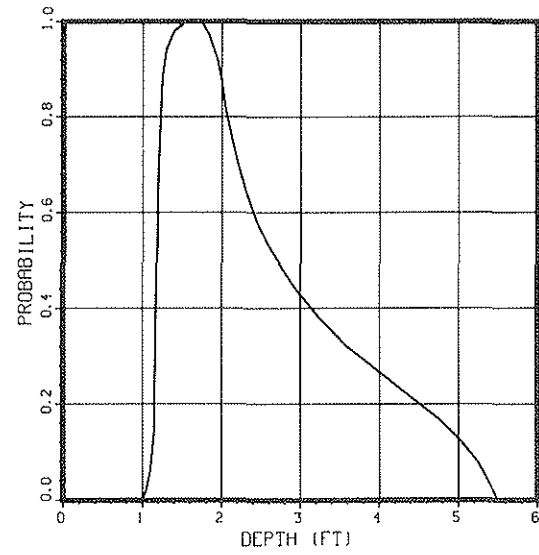
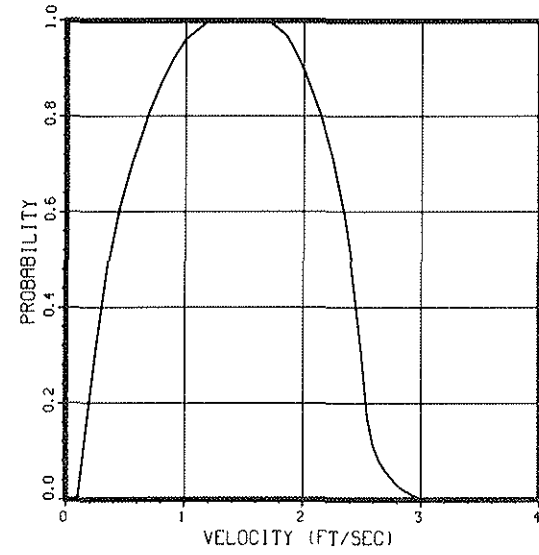


CUTTHROAT TROUT

11202

ADULTS

78/01/24.

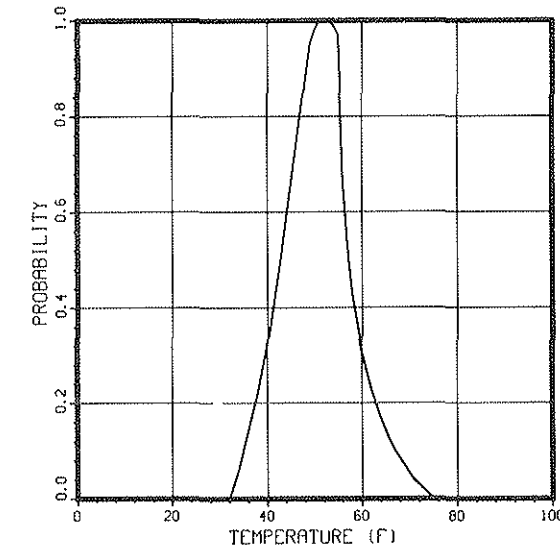
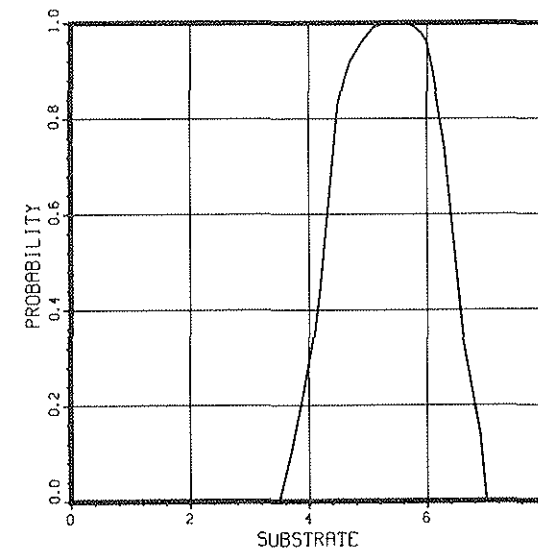
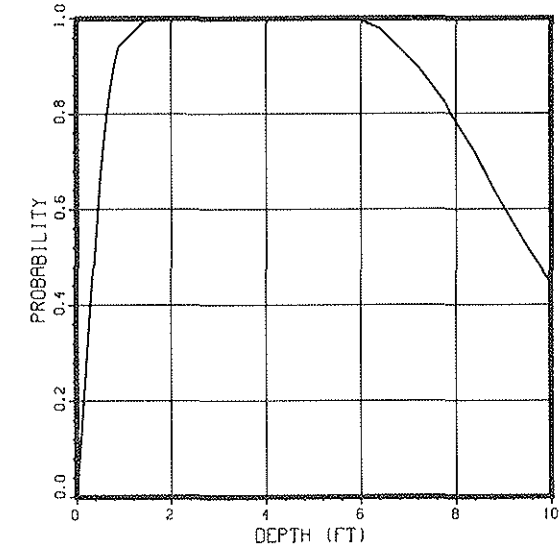
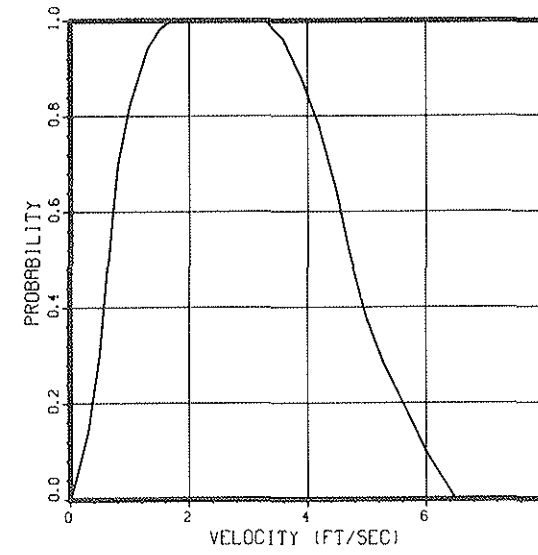


WINTER STEELHEAD (CLEAR WATER, S=.001)

11021

INCUBATION

78/01/24.

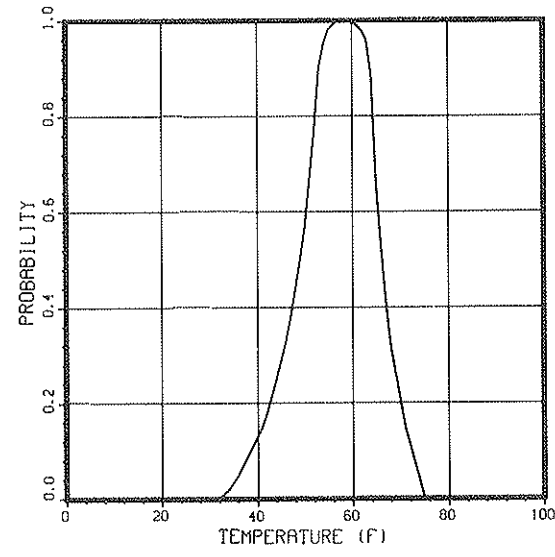
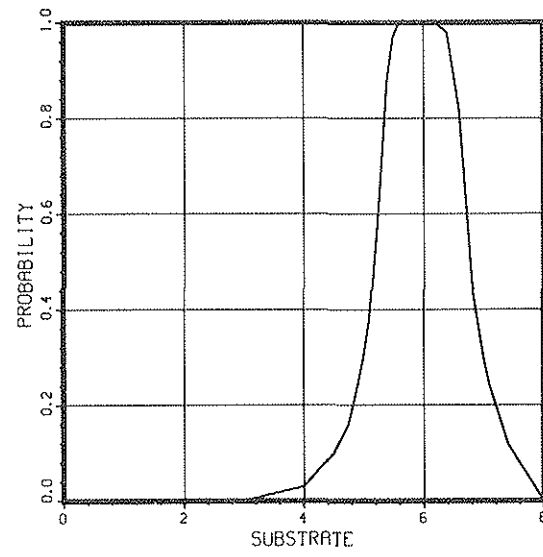
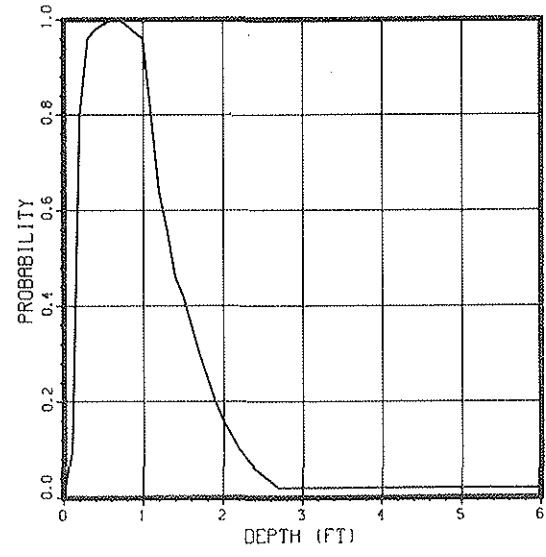
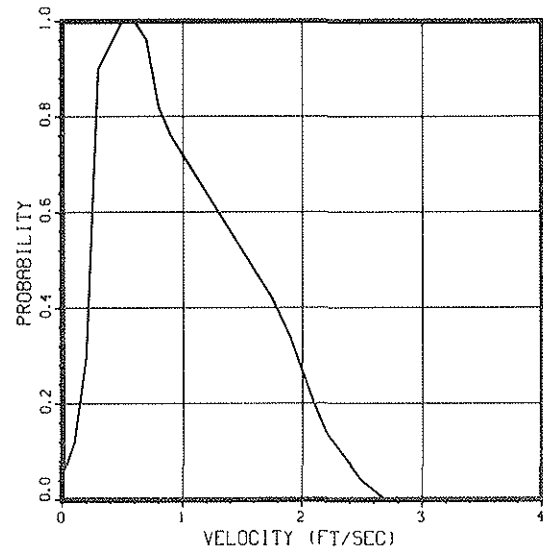


WINTER STEELHEAD

11000

FRY

78/01/24.

