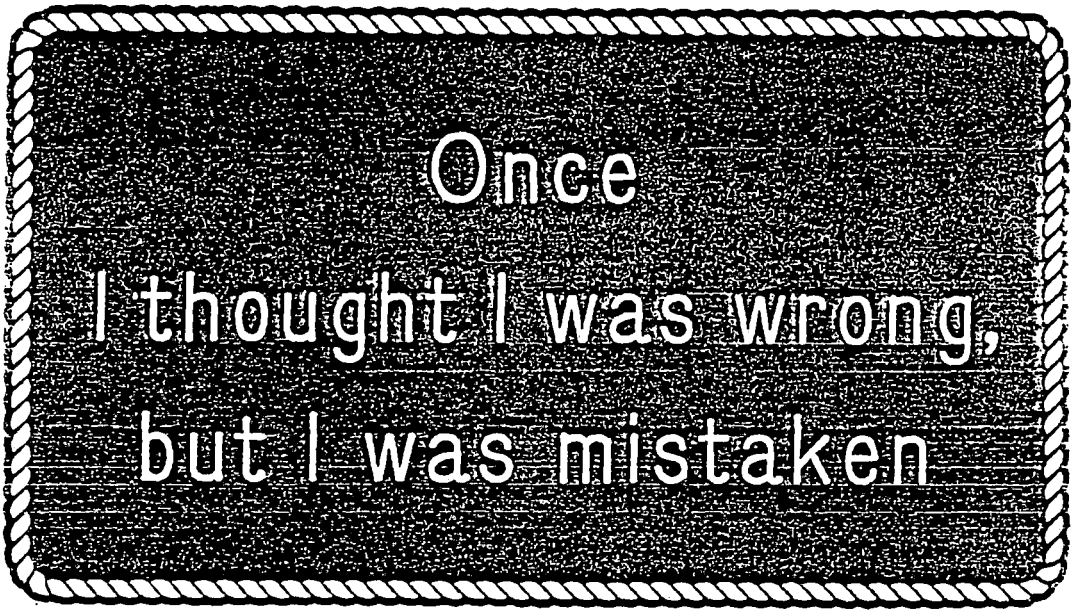
BRISTOL BAY DATA REPORT NO. 86-11

AERIAL SURVEY INSTRUCTION MANUAL FOR NUSHAGAK AND TOGIAK DISTRICT SALMON AND HERRING FISHERIES



(Author's Survey Motto)

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AREA DATA REPORTS: This series of reports is designed to facilitate archiving of small data sets and internal agency information. It generally consists of data sets of less significant nature that frequently are combined on an annual basis and published through the ADF&G Technical Data Report Series. This series also includes noteworthy field observation, feasibility studies, Board of Fisheries Reports and staff meeting notes. To promote documentation of as many observations as possible which would otherwise remain unreported, this informal report series receives very little editing, thus caution is recommended in use of data and any analysis persented within.

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AERIAL SURVEY INSTRUCTION MANUAL FOR NUSHAGAK AND TOGIAK DISTRICT SALMON AND HERRING FISHERIES

INTRODUCTION

Aerial methods of assessing salmon and herring populations have been developed in Bristol Bay to assist in the regulation and management of the areas' salmon and herring resources. Aerial evaluation of both Nushagak and Togiak district salmon stocks to record spawning ground distribution and abundance is well documented in previous manuscripts (Nelson, 1972 and 1979). Aerial survey techniques have also been developed to assess herring biomass abundance (Lebida and Whitmore, 1985). The aerial survey endeavor is an integral part of the salmon and herring resource management program, and as such, provides a basis for the management and control of these important renewable resources (Barton, 1986 and Gilbert, 1968).

This manual discusses methods and procedures for conducting inseason "management" related salmon surveys on Wood, Igushik, Nushagak and Togiak Rivers, and herring biomass surveys in the Togiak district. Inseason "management" aerial surveys are conducted annually in Bristol Bay to provide escapement estimates and indications of resource run strength, and as such, provide support for subsequent management decisions on allowable fishing time to harvest the stocks in excess of spawning requirements.

SALMON

Introduction

Enumeration of salmon stocks using aerial means has been a recognized method of recording salmon populations. The methods and techniques used to survey sockeye salmon spawning grounds in Bristol Bay has sought to develop reliable annual estimates of the total spawning populations in the various river systems of Bristol Bay (Rogers, 1984).

The first recorded aerial stream survey in Alaska was conducted in 1930 by U. S. Bureau of Fisheries employees at Lake Clark in Bristol Bay. However, serious use of aircraft for surveys was not carried out until 1937-38, when the U. S. Bureau of Fisheries initiated a biological research program in Bristol Bay, and aerial survey methods and techniques were developed in the ensuing years (Eicher, 1953).

Accurate determination of spawning escapement is vitally important to those responsible for regulation of the fisheries, to the fishing industry that harvests the salmon, and to the programs of research on salmon populations. No other single factor has influenced regulation of the salmon fisheries to the same extent as has magnitude of the spawning escapement. While decisions governing regulations have not always been based on sound knowledge of magnitude of escapement desired or even upon accurate estimates of magnitude of escapement obtained, the criterion of escapement has been the primary factor in determining fishing regulations in Alaska, from the passage of the White Act in 1924 to the present time.

Escapement Enumeration

Most Bristol Bay sockeye populations escape the fisheries through a trunk river to which all of the spawning grounds are tributary. Visual count of the numbers of fish passing by vantage points or specially constructed towers that

allow unobstructed passage of the fish upriver is the most common method employed in Bristol Bay to estimate the total escapement. This technique, developed and initiated in 1953 in the Wood River system, has permitted total sockeye escapement estimates to be made in many streams where it is not feasible to construct weirs or expensive sonar operations.

Notwithstanding the need for total escapements, it is desirable from a fishery manager's viewpoint to estimate salmon escapements after these fish have passed through the terminal fishing area, and before they are enumerated by personnel at land-based counting towers/sonar sites.

Various projects are (have been) conducted to give real-time escapement estimates before the fish are enumerated by hand tally or sonar means. Test fish programs are operated on some Bristol Bay river systems to estimate numbers of sockeye salmon before actual counts become available. Fishery management decisions, whether or not to open or close a fishery, depend upon the best estimate of the numbers of fish entering and leaving the fishery. Management of the fishery is directed at achieving sockeye escapement goals, while at the same time maximizing harvest of the available surplus. Actual counts of escapement are not available until the fish move upriver in clear water where they can be counted. Although test fishing programs are a useful management aid in developing fishing schedules, actual escapement as documented by experienced aerial survey personnel are invaluable to the management process.

Management Aerial Surveys

Aerial surveys to determine sockeye salmon abundance and rates of escapement are flown, on a as needed basis, on Wood, Igushik and Nushagak Rivers of Nushagak district, and on Togiak and Kulukak Rivers of Togiak district.

Aerial survey estimates can produce quantifiable results through careful standardization of procedures. Aerial counts can serve either as indices of relative abundance for estimation of total escapement from base year data by established expansion factors, or they may be used to gauge inseason escapement rates, which allow the fishery manager to estimate daily escapements and accumulative totals compared to long-term established escapements by date.