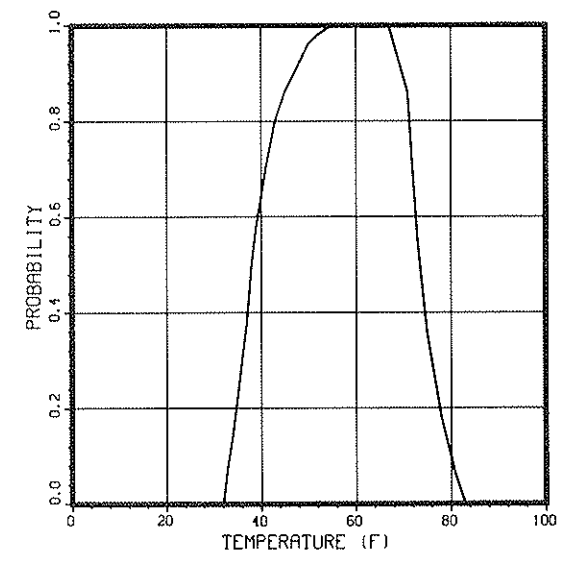
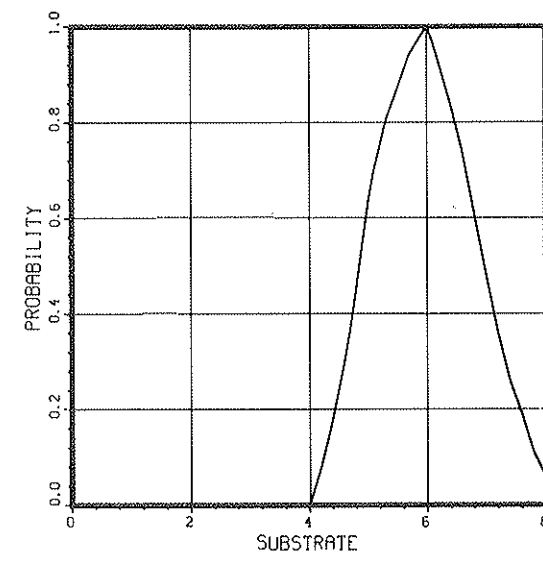
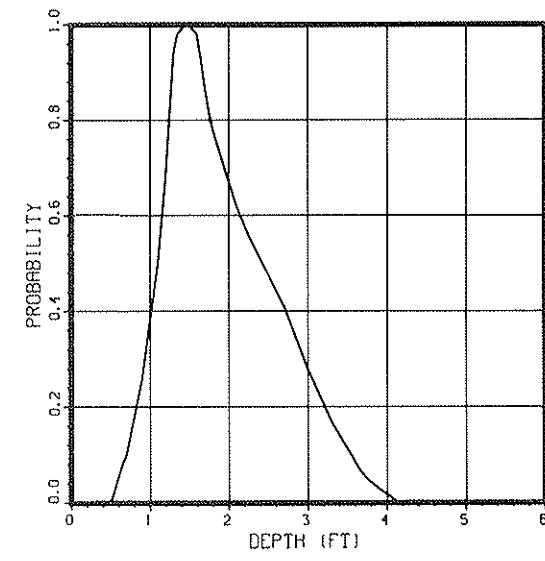
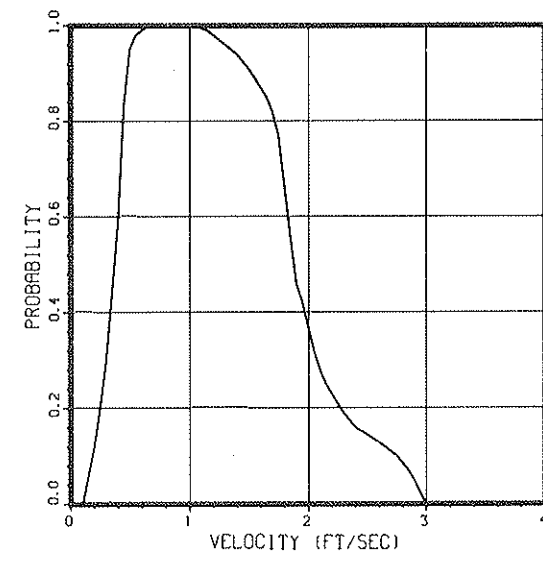


CUTTHROAT TROUT

11201

JUVENILE

78/01/24.

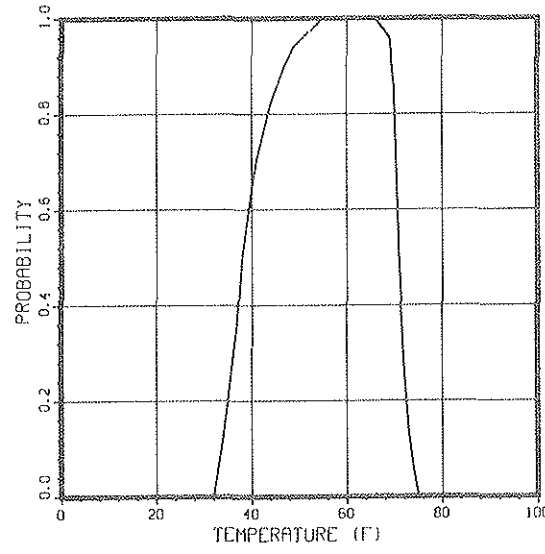
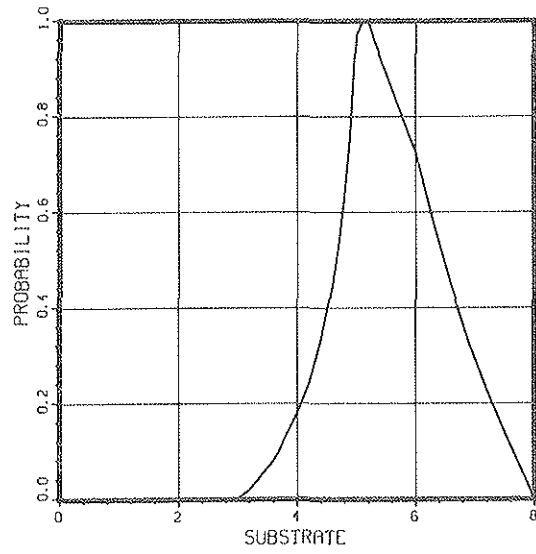
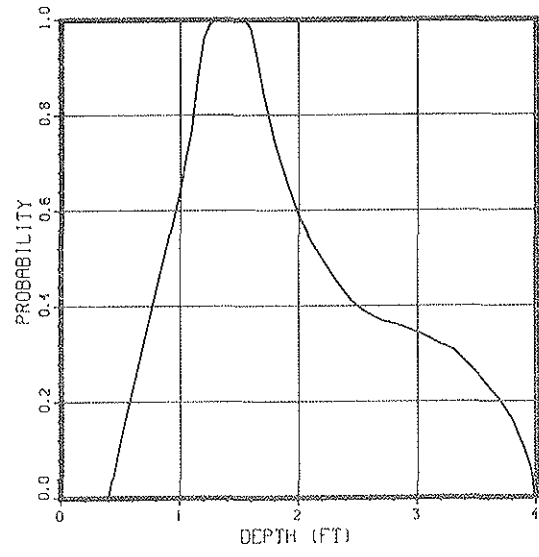
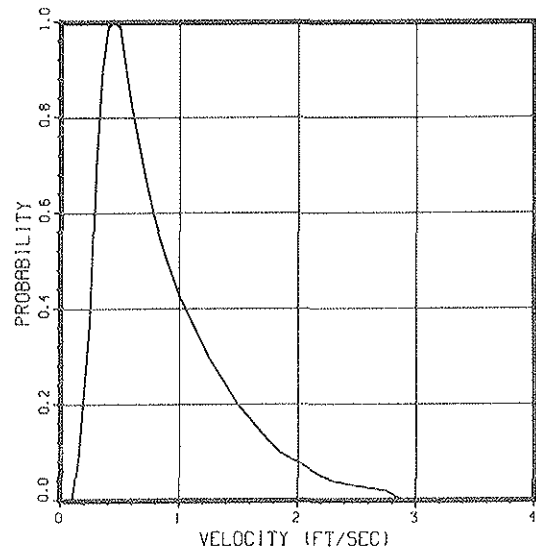


CUTTHROAT TROUT

11200

FRY

78/01/24.

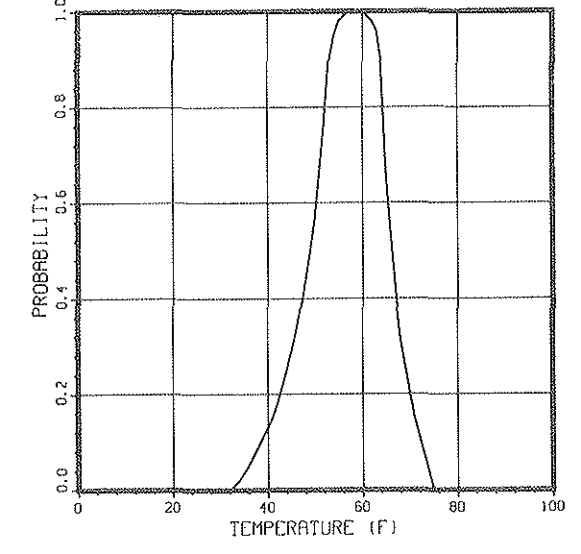
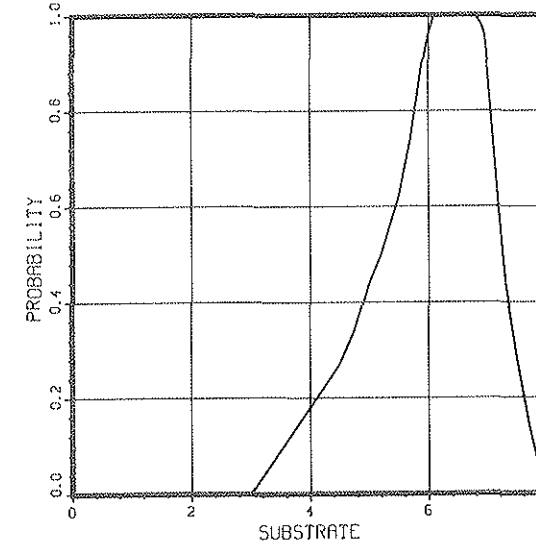
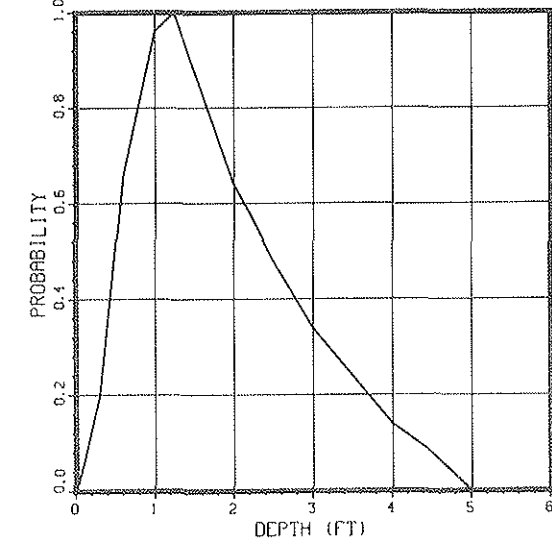
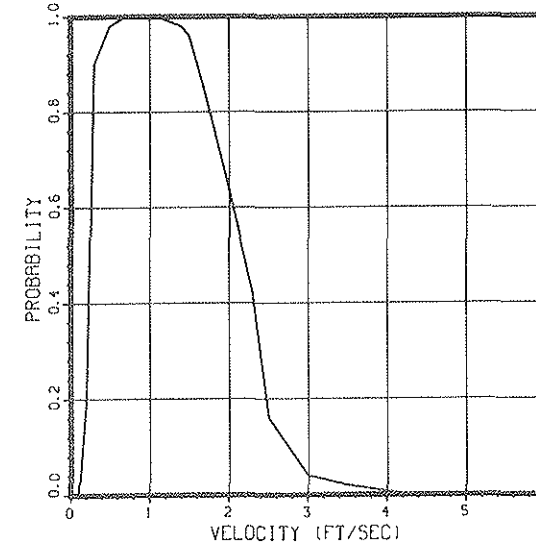


WINTER STEELHEAD

11001

JUVENILE

78/01/24.

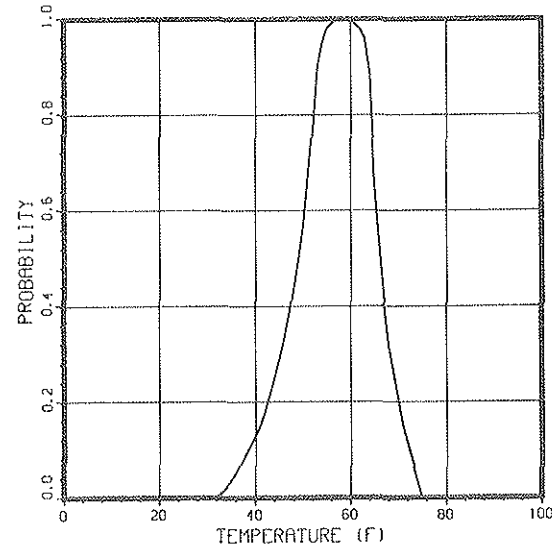
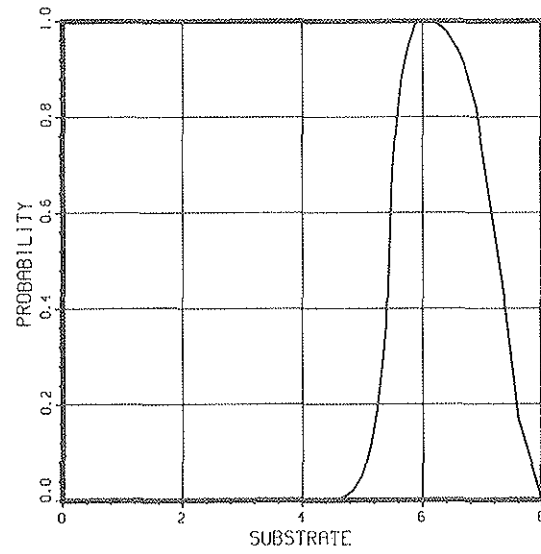
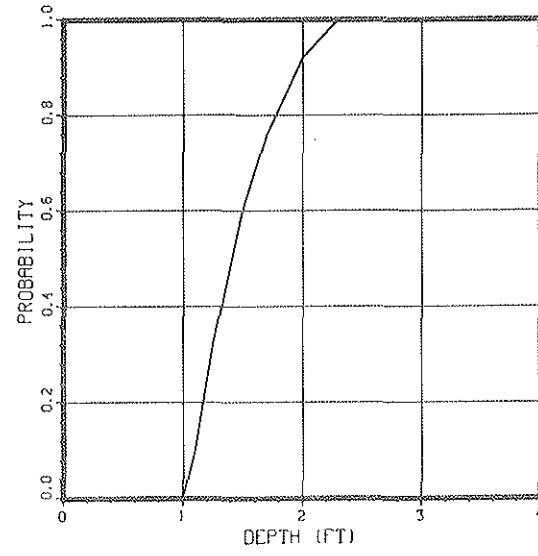
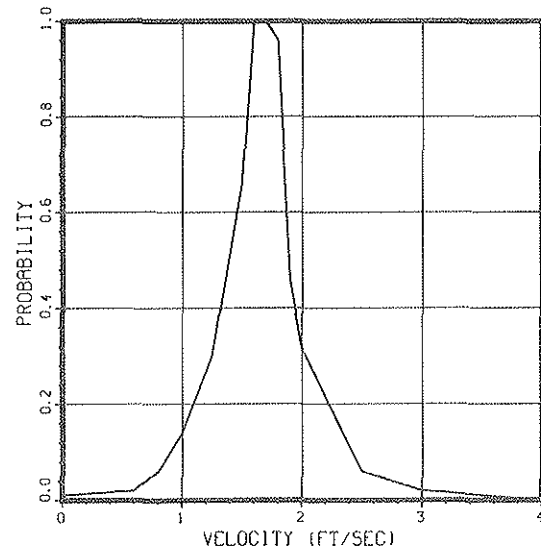


WINTER STEELHEAD

11002

ADULT

78/01/24.

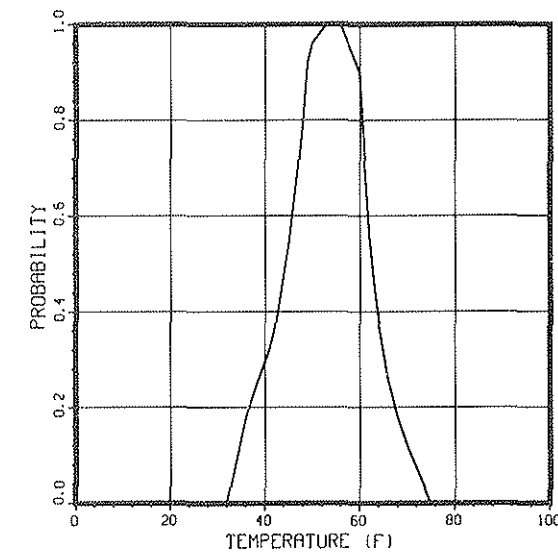
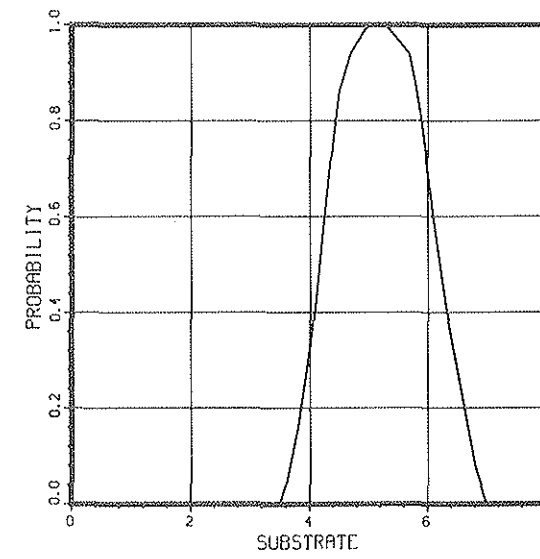
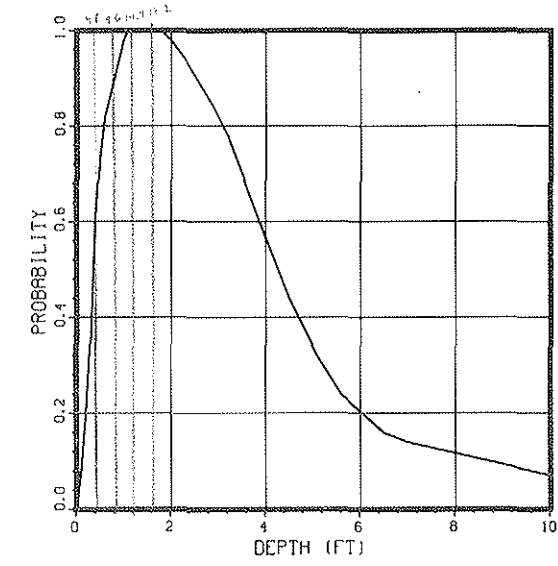
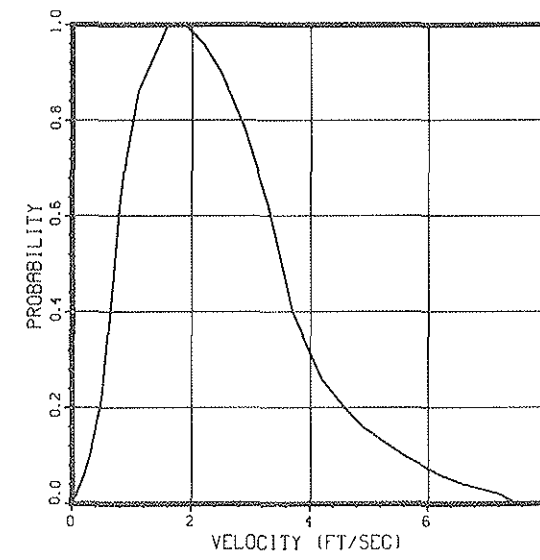


CUTTHROAT TROUT (CLEAR WATER, S=.001)

11221

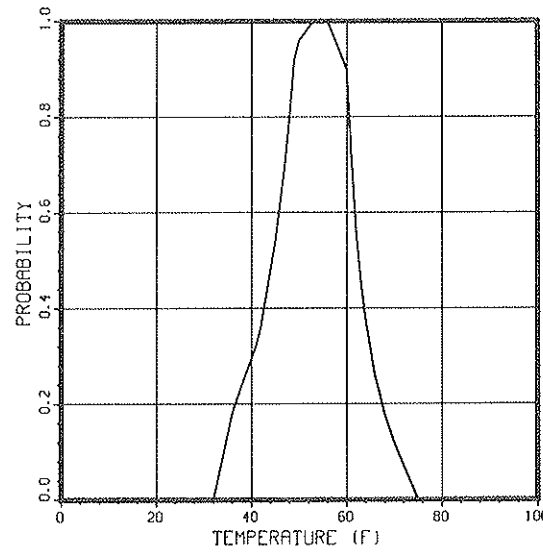
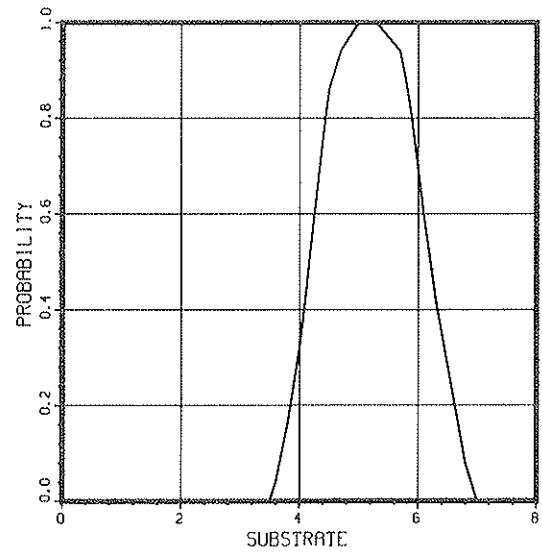
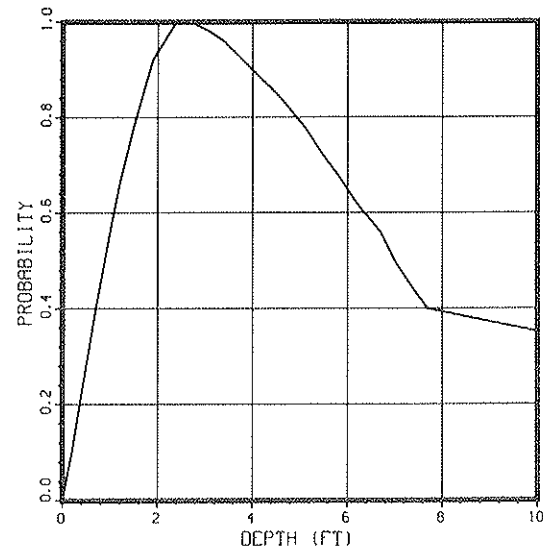
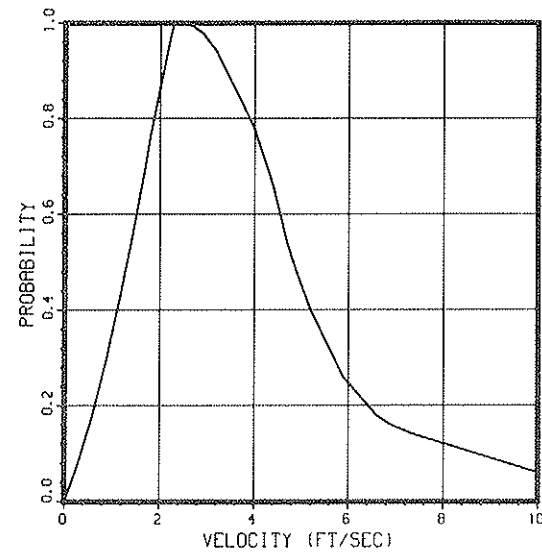
INCUBATION

78/01/24.