Survey techniques vary by observer to some extent, depending upon prior experience, training and devotion to the job at hand:

1. Pilot/Aircraft - Experienced aerial survey pilots with well-maintained aircraft are a must. Pilots with previous experience will expedite the survey process, and still maintain the degree of safety necessary. If the pilot does not file a flight plan, ask him to do so, even for the short Wood River survey flights. High-wing wheeled aircraft with a bubble observation window produce the best results. Type of aircraft is not critical, and good results have been obtained by this author with both Cessna 180 and 185 aircraft, as well as with Piper Supercubs. Wheeled aircraft are preferable over float or ski-equipped planes for obvious visibility reasons.

2. Observer - The use of two observers on surveys is significant since this provides for a built in check and balance system and decreases the chances of glaring individual errors. The attached survey maps (Appendix I) also indicate how each area is divided up into smaller sub-sections to facilitate a more systematic survey. This breakdown also makes it easier to pinpoint those sections contributing to differences in counts between the two observers.

3. Survey Conditions - Choice of altitude is important but is often compromised due to weather conditions. Ideal survey altitude is about 300 to 400 feet with aircraft speed of 80 to 90 mph. Poor weather conditions often require lower survey altitudes, and slower flying speeds. STOL equipped aircraft

allow a slower, safer flying speed and are recommended if available. Ideally, best survey conditions exist when there is little or no wind (less than 5 mph), cloud cover is negligible and sun angle is high. Again, these ideal conditions seem to exist only on paper, so "little adjustments" must be made when flying conditions are less than ideal.

4. Timing of Surveys - The most critical controllable aspect of aerial surveys to estimate escapement (other than uncontrollable conditions), is timing of the survey. Optimum time to fly aerial escapement surveys is summarized below from a 11/16/82 "management note":

Wood River - About 1 to 2 hours before high water book time. In effect, this timing is on the half flood as high water in Wood River is about 2-1/2 hours after book time. Surveys at other times are possible; however, only the upper 1/3 of the river is clear. Large run-outs (minus tides) produce very muddy waters. On large run-outs (-2/-4 ft.) fly survey 1/2 to 3/4 hr. after low water, which is at low slack in the upper river and the river is just beginning to ebb.

Igushik River - Usually flown in conjunction with Wood River. No really proper timing is best on this river, other than surveys under cloudy and windy days produce very poor results. Best results come from a survey 2 to 2-1/2 hrs. after high water.

Nushagak River - About 2-4 hrs. after low water produces the best results. Often is a very difficult river to survey as the Mulchatna River system is very murky in most years, and tidal influence goes upriver as far as Portage Creek. Usually very poor visibility below Portage Creek at all stages of tide. Pink salmon utilize "Keefer Cutoff" almost exclusively.

Togiak/Kulukak Rivers - Since the tides at Togiak are about half of Nushagak tides there is little fluctuation in this district which affects surveys of Togiak and Kulukak Rivers. Weather is usually the overriding factor on Togiak surveys.

APPENDIX II summarizes aerial survey data collected by river system from 1975-86. After a more complete analysis of this aerial data, additional comments are in order for:

Wood River - Further analysis of survey results continue to suggest that a 1 to 2 hour before high water book time survey start time is best. However, good results can be obtained at other tide stages depending on weather conditions and the height of the hold-over tides. Under optimum survey conditions (time, weather and tides), fish can be enumerated from just above Red Bluff (near the mouth of Muklung River), however, in most cases fish can be enumerated beginning at Hoseth's home site. On large flood tides (18-20 ft.) fish often will switch their migration path from the west side of the river to the east side. Cross-over usually starts in the Muklung River to the Hoseth home site area and is completed by Silver Salmon Creek below "Big Bend". It is particularly important to recognize this factor, for it often becomes necessary to survey mid-river to pick up "wandering" migrating fish. Often-times these mid-river schools of fish, which usually occur from "Hoseth's to Big Bend", amount to 40-50,000 fish or more. Mid-river migrations is prevalent when tides are near high slack or right after the tide begins to gently ebb. Presence of fish in the mid-river areas can

often be seen as "dimples" and "finners", and the surveyor is then alerted to the need to check the mid-river area. In most cases, the majority of migration takes place on the west side of Wood River, however, the east bank should be checked out for cross-over fish on the downriver return trip to as far south as "Big Bend", and especially if large flood tides are occurring.

Igushik River - Also no change from the original 2-3 hrs. after high water book time best start time. However, this river very seldom is flown at the optimum time, as it would require a separate individual (costly) survey. Igushik River continues to be flown in conjuction with Wood-Nushagak Rivers, and generally good survey results can be obtained. If additional rate of escapement information is required, the 2-3 hour after high water start time is recommeded. If a Wood/Nushagak River and fishing district survey is flown on a single flight, Igushik River should be flown last, which (depending on the Wood/Nushagak/district flight time) will put the Igushik River survey near the proper survey time.

Nushagak River - Surveys flown 2-4 hours after low water still produce the best results. In some years (1986), sockeye salmon will also use Angel Bay to some extent, although the main river channel is utilized by most sockeye and pinks. Surveys start at Black Point, although signs of fish (jumpers) are often seen below Black Point.

Togiak/Kulukak River - To a large extent tides do not affect surveys in these two rivers, although a low water survey is preferable. Data analysis is incomplete and needs to be updated to be of maximum inseason management value.

District-Wide Surveys - In the case of a Nushagak district-wide survey (rivers and fishing area), start the survey about 3 to 4 hours after low water and fly Nushagak River (Black Point to sonar site) first, then proceed back and survey Wood River, which will be about 1-2 hours before high water if not delayed, then proceed to survey the fishery, which would be ongoing (1-2 hrs. after opening) at this time if the opener was on the half flood as per long-standing operational procedures. Survey Igushik River last, nearer to high water book time, which would be on the ebb in the upper Igushik River.

If it is deemed necessary to fly the fishery first (and often it is!) fly the fishery right at the opener, then to Wood River (2 hours before high water), then to Nushagak River (4 hours after low water) and last to Igushik River (right at high water).

5. Data Analysis - The data is summarized on a daily basis during the field season. At the end of the season all pertinent data from the field forms are extracted and summarized in tabular form by system and filed along with past year's data (See Appendix II, pages 4-6 for example). Comments on the surveys are also incorporated into the text and tables of the annual management report with references as to how they supported day to day management decisions.

The use of expansion factors is important only to the analysis of the Togiak River surveys, although Wood and Nushagak River survey results are often "roughly interpreted" to allow a "best assessment" of total escapement between counting stations and the fishing district.

Aerial survey data collected from Togiak River in 1966 indicated that aerial survey estimates were about 30% of the actual river population

at the time of the survey (Appendix III). Data collected since 1966 also indicate that expansion factors of 2.5 to 3.5 will generally "roughly account" for river populations at the time of the survey. We now have many years of survey data from Togiak River that needs to be analyzed. A complete and thorough analysis of this data should become a priority of the current Togiak Area Management biologist.