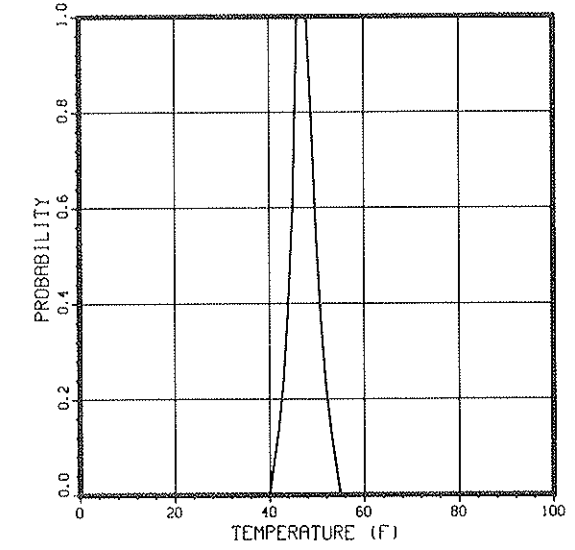
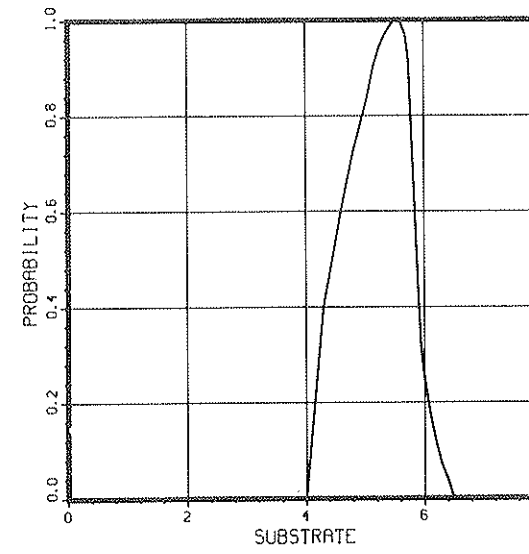
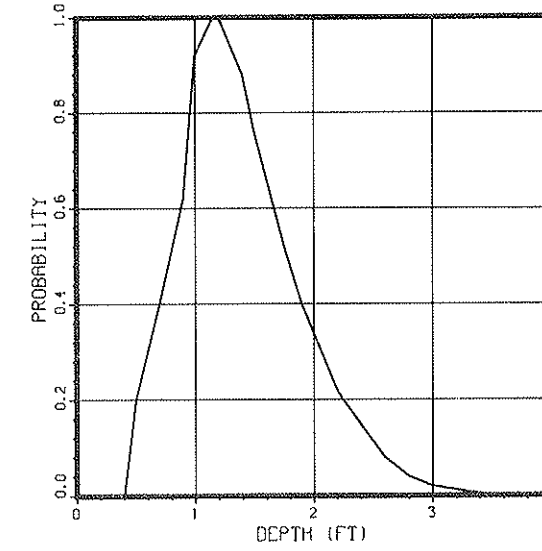
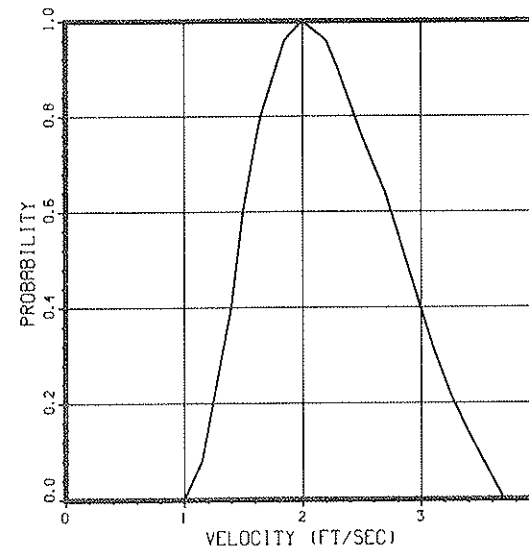
CUTTHROAT TROUT (TURBID WATER, S=.001)

11222 INCUBATION 78/01/24.



WINTER STEELHEAD

11010 SPAWNING 78/01/24.



STEELHEAD
Salmo gairdneri

CUTTHROAT TROUT (CLEAR WATER, S=.0025)
 11223 INCUBATION 78/01/24.

Catalog No.	11013				11002				11001				11000				11021-11026			
	Spawning				Adult				Juvenile				Fry				Egg Incubation			
SPECIES:	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature
Steelhead																				
IFG EVALUATION	E	E	G	G	F	F	F	F	G	G	G	F	G	G	G	F	F	G	F	R
REFERENCE	22	22	28	22	18	18	18	15	14	14	14	15	14	14	14	15	9	9	11	21
	FA	FA	FA	PO	FA	FA	FA	PO	FA	FA	FA	PO	FA	FA	FA	PO	IN	IN	IN	RO
ANALYSIS	28	28							17	17	17		17	17	17		11	11	36	
	FA	FA							RO	RO	RO		RO	RO	RO		IN	IN	IN	
COMMENTS																				

Key to IFG Evaluation Matrix

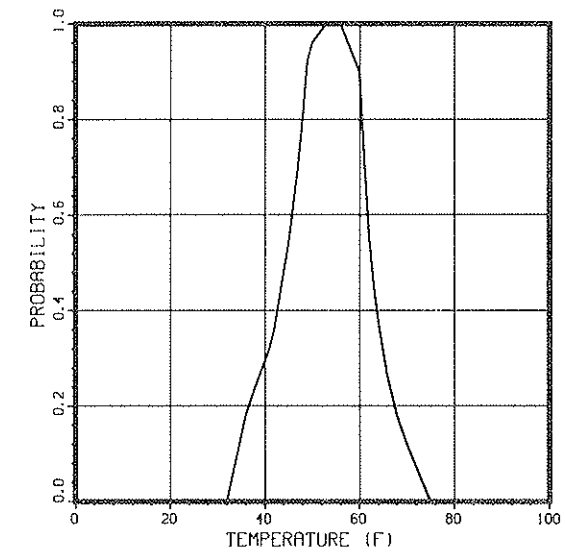
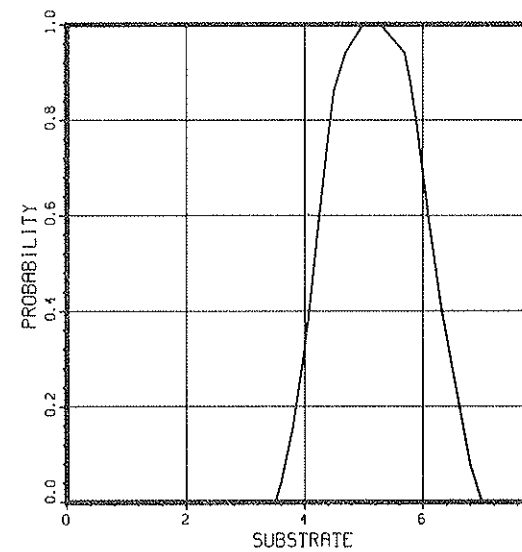
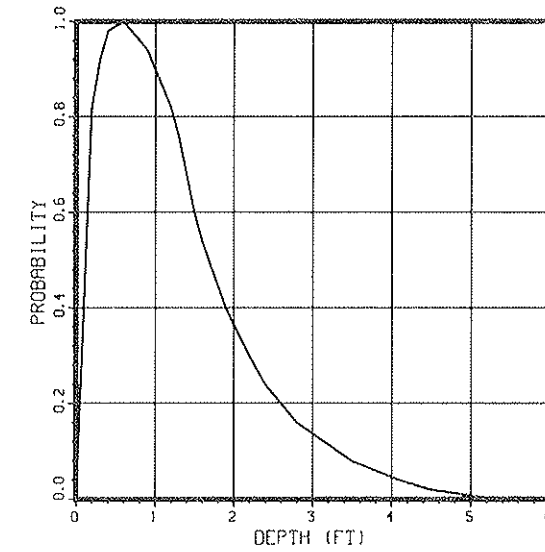
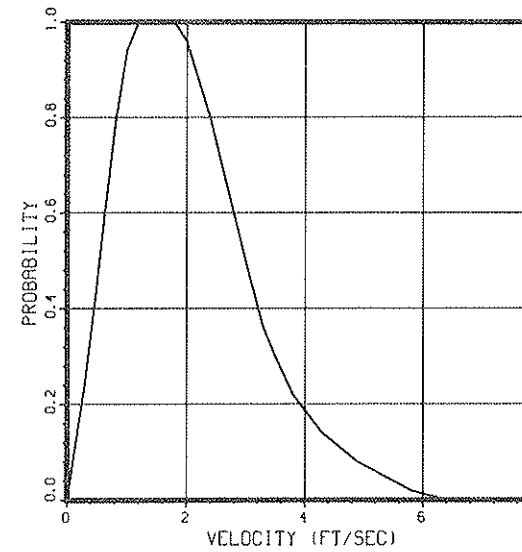
IFG Evaluation: E - Excellent
 G - Good
 F - Fair
 R - Reconnaissance Grade

Analysis: FA - frequency analysis
 RO - range and optimum
 PO - Parameter overlap
 IN - indirect analysis

Reference: Refer to listed number in bibliography.
 Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

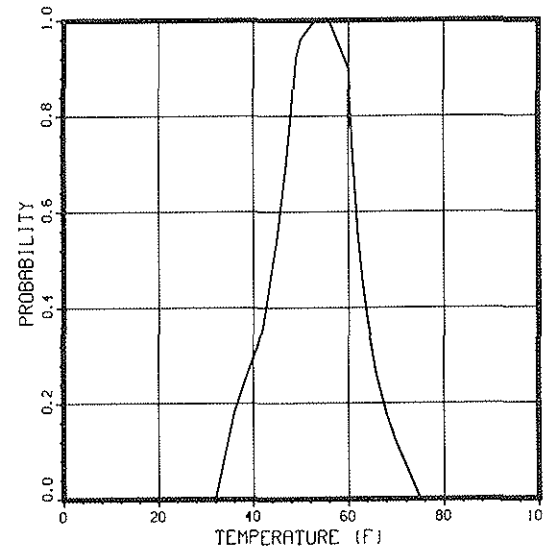
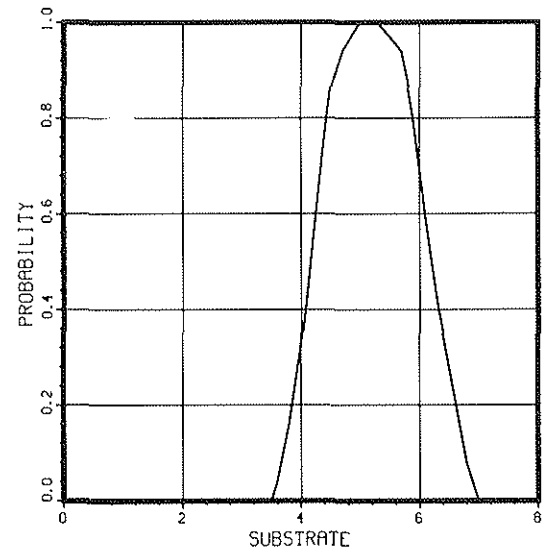
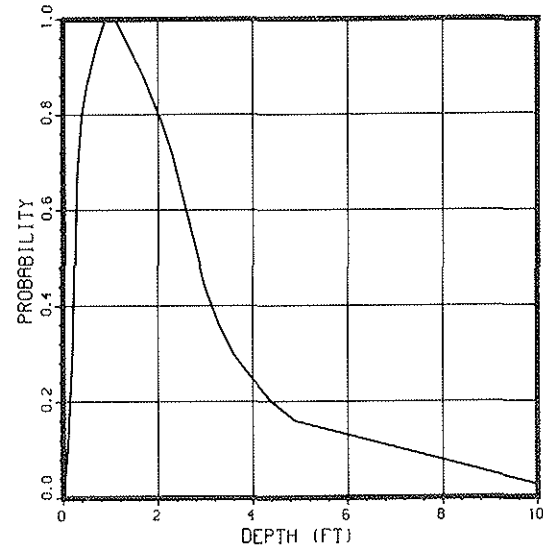
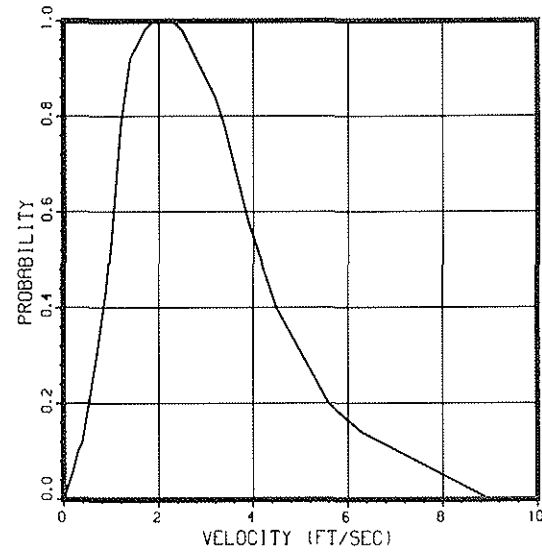
Comments - Winter Steelhead

1. Frequency Analysis from Everest and Chapman utilized density rather than frequency of observation. Sample size unknown.
2. Everest and Chapman show conflicting data. In one study section they found steelhead pre-smolts over a silt bottom, but not so in two others. These two agreed well with the data provided by Hanson. Data from the conflicting stream reach was not used in the analysis.



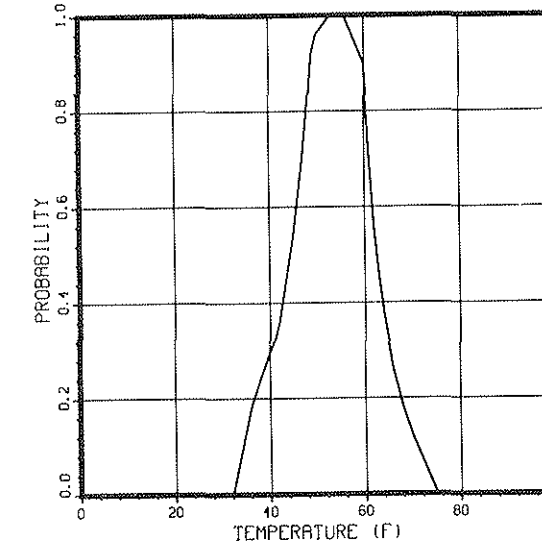
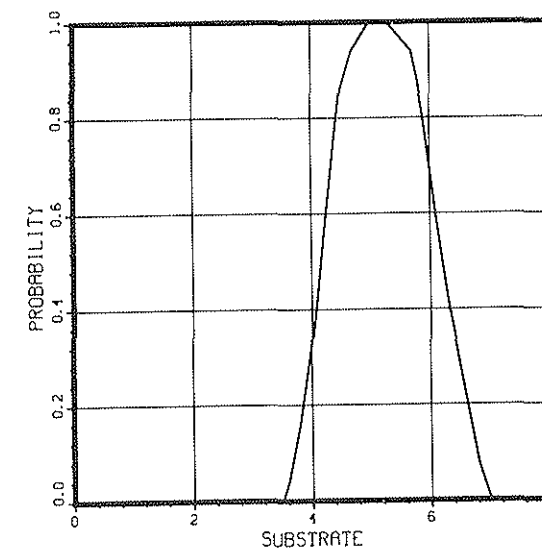
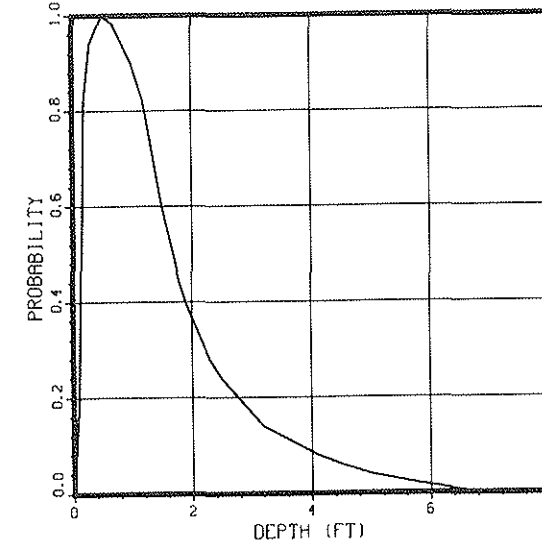
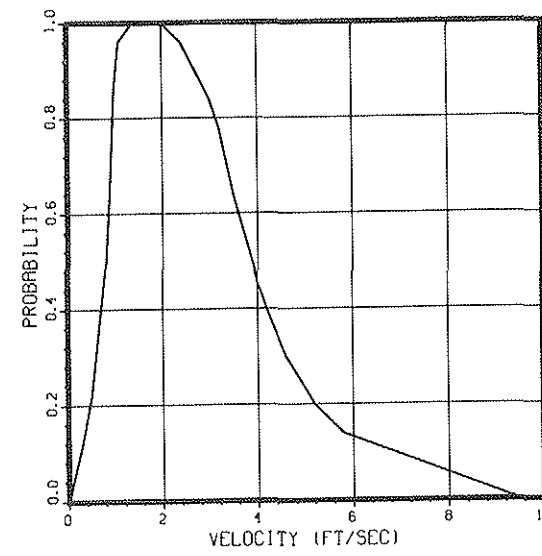
CUTTHROAT TROUT (TURBID WATER, S=.0025)

11224 INCUBATION 78/01/24.



RAINBOW TROUT (TURBID WATER, S=.004)

11126 INCUBATION 78/01/24.

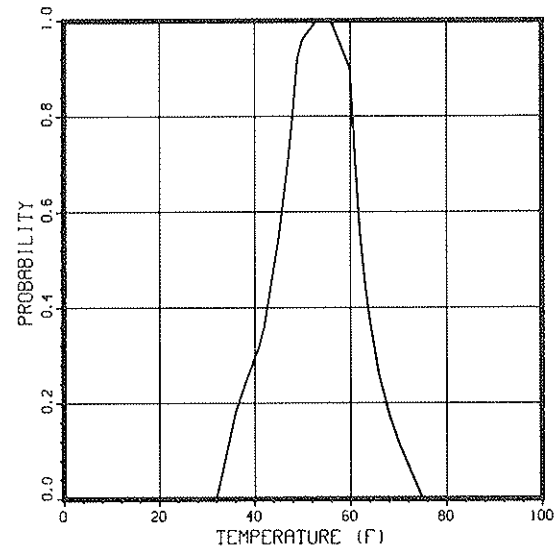
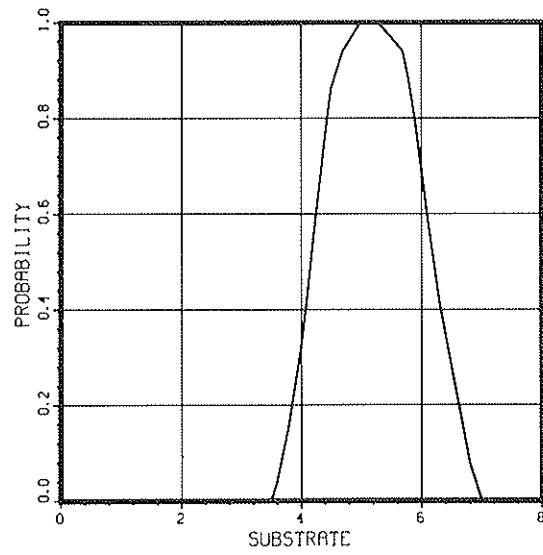
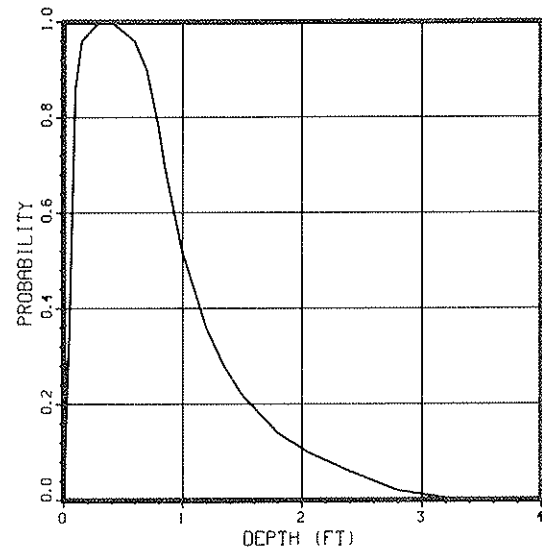
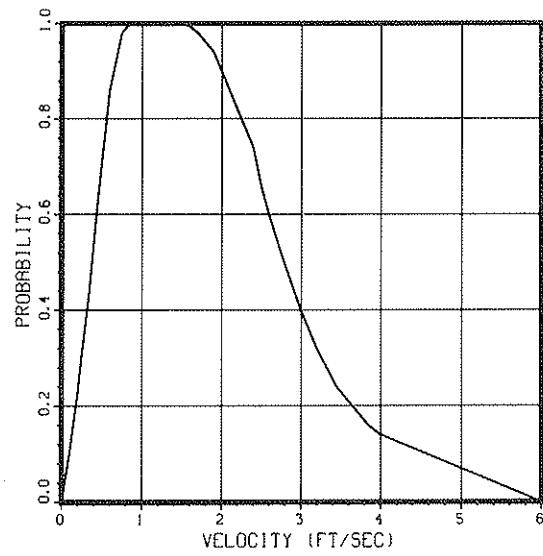


RAINBOW TROUT (CLEAR WATER, S=.004)

11125

INCUBATION

78/01/24.

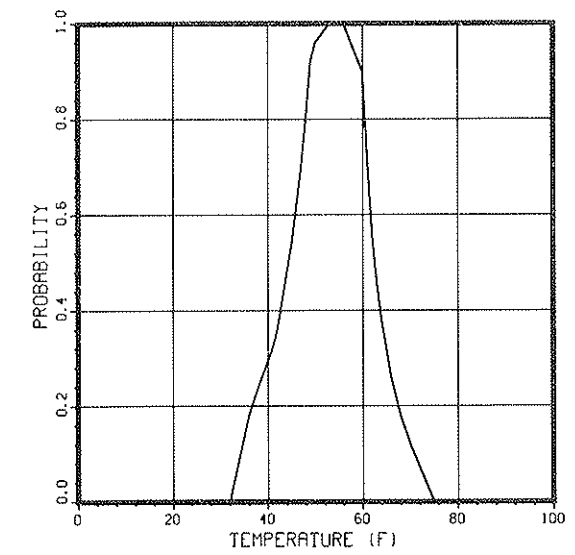
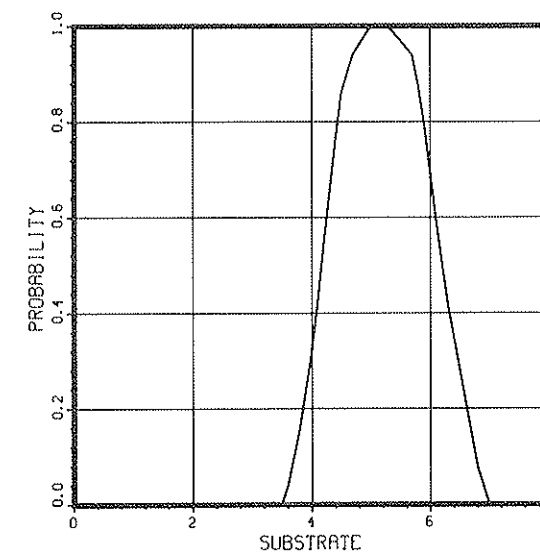
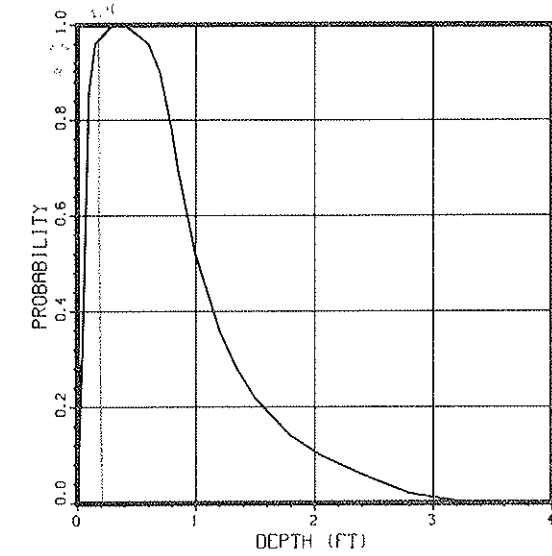
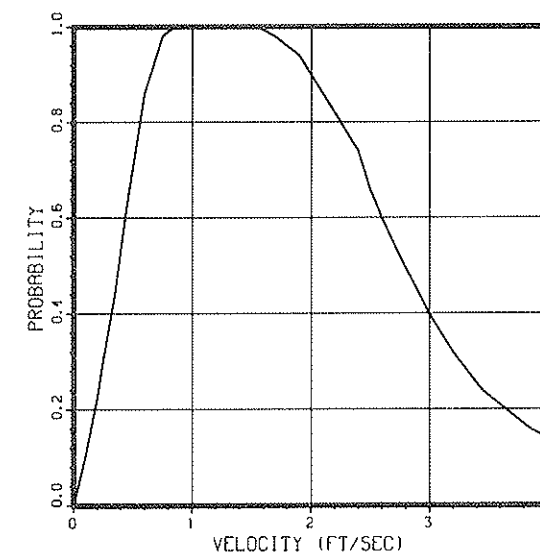


CUTTHROAT TROUT (CLEAR WATER, S=.004)

11225

INCUBATION

78/01/24.