Fishing Period Surveys

Aerial surveys of commercial fishing periods are often completed to show fleet distribution and fishing effort, initial fishing success, etc. Appendix IV summarizes the best times to complete fishing period surveys. These general instructions still hold, with the added comment that aerial surveys in 1980, indicated that "jumper surveys" are sometimes successful in showing fish location and movement from day to day, especially when the fish are holding within the district. Experience in 1980 (see below) indicated that most "jumper" activity takes place about 1/2 to 3/4 hours after high water (or when the tide just begins to ebb):

			Aerial Survey		
Year	Date	High Water (ft).	Time	Hr. After High	Comments
1980	June 28	2:20 p.m.(14.1 ft.)	2:20-2:55 p.m.	1/2 hr.	"Jumpers all along upper Ekuk Beach"
	June 29	3:17 p.m.(14.0 ft.)	3:45-4:20 p.m.	1/2-3/4 hr.	"Jumpers 1/2 way up Combine and on Ekuk Beach"
	June 30	4:07 p.m.(14.0 ft.)	3:05-3:20 p.m.	1 hr. +	"Jumpers Nush. Pt. to Flounder Flats".

HERRING

Introduction

The Bristol Bay herring fishery was initiated in 1967, but it wasn't until 1977 that the fishery began to expand rapidly. With the fishery growing each year, aerial survey techniques to estimate total herring biomass were developed to provide a basis for management decisions. The Togiak district herring fishery is managed to achieve a 10% to 20% harvest of the observed herring biomass and this objective is largely dependent upon information obtained through aerial surveys.

A thorough discussion of aerial survey methods and techniques can be found in Barton and Steinhoff (1980), and Lebida and Whitmore (1985). The two foregoing reference sources very adequately document the initial survey methods and techniques developed for this fishery, and the current methods presently used to assess herring abundance in the Bering Sea. The following informational manual will primarily address and discuss the bottom profile of the index areas, and how the various profiles can be mistaken for herring under less than ideal survey conditions.

Bottom Profile Characteristics

Aerial survey results are often limited by adverse weather and poor water clarity. Poor water clarity, due to winds and tides, can distort visibility to the extent that the aerial observer can mistake various bottom configurations for herring.

The following discussion lists by index area, the general bottom profile and type, and shows bottom configurations and obstructions that can be misidentified as herring during adverse survey conditions.

Index Areas

Each index area (13 in number) is discussed individually. The entire index area is briefly discussed in general terms, bottom profile and obstructions are shown, surveyability is discussed, and the "general" survey track is shown (Refer to Appendix V).

Nushagak (NUS-1)

The Nushagak index area (NUS-1) runs for some 28 linear miles along Nushagak Peninsula from Cape Constantine to Kikertalik Lake (Index Lake).

Water depth is relatively shallow, and winds and tides result in constantly turbid water conditions. There are no definable obstructions, although there exist several "flats" which cause excessive turbidity due to the shallow water and swift tides. This area and NUS-2 collect post-spawners as the season progresses. Late in the season capelin begin to show in both Peninsula index areas.

Nushagak (NUS-2)

NUS-2 index area is about 16 miles long from "Index Lake" to Tvativak Bay. Water depth and clarity are similar to NUS-1, and surveyability is also similar, although offshore areas in the Tvativak Bay area is better as the water depth deepens and turbidity is less a problem.

Several obstructions (rocks) are found near the mouth of Tvativak Bay which can be mistaken for herring.

Kulukak (KUK-1)

Kulukak Bay proper and offshore make up this index area (KUK-1). Survey success is variable as shallow bay waters and mud bottoms cause excessive turbidity. Several bottom configurations (noted as "scars") have given

observers problems when survey conditions are poor. These bottom "scars" are located on the west side of the bay. Kulukak Bay is a staging area for post-spawn herring, and the large, thinly distributed schools of herring are often so "light" that a different biomass conversion is applied. The dashed line shows how biomass conversion factors have been applied in the past, and those areas where a 1.00 conversion has been used.

Metervik (MET-1)

This index area (MET-1) includes Metervik Bay and all waters west to Right Hand Point. This index area is relatively easy to survey, as most fish lie fairly close to shore. Metervik Bay is shallow and 1.00 to 1.52 biomass conversions are probably valid. One rock lies off the east side of the entrance to Metervik Bay, and is noted primarily as a hazard to navigation.

Nunavachak (NVK-1)

This large index area (NVK-1) supports a number of bottom configurations which can be mistaken for herring. One submerged "rock" (Old George), has been "set on" by purse seiners practically every year, and another "dark bottom" area near Nunavachak Lake is often thought to be herring. Under poor survey conditions, "dark bottoms" and rock in the "Gravel Beach" area are often mistaken for herring.

Ungalikthluk (UGL-1)

The Ungalikthluk index area (UGL-1) is composed of inshore shallow water areas, and offshore deeper water. Again, two different biomass conversions have been applied to herring biomass. A "light colored" bottom gully or gut

near the mouth of the Ungalikthluk River was incorrectly called herring spawn years ago, and some "expert" herring surveyors still report "deep-water" spawning in this area when water conditions are poor.

Togiak (TOG-1)

The Togiak index area (TOG-1) is also a staging area for both pre and post-spawners. The area has been roughly separated for biomass coversion purposes, and very often the 1.00 conversion is applied to inshore large, thinly distributed schools. Several bottom configurations ("bands or patches") are very often called herring under poor survey conditions. These areas are located along the inner bay and along the west side out to Togiak Reef. A systematic grid survey pattern is often necessary if herring are widely scattered (Refer to map).

Tongue Point (TNG-1)

Relatively easy to survey, but often water conditions are extremely turbid. Rocks along the shoreline near Togiak Reef have been set upon by purse seiners. This author has not had problems identifying fish vs. rocks in this area. It is often necessary to fly inshore as well as offshore to adequately cover this index area. Herring can often be found outside of the tide rip that runs up to 4-6 miles offshore.

Matogak (MTG-1)

Again shallow water, muddy bottom (offshore) often create difficult survey conditions. Inshore waters behind Tongue Point are usually clear if the winds are light. Schooled smelt have been mistaken for herring in the inner bay area.

Osviak (OSK-1)

No bottom configuration problems in this index area (OSK-1). Winds often create poor survey conditions.

Pyrite Point/Cape Newenham (PYR-1/CN-1)

Most aerial surveys terminate at Asigyukpak Spit (Oosik Spit) and proceed to Hagemeister Island index area, but occasionally the survey is extended to Cape Newenham. This area is almost always extremely turbid, and the best survey success is found close to shore.

Hagemeister (HAG-1)

The Hagemeister Island index area (HAG-1) is often difficult to survey due to strong winds that frequent this area. Stay away from the south end of the island unless winds are calm, for it can become very rough here! One bottom "gully or gut" located off the west side near the long Hagemeister Spit has been confused for herring in the past.

The seaward side of Hagemeister Island should be surveyed, as this area has been proven to be both a entry (early in the season) and exit (late season) route for herring.

Migration Patterns

Herring migration patterns are still not clearly understood, and there may be significant yearly fluctuations due to ice conditions, water temperature, winds, etc. However, several general patterns seem to repeat with some consistency each year:

1. herring enter the area along the seaward side of Hagemeister Island and move into Togiak Bay, and then disperse to the east;
2. from Togiak Bay, herring show a generally west to east movement to spawning beaches between Togiak and Kulukak Bays;

3. once spawning is completed, Togiak and Kulukak Bays become staging and resting areas for spawn-outs;
4. herring exit the area in two separate definable routes -
   a. directly out of Togiak Bay and south along the seaward side of Hagemeister Island, and
   b. out of Togiak Bay to the east, where they form long bands of fish as they move down the Nushagak Peninsula; and
5. herring have also been seen exiting the area in large numbers to the west from the Matogak/Osviak index areas.