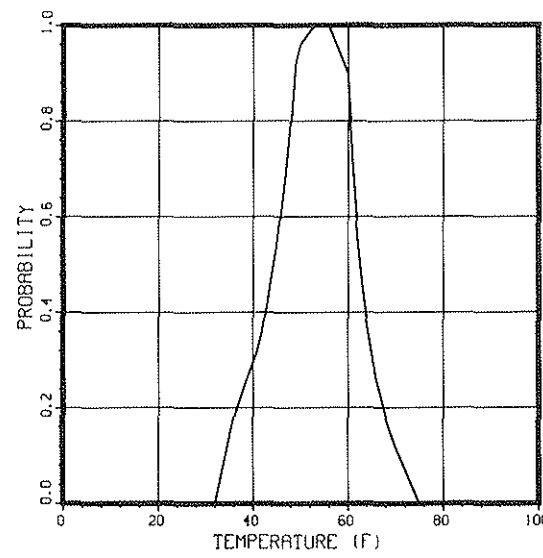
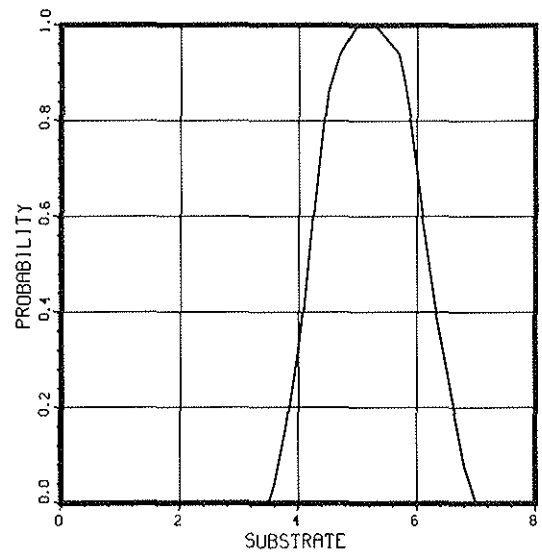
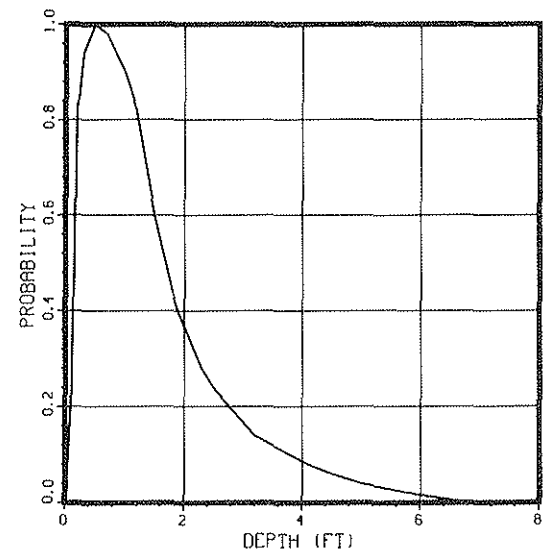
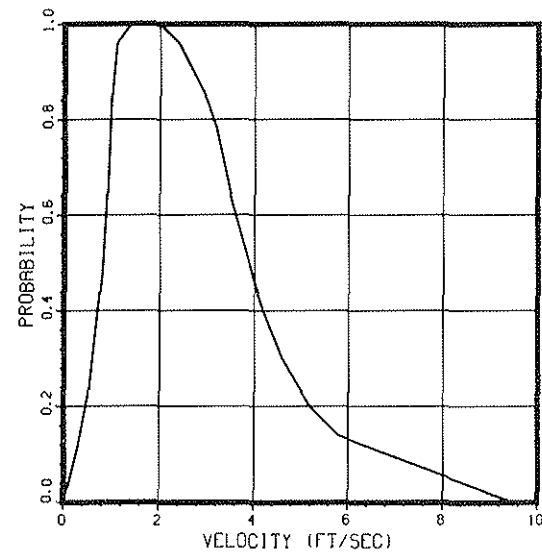


CUTTHROAT TROUT (TURBID WATER, S=.004)

11226

INCUBATION

78/01/24.

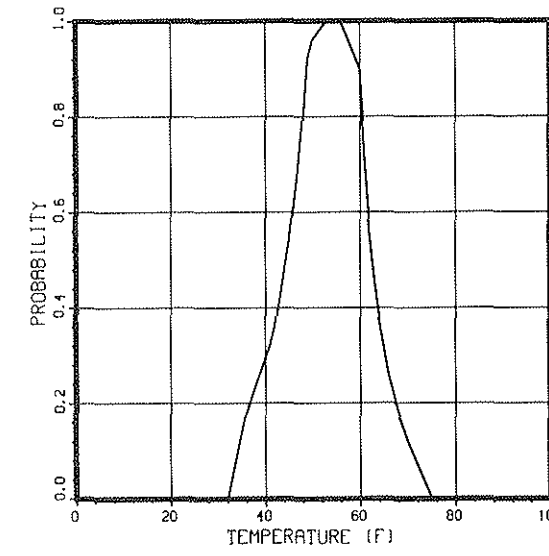
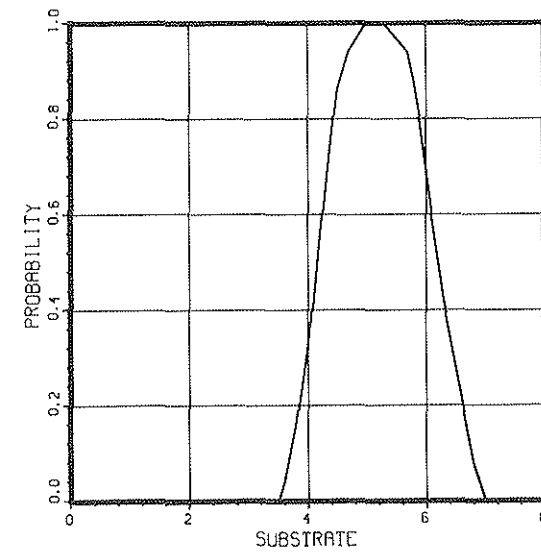
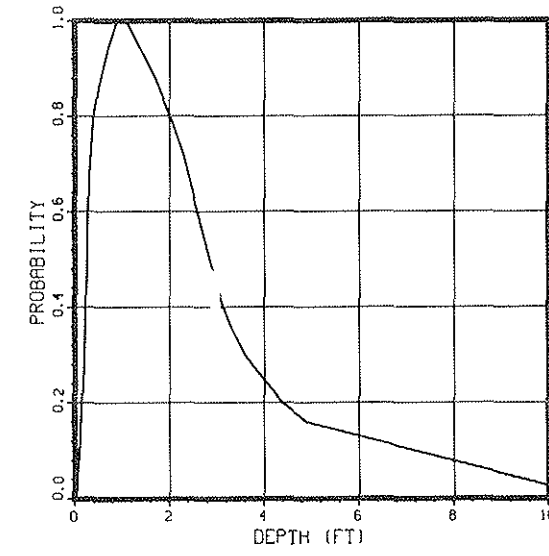
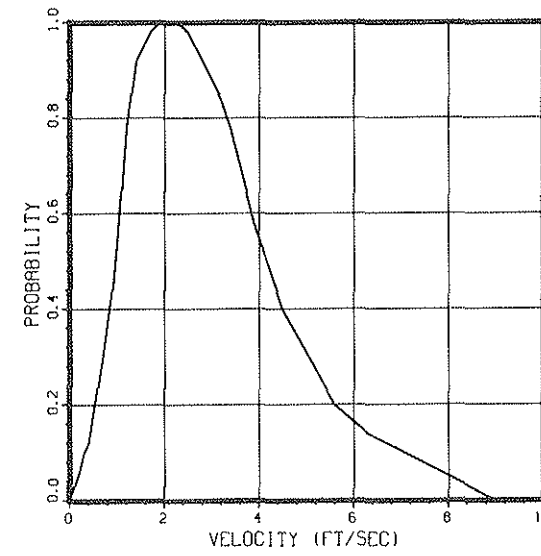


RAINBOW TROUT (TURBID WATER, S=.0025)

11124

INCUBATION

78/01/24.

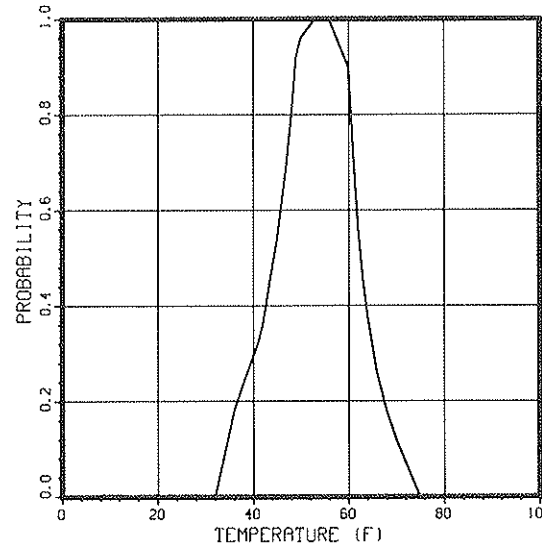
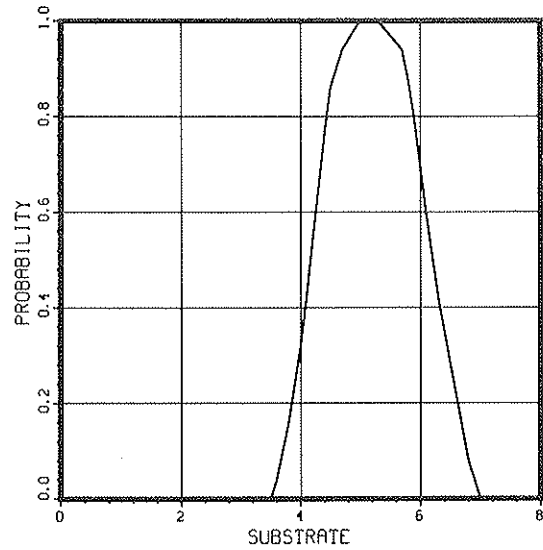
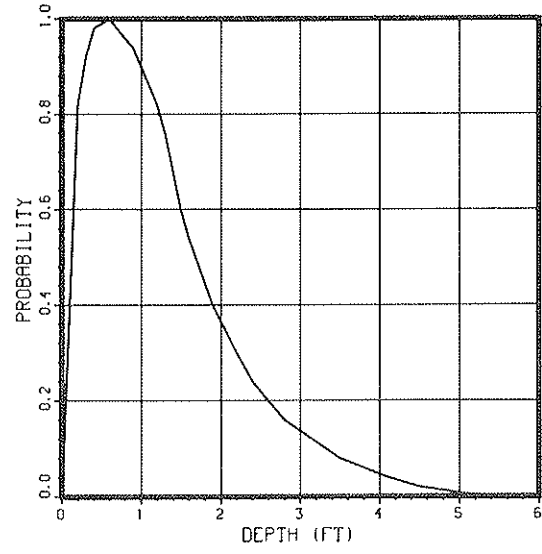
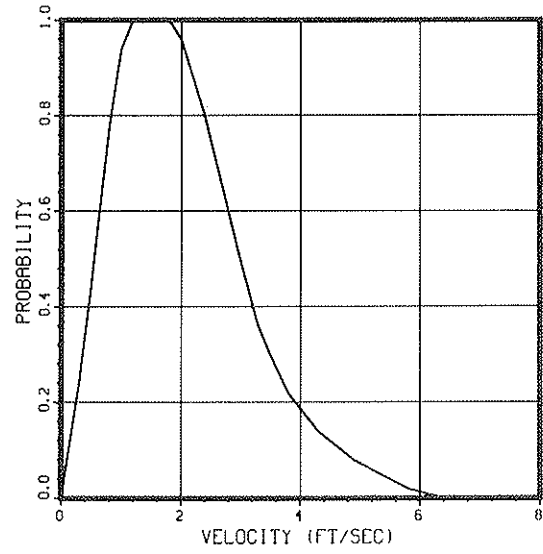


RAINBOW TROUT (CLEAR WATER, S=.0025)

11123

INCUBATION

78/01/24.