Clearly migration patterns are not well understood, and they probably vary considerably from year to year.

Miscellaneous Observations

The following miscellaneous observations may be of assistance:

1. if weather conditions allow, the best survey altitude is 1,500 to 2,000 feet. Surveys that commence at or 1-2 hours after low water have been most successful, especially if it's a late afternoon survey. Herring seem to be more confined and grouped together on the flood tide, especially on a mid-afternoon or early-evening flood tide;
2. commencement of surveys is closely tied to both Bering Sea ice coverage and water temperatures. A general early-season survey will cover that area on Nushagak Peninsula from "Index Lake" (NUS-2) to "Oosik Spit" (OSK-1) in Osviak Bay. This survey track is flown every 3-4 days, and as the season progresses and fish begin to show inshore, the survey frequency is stepped up. Every third flight or so will include that area west of Oosik Spit to Cape Newenham and the Hagemeister Island area (HAG-1);

3. if many various sized schools are encountered in a particular index area, select an appropriate size (i.e.: 100 x 100 ft., 200 x 100 ft., etc.) and then convert all schools seen to equal these parameters. If this method is not followed, it will be impossible to record accurately all schools by appropriate size category;
4. early in the season herring are forming offshore before coming in, and several key areas have produced good results - offshore Kulukak Bay, the seaward side of Hagemeister Island, and the offshore areas of Nunavachak and Togiak Bays. Herring will also lie with the tide rips, and both the Togiak and Kulukak Bay rips will help define fish location. Once spawning has commenced and spawn-outs are prevalent, the shallow water areas of Togiak and Kulukak Bays seem to be favorite resting and staging areas;
5. herring biomass not only varies by water depth, but biomass density also seems to change between pre and post-spawners, with pre-spawners showing more biomass per surface area than post-spawners. School appeareance of pre and post-spawners is often a tip-off to whether fish are spawn-outs or good fish; and
6. specie identification at Togiak is generally confined to distinguishing between herring, capelin and smelt. Smelt are not a major problem at present, their biomass is small compared to herring, and they generally can be found in the same locations. Most problems with specie identification concern herring and capelin. Fortunately, the two species do not over-lap significantly in run timing. As the herring run begins to wind down, capelin begin to show in greater numbers. Capelin often appear in small, tight balls laying in close proximity to gravel beaches where they spawn, or as a steady dark band along gravel beaches. Often times they appear with odd-shaped "tails" and appear blue/black in color. Correct specie identification can only be guaranteed with test fishing on schools sighted.

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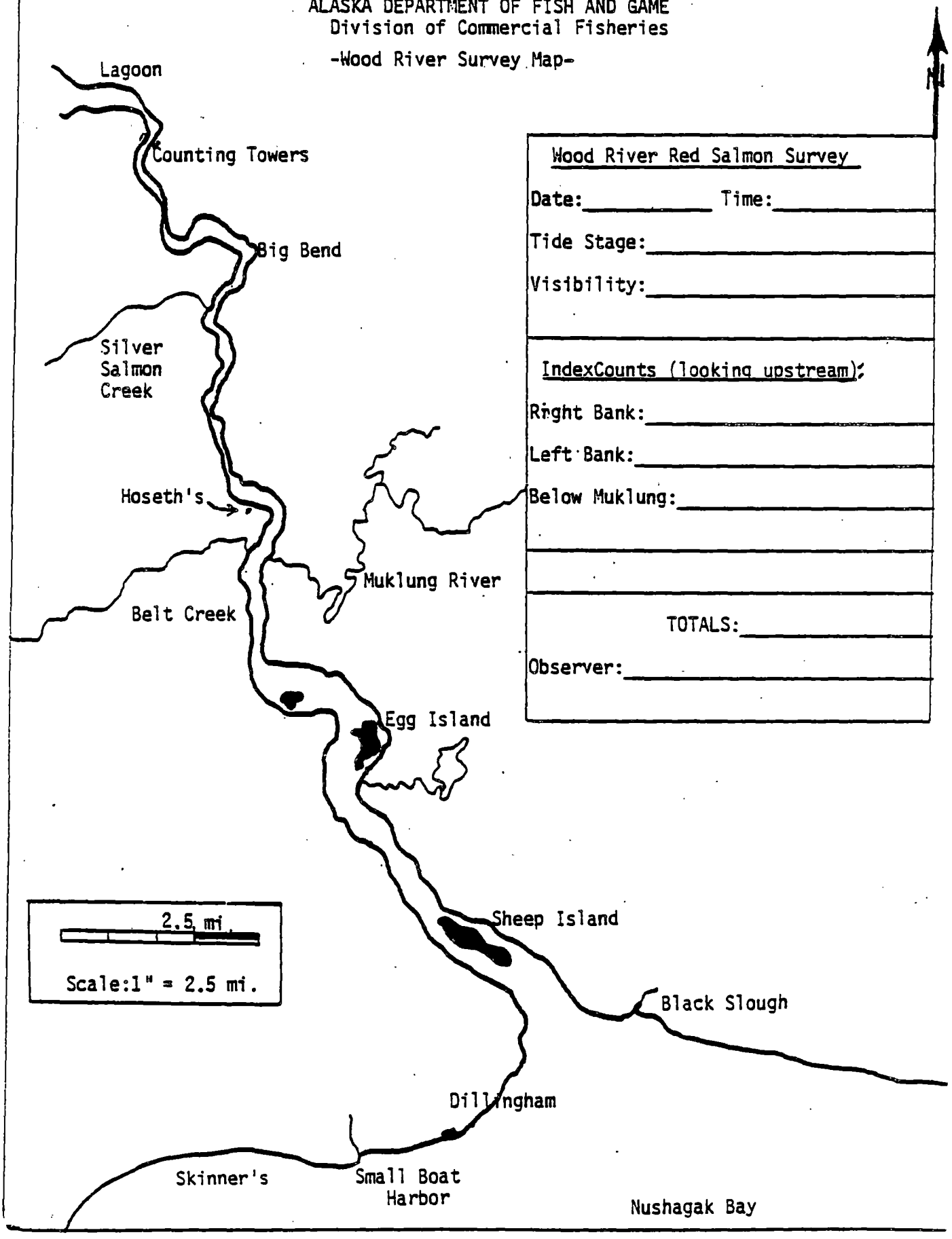
ALASKA DEPARTMENT OF FISH AND GAME
Division of Commercial Fisheries
-Wood River Survey Map-



Wood River Red Salmon Survey

Date:_____ Time:_____

Tide Stage:_____

Visibility:_____

IndexCounts (looking upstream):