RAINBOW TROUT

Salmo gairdneri

Catalog No.	011110				011102				011101				011100				01121-011126				
	Spawning		Adult		Juvenile		Fry		Egg		Incubation										
SPECIES:	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	Velocity	Depth	Substrate	Temperature	
Rainbow Trout																					
IFG EVALUATION	E	E	G	G	F	F	F	G	E	E	E	G	G	E	E	G	F	F	G	G	
REFERENCE	19	19	19	2	15	15	15	27	15	15	15	27	15	15	15	4	11	11	11	8	
	RO	RO	RO	PO	FA	FA	FA	PO	FA	FA	FA	PO	FA	FA	FA	FA	IN	IN	IN	IN	
	23	23	20	8	18	18	18	2	18	18	18	2	18	18	18	8	9	9	35	8	
ANALYSIS	FA	FA	RO	PO	FA	FA	FA	PO	FA	FA	FA	PO	FA	FA	FA	PO	IN	IN	IN	IN	
	28	28		20				31				31				31	25	25	29		
	FA	FA		RO				PO				PO				PO	IN	IN	IN		
				31				8				8				36	36				
				PO				PO				PO				IN	IN				
COMMENTS								2				2	1		2	3				4	

Key to IFG Evaluation Matrix

IFG Evaluation: E - Excellent
G - Good
F - Fair
R - Reconnaissance Grade

Reference: Refer to listed number in bibliography.

Analysis: FA - frequency analysis
RO - range and optimum
PO - Parameter overlap
IN - Indirect analysis

Comments: Refer to listed number on comment sheet (following IFG Evaluation Matrix).

Comments - Rainbow Trout Curves

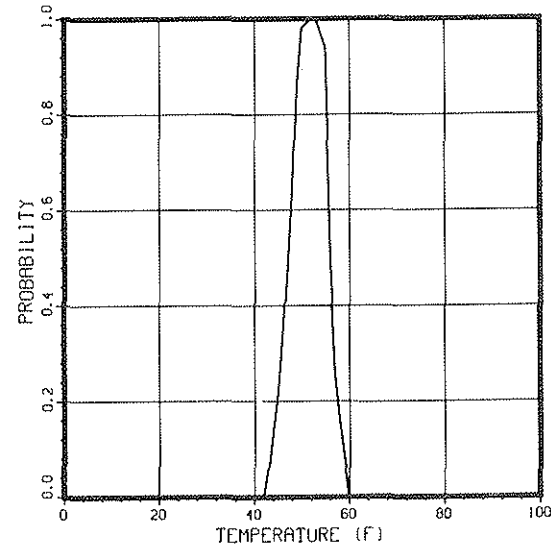
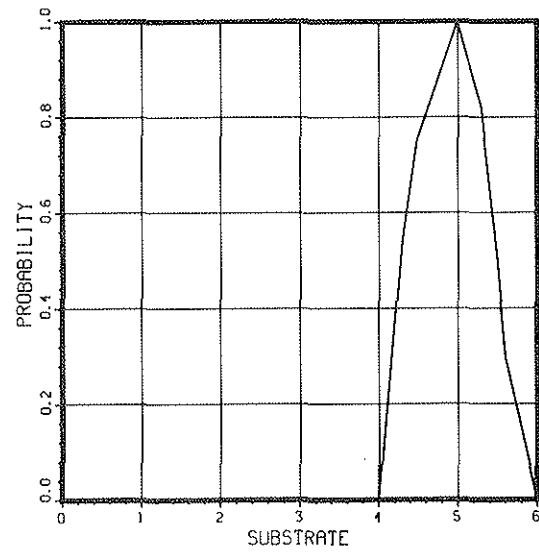
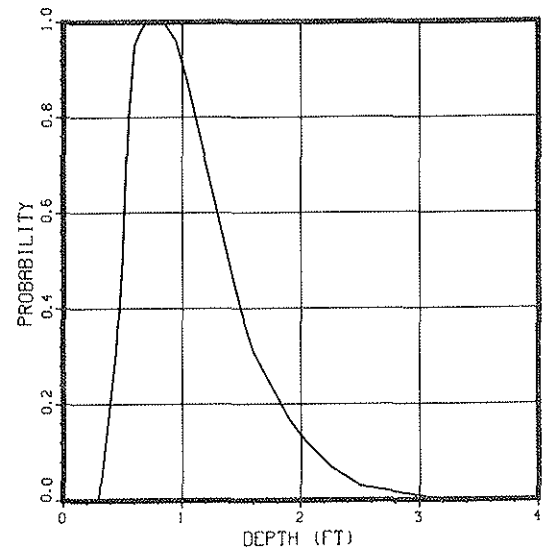
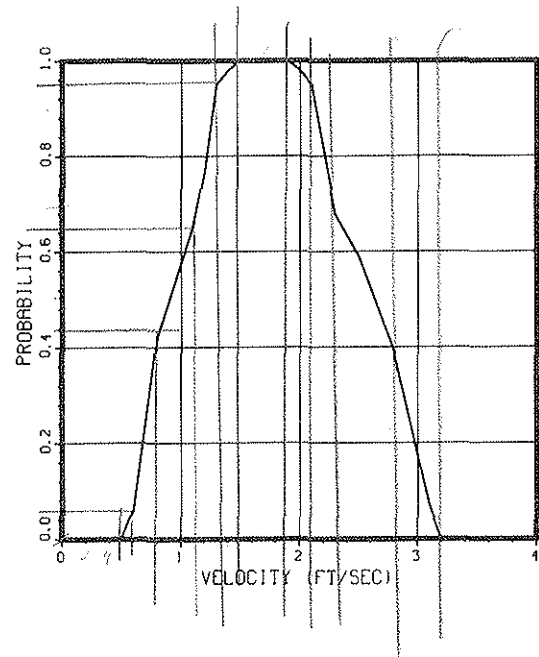
- Multiple modes in data. Variance not removed by clustering of adjacent velocity classes. Because fry tend to school, it is possible to observe a large number of fish in relatively few types of areas; therefore, the actual sample size here is smaller than would be indicated by the number of observations (n = 524).
- Digestion is poor at temperatures lower than 38°F.
- Fry exhibit downstream drift at temperatures less than 55°F.
- Probabilities of survival based on time required for hatching at different temperatures.

RAINBOW TROUT

11110

SPAWNING

78/01/24.

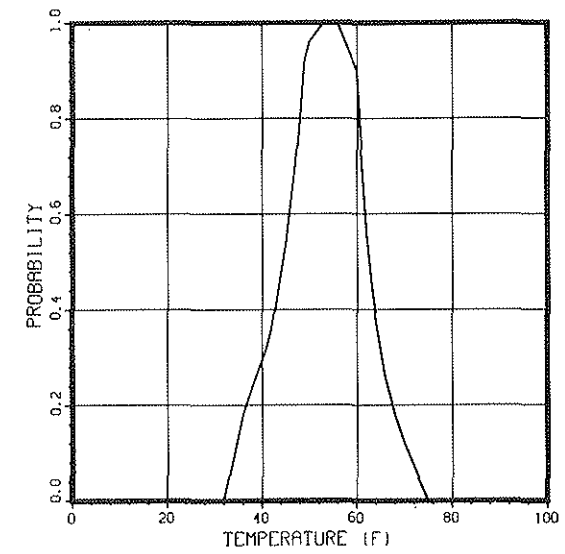
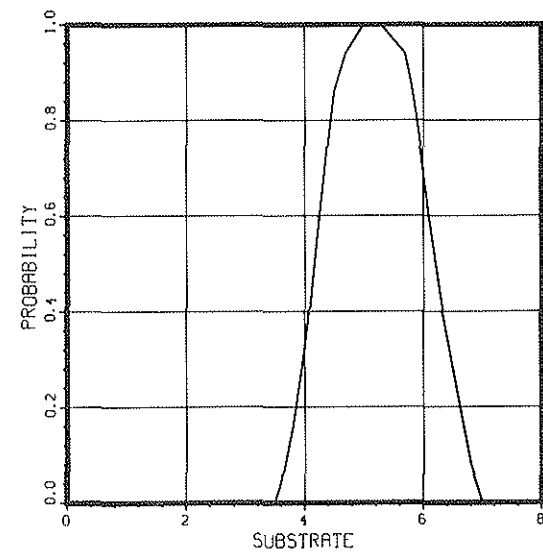
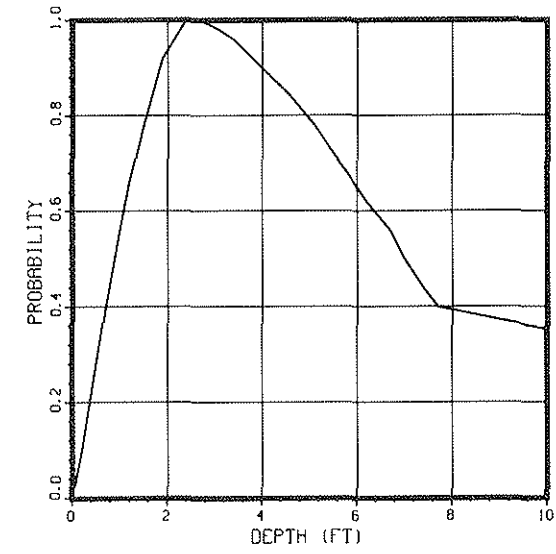
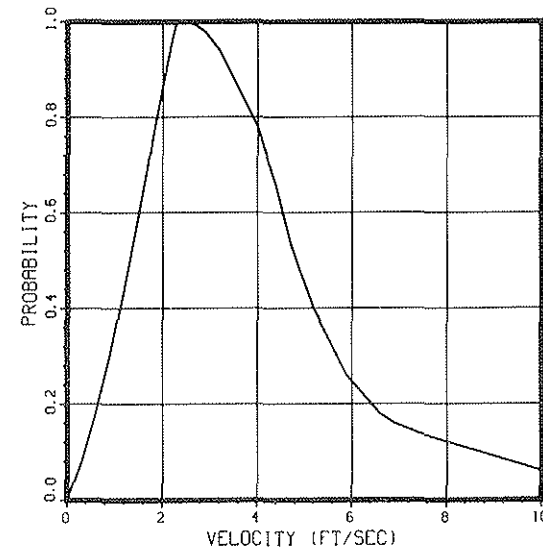


RAINBOW TROUT (TURBID WATER, S=.001)

11122

INCUBATION

78/01/24.