Right Bank:_____

Left Bank:_____

Below Muklung:_____

TOTALS:_____

Observer:_____

ALASKA DEPARTMENT OF FISH AND GAME
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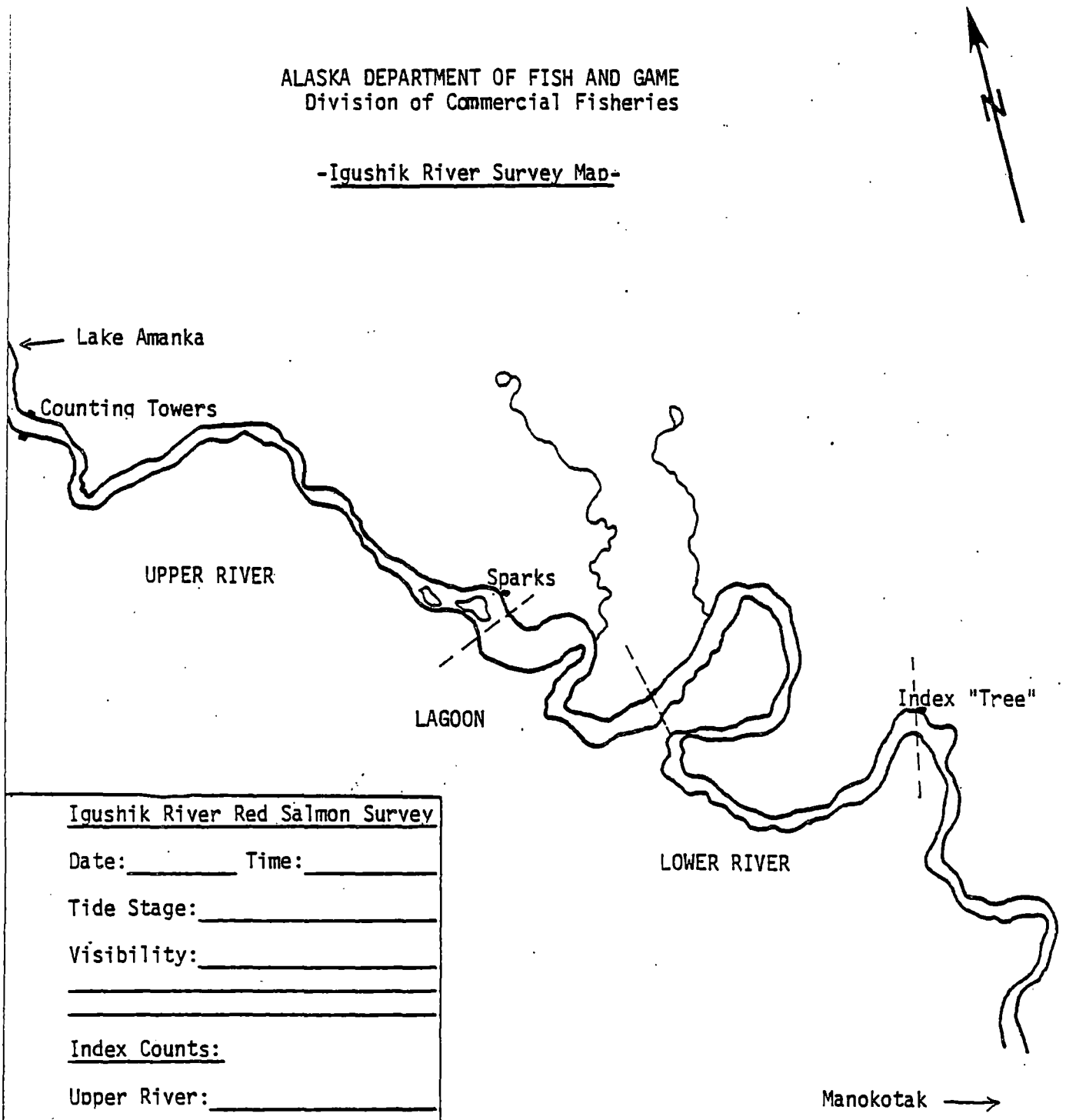
-Igushik River Survey Map-



Igushik River Red Salmon Survey

Date:_____ Time:_____

Tide Stage:_____

Visibility:_____

_____

_____

Index Counts:

Upper River:_____

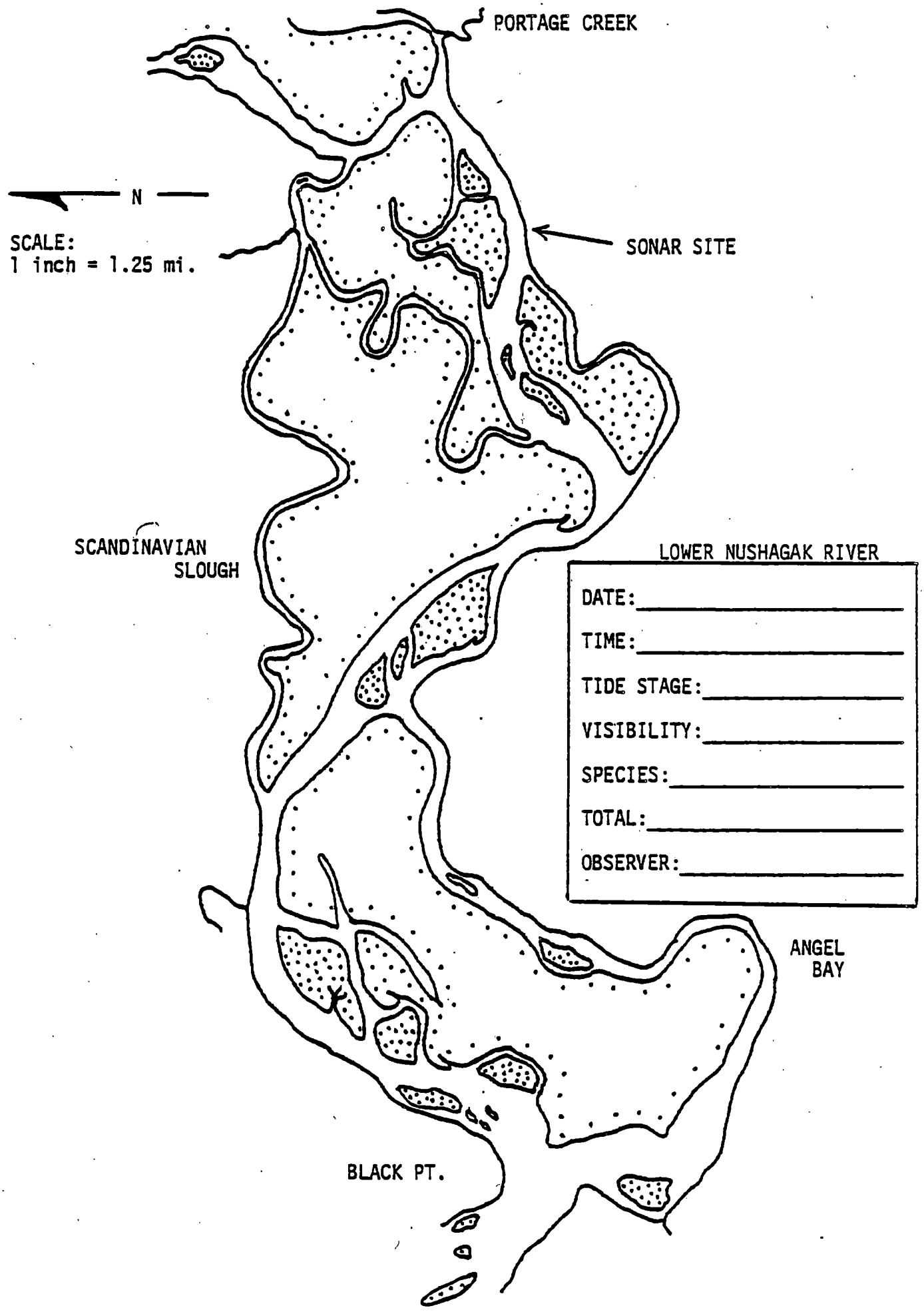
Lagoon:_____

Lower River_____

Below Index "Tree":_____

TOTAL:_____

Observer:_____


PORTAGE CREEK
N
SCALE:
1 inch = 1.25 mi.
SONAR SITE
SCANDINAVIAN
SLOUGH
LOWER NUSHAGAK RIVER
DATE:
TIME:
TIDE STAGE:
VISIBILITY:
SPECIES:
TOTAL:
OBSERVER:
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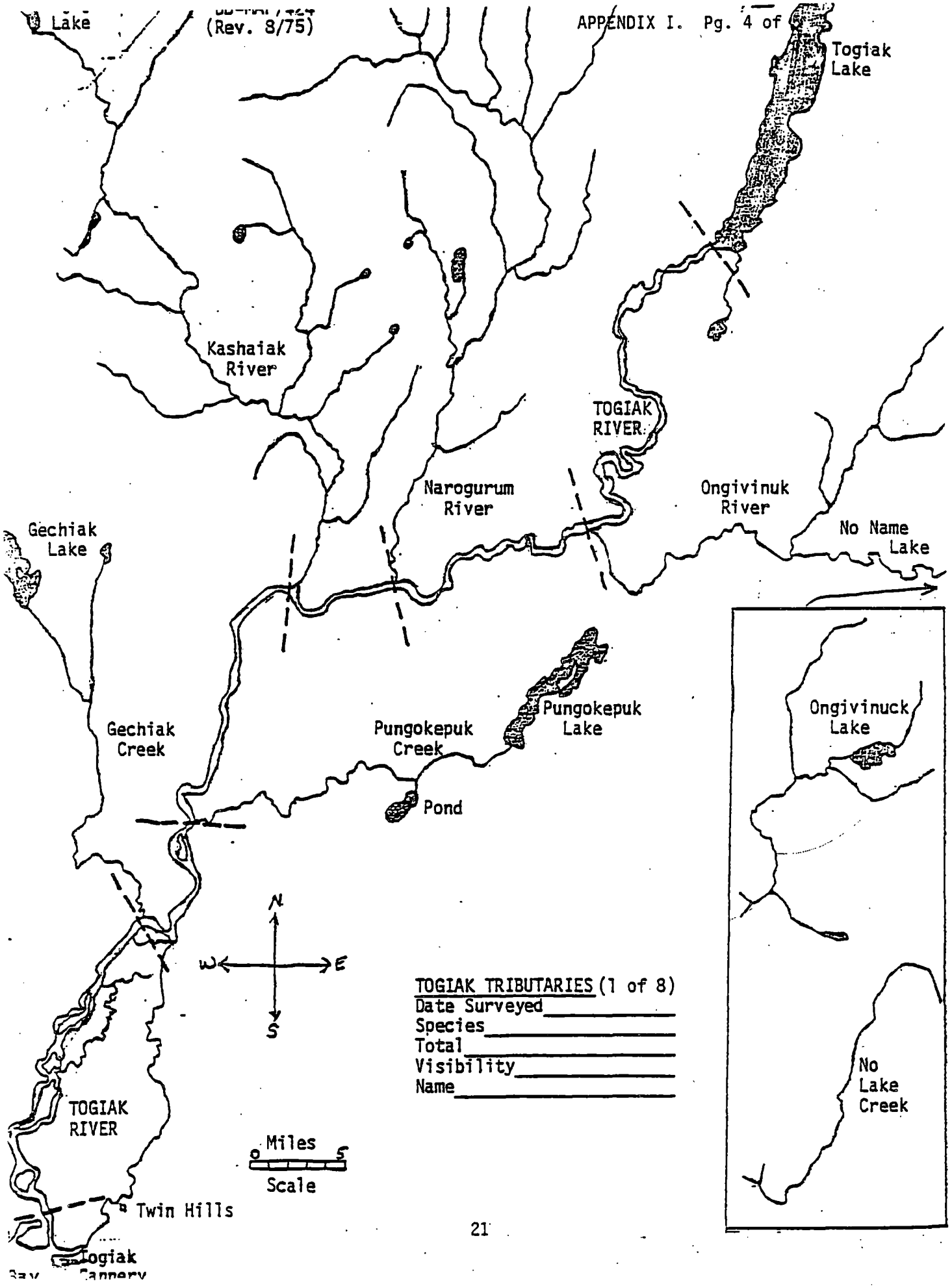


TOGIAK TRIBUTARIES (1 of 8)