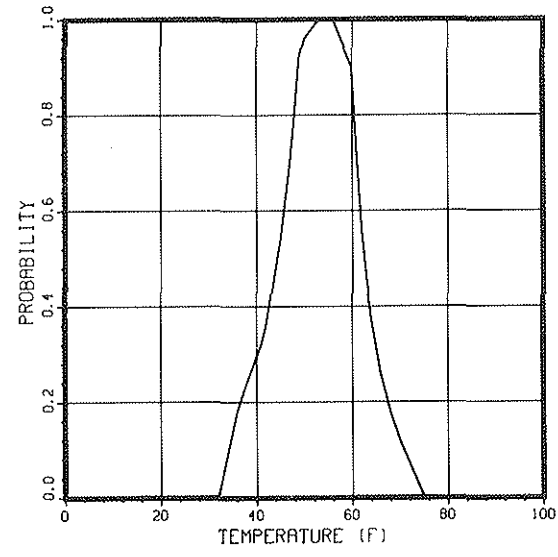
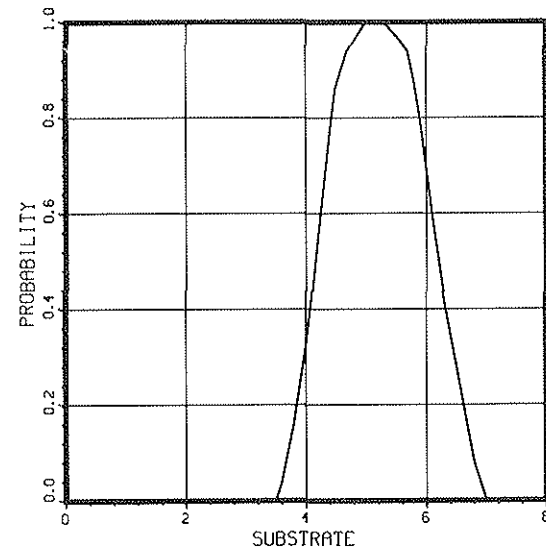
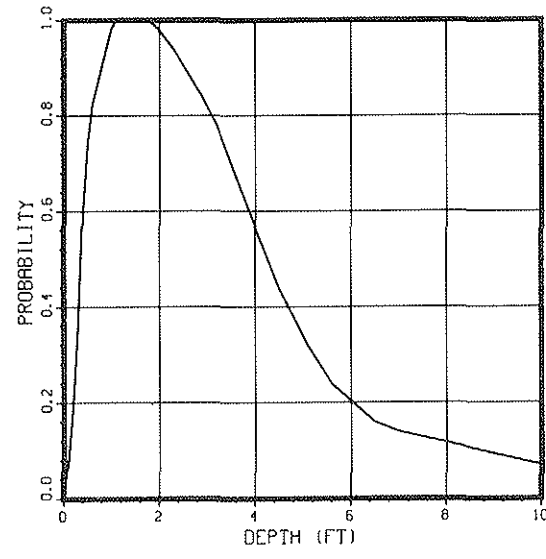
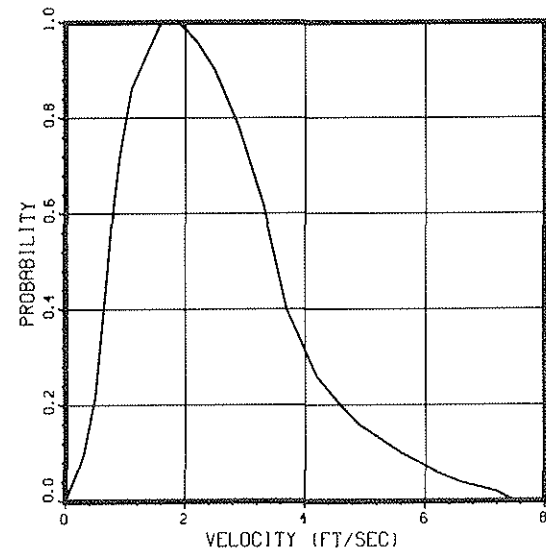


RAINBOW TROUT (CLEAR WATER, S=.001)

11121

INCUBATION

78/01/24.

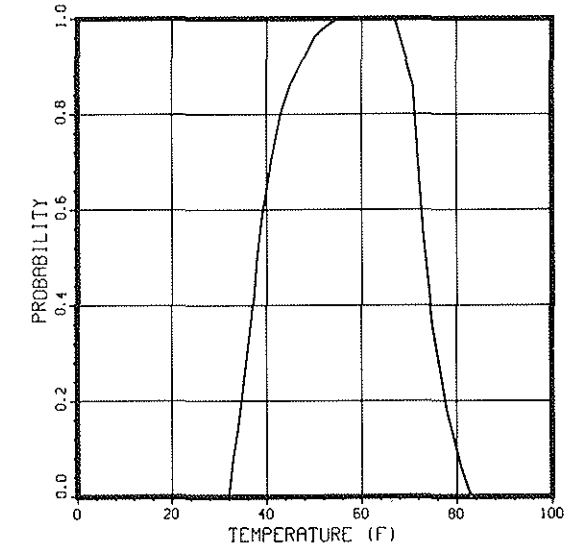
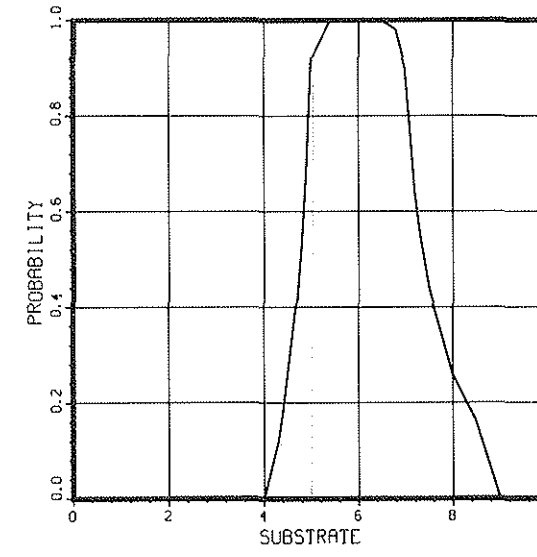
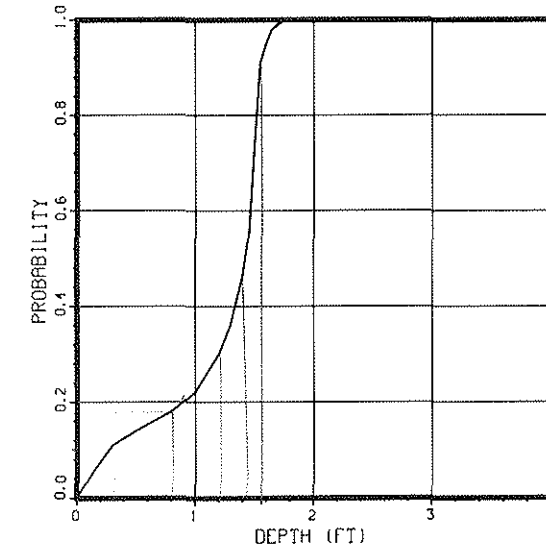
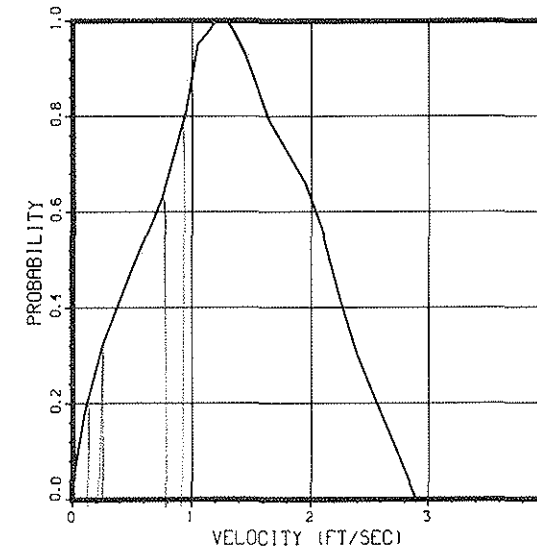


RAINBOW TROUT

11102

ADULT

78/01/24.

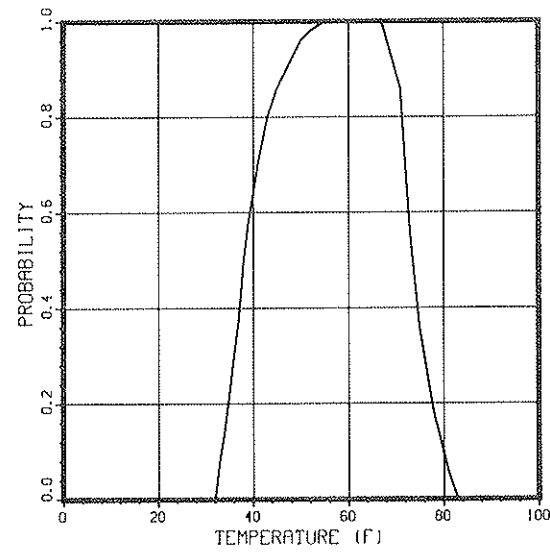
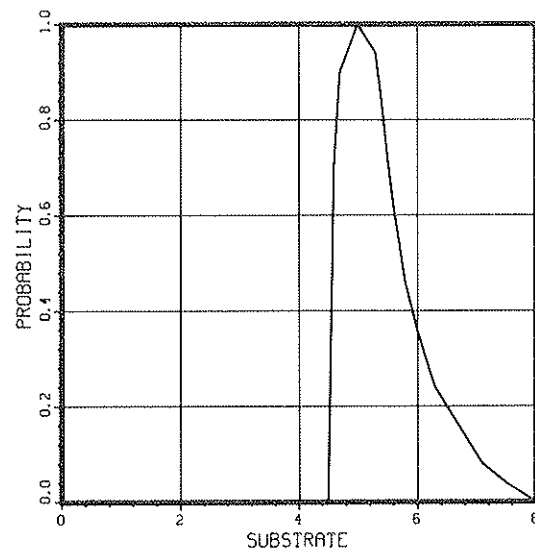
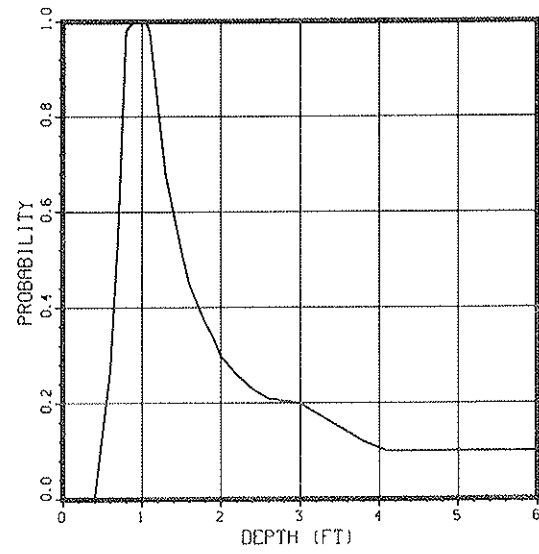
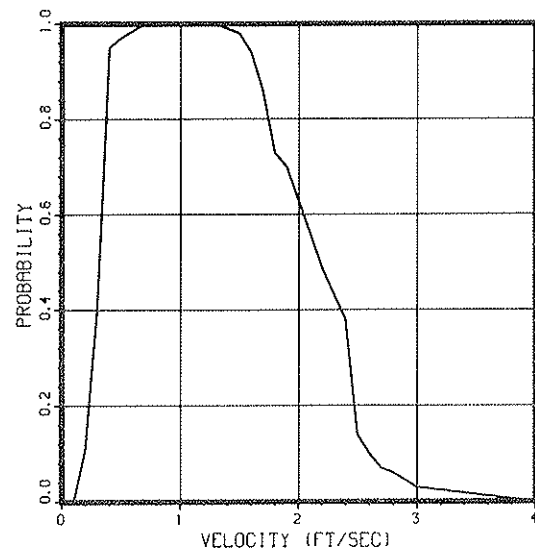


RAINBOW TROUT

11101

JUVENILES

78/01/24.



RAINBOW TROUT

11100

FRY

78/01/24.