Date Surveyed _____

Species _____

Total _____

Visibility _____

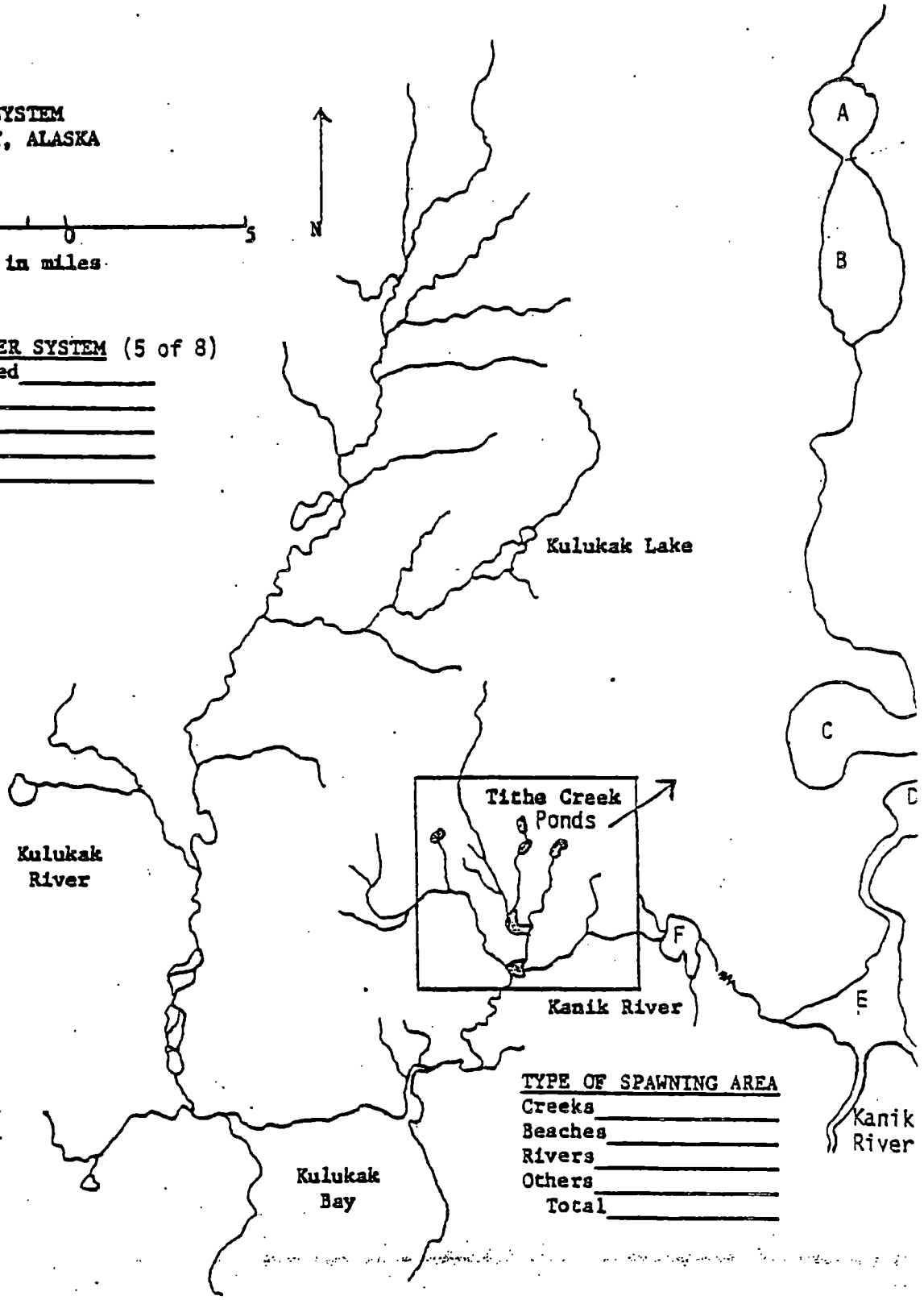
Name _____

KULUKAK SYSTEM
BRISTOL BAY, ALASKA

5 0 5
Scale in miles

N

KULUKAK RIVER SYSTEM (5 of 8)
Date Surveyed_____
Species_____
Total_____
Visibility_____
Name_____



TYPE OF SPAWNING AREA
Creeks_____
Beaches_____
Rivers_____
Others_____
Total_____

APPENDIX II. Summary of successful salmon aerial surveys of Wood, Igushik and Nushagak Rivers, Nushagak District, Bristol Bay, 1975-1986.

River (Year)	Date	Time Flown	Time High Tide (Ft.)	Flown Before High Tide	Comments
WOOD					
1975	7/ 5	9:40 a.m.	12:35 p.m. (15.2')	3 hrs.	Clear down to Red Bluff.
	7/ 8	11:45 a.m.	1:25 p.m. (15.1')	1-1/2 hrs.	Clear L. bank Dlg. up.
1976	7/ 5	7:50 a.m.	9:54 a.m. (18.4')	2 hrs.	"Perfect timing" right on high slack.
	7/ 8	6:45 p.m.	12:56 a.m. (21.3')	6 hrs.	"Perfect timing" low slack in upper river: 6 p.m. low slack -3.9 ft.
1977	7/ 8	5:50 p.m.	9:53 p.m. (17.5')	4 hrs.	"Good survey time, clear to Muklung R.
1978	7/ 2	11:15 a.m.	12:44 p.m. (16.4')	1-1/2 hrs.	Good vis. to below Muklung R.
1979	6/28	4:35 p.m.	6:09 p.m. (13.3')	1-1/2 hrs.	"Perfect timing" clear to Egg Is.
1980	6/28	3:35 p.m.	2:29 p.m. (14.1')	(1 hr. after)	Good to Egg Is.
	7/ 3	5:35 p.m.	7:07 p.m. (15.5')	1-1/2 hrs.	Good to below Muklung.
	7/ 4	10:10 a.m.	7:46 a.m. (21.5')	(2-1/2 hrs. after)	Good to below Muklung.
1981	6/22	3:15 p.m.	12:33 p.m. (17.3')	(3 hrs. after)	Clear down to Red Bluff.
1982	7/ 4	12:10 p.m.	1:35 p.m. (14.4')	1-1/2 hrs.	Clear down to Muklung R.
1983	6/22	11:45 a.m.	12:33 p.m. (17.3')	1 hr.	Clear to Hoseth's.
	7/ 3	"Fish leading edge 2 miles below Silver Salmon Cr.; took 5 hrs. to move by tower".			
	7/ 4	3:30 p.m.	10:25 p.m. (15.4')	(at low)	Clear to Hoseth's.

River (Year)	Date	Time Flown	High Tide (Ft.)	Flown Before High Tide	Comments
WOOD (con't.)					
1984	7/ 4	5:55 p.m.	7:32 p.m. (15.7')	1-1/2 hrs.	Good vis. down to Hoseth's.
	7/ 6	7:10 p.m.	9:49 p.m. (17.8')	2-1/2 hrs.	"Perfect timing".
	7/ 7	8:00 a.m.	9:42 a.m. (20.2')	2 hrs.	"Good survey time"
1985	6/25	1:10 p.m.	9:47 p.m. (15.2')	6-1/2 hrs.	Good to Muklung River.
	7/10	8:40 a.m.	10:16 a.m. (18.1')	2 hrs.	Good to Belt Cr.
	7/11	9:45 a.m.	10:52 a.m. (17.1')	1 hr.	"Perfect timing"
1986	7/11	9:35 a.m.	7:27 a.m. (19.6')	(2 hr. after)	Good down to Hoseth's.
	7/12	8:00 a.m.	7:59 a.m. (19.4')	(at Hi)	Fish "wandering in mid-river from Big Bend down to Hoseth's."
	7/13	7:40 a.m.	8:33 a.m. (19.2')	1 hr.	Fish "wandering", similar to 7/12.
IGUSHIK					
1976	7/ 5	8:20 a.m.	8:48 a.m. (19.9')	1/2 hr.	Good vis. down to Index Tree.
	7/ 7	8:00 a.m.	10:29 a.m. (19.1')	2-1/2 hrs.	"Perfect timing".
1977	7/10	2:15 p.m.	11:49 p.m. (18.1')	(4 hrs. after)	Good down to Index Tree.
	7/11	3:50 p.m.	12.43 a.m. (18.3')	(2 hrs. after)	Good down to Index Tree.
1979	6/23	5:00 p.m.	- -	-	Good to below Index Tree, 3 hrs. before low tide.
	6/25	2:20 p.m.	3:42 p.m. (14.5')	1 hr.	Good below Index Tree.
	7/ 1	9:45 a.m.	8:14 a.m. (18.8')	(2 hrs. after)	Good survey.
	7/ 2	11:25 a.m.	8:47 a.m. (18.3')	(2-1/2 hrs. after)	Good tide stage.
1983	6/22	11:20 a.m.	12:33 p.m. (17.3')	1 hr.	"Perfect timing" clear below Index Tree."
	7/ 4	10:15 a.m.	9:24 a.m. (17.9')	(1 hr. after)	"Perfect timing".
1985	7/ 9	9:00 a.m.	9:38 a.m. (19.3')	1/2 hr.	Good tide stage.
1986	7/10	8:50 a.m.	6:55 a.m. (19.7')	(2 hrs. after)	-

River (Year)	Date	Time Flown	Low Tide (Ft.)	Flown Before Low Tide	Comments
NUSHAGAK					
1976	7/25	10:30 a.m.	8:01 a.m. (7.5')	2-1/2 hrs.	"Perfect timing"
	7/28	2:30 p.m.	10:22 a.m. (5.7')	4 hrs.	"Perfect timing"
1978	7/26	5:00 p.m.	2:39 p.m. (-1.2')	2-1/2 hrs.	"Good time", Black Pt. up.
	7/27	7:00 a.m.	2:57 a.m. (2.7')	4 hrs.	"Good time", Black Pt. up.
1983	7/ 4	4:05 p.m.	4:16 p.m. (-2.2')	-	"Fair" from Black Pt. up.
1984	6/26	11:20 a.m.	7:10 a.m. (8.1')	4 hrs.	"Fish vis." Black Pt. up.
	7/ 1	2:30 p.m.	11:31 a.m. (6.9')	3 hrs.	-
1985	7/ 3	1:35 p.m.	11:03 a.m. (6.3')	2-1/2 hrs.	"Fish vis." Black Pt. up.
1986	7/ 7	3:00 p.m.	11:17 a.m. (8.3')	4-1/2 hrs.	Fish using both main river and Angel Bay.
	7/10	4:45 p.m.	1.23 p.m. (7.4')	3-1/2 hrs.	Fish in main river and Angel Bay.

By: M. Nelson
Date: 3/24/86

Aerial Survey Escapement Counts of Sockeye Salmon in Wood River, 1985.

Date	Time	Observer	Aerial Estimate by River Bank			Tower Count 1/		Remarks
			Left	Right	Total	Partial 2/	Daily	
6/19	2:10 p.m.	Nelson	0	-	0	0	0	Poor vis.
6/21	2:10 p.m.	Nelson	0	-	0	0	0	Good vis.
6/24	9:07 a.m.	Nelson	10	-	10	0	0	Good vis.; no sign lower river
6/25	1:10 p.m.	Nelson	7	-	7	0	0	Good vis.; no sign lower river
6/26	1:00 p.m.	Nelson	1	-	1	0	0	Good vis.; no sign lower river
6/27	9:00 a.m.	Nelson	0	-	0	0	0	Good vis.; no sign lower river
6/28	10:00 a.m.	Nelson	0	-	0	0	0	Fair vis.; no sign lower river
6/29	11:05 a.m.	Nelson	30	-	30	0	0	Fair vis; no
	4:20 p.m.	Nelson	0	-	0			sign lower river
6/30	10:05 a.m.	Nelson	10	-	10	0	3,000	Fair vis.; no
		Skrade	20	-	20			sign lower river
	3:45 p.m.	Nelson	620	0	620			Poor vis.; finne above Red Bluff.
7/ 1	9:45 a.m.	Nelson	45,000	3,000	48,000	18,000	78,000	Poor vis.; heavy
	11:30 a.m.	Nelson	68,000	-	68,000			4-6 wide at Hose finners below.
7/ 2	1:35 p.m.	Nelson	30,000	700	30,700	24,000	86,000	Fair vis.; no
		Skrade	38,000	-	38,000			sign heavy fish lower river.
	3:45 p.m.	Nelson	22,000	-	22,000	25,000		Very poor vis.

(continued

Date	Time	Observer	Aerial Estimate by River Bank			Tower Count 1/		Remarks
			Left	Right	Total	Partial 2/	Daily	
7/ 3	2:15 p.m.	Nelson	46,000	-	46,000	35,000	87,000	Good vis.; est. tot. river at 100,000; finners in lower river.
7/ 4	4:35 p.m.	Nelson	70,000	3,700	73,700	26,000	98,000	Poor vis.; est. tot. river at 150,000; no sign lower river.
7/ 5	4:05 p.m.	Nelson	18,400	-	18,400	7,000	29,000	Good vis.; no sign lower river.
7/ 6	8:05 a.m.	Nelson	300	-	300	7,000	20,000	Poor vis.; no sign lower river.
	4:15 p.m.	Nelson	11,300	-	11,300			
		Skrade	10,400	-	10,400			
7/ 7	1:05 p.m.	Nelson	9,900	100	10,000	4,000	21,000	Fair vis.; some sign in lower river, not strong.
	6:05 p.m.	Nelson	21,000	-	21,000			
7/ 8	6:15 p.m.	Nelson	22,000	2,700	24,700	19,000	67,000	Good/exc. vis.; finners in lower river, not heavy.
		Skrade	23,000	3,000	26,000			
7/ 9	8:20 a.m.	Nelson	15,600	4,300	19,900	36,000	84,000	Exc. vis.; no sign lower river.
7/10	8:40 a.m.	Nelson	35,000	0	35,000	19,000	49,000	Exc. vis.; no sign lower river.
7/11	9:45 a.m	Nelson	6,400	300	6,700	9,000	24,000	Good vis.; no sign lower river.
7/12	10:35 a.m.	Nelson	2,600	1,800	4,400	10,000	31,000	Fair vis.; no sign lower river.
7/13	11:00 a.m.	Nelson	1,000	-	1,000	2,000	20,000	Very poor vis.

(continued)

Date	Time	Observer	Aerial Estimate by River Bank Left	Right	Total	Tower Count 1/ Partial 2/	Daily	Remarks
7/15	8:20 a.m.	Nelson	34,000	3,000	37,000	33,000	92,000	Poor vis.; finners present in lower river.
	4:10 p.m.	Nelson	17,300	-	17,300	8,000		
		Skrade	17,000	-	17,000			
7/16	8:10 a.m.	Nelson	16,500	400	16,900	11,000	35,000	Good vis.
					Season Total Escapement:		939,000	

1/ To nearest 1,000 fish.
2/ Wood River tower count from time of survey, plus 8 hours later to account for migration lag time.

NOTE: In 1985 the following factors applied to the aerial survey estimate will bring the aerial survey estimate and 8 hour tower count into rough parity:

Low migration rates (up to 10,000 for 8 hrs.) = 0.8 (7 observations)
Medium migration rates (10 to 30,000 for 8 hrs.) = 0.6 (7 observations)
High migration rates (30,000 > for 8 hrs.) = 1.0 (3 observations)
All migration rates (all rates for 8 hrs.) = 0.7 (17 observations)

MEMORANDUM

State of Alaska

TO: Michael L. Nelson
Division of Commercial Fisheries
Box 199
Dillingham, Alaska

FILE NO:

DATE : May 31, 1967

FROM: Mel Seibel, Biometrics Staff
Division of Commercial Fisheries
Research Section
Juneau, Alaska

SUBJECT: Estimated escapements for Togiak River

Mike - sorry about the delay. Furthermore, I doubt whether I will be able to add much more than you've already realized. At any rate will put down a few comments that come to mind.

From the graphs attached, it appears that the percent of fish (present in the river) accounted for by aerial survey changes during the season. Another season's data should indicate whether this is a valid assumption. We would expect some deviations as a result of the survey conditions existing. Until more extensive data is available, we can fit freehand curves to the data.

One possible approach would be as follows:

1) Survey the river.

2) On the basis of past data, determine what percent of the fish were accounted for and hence estimate the number of fish actually in the river. This will also yield an estimated total tower count by a certain date.

3) Using the above estimated total tower count by a given date, estimate the total seasonal escapement from your data on percent of escapement obtained by a certain date.

Note that you will actually have three estimates of the total seasonal escapement. The first will be obtained by expanding the actual tower count for a given date. The second estimate will be obtained by estimating the * escapement past the tower after eight additional days and expanding that estimate.

The degree of agreement between these three estimates will provide some measure of the reliability of these estimates.

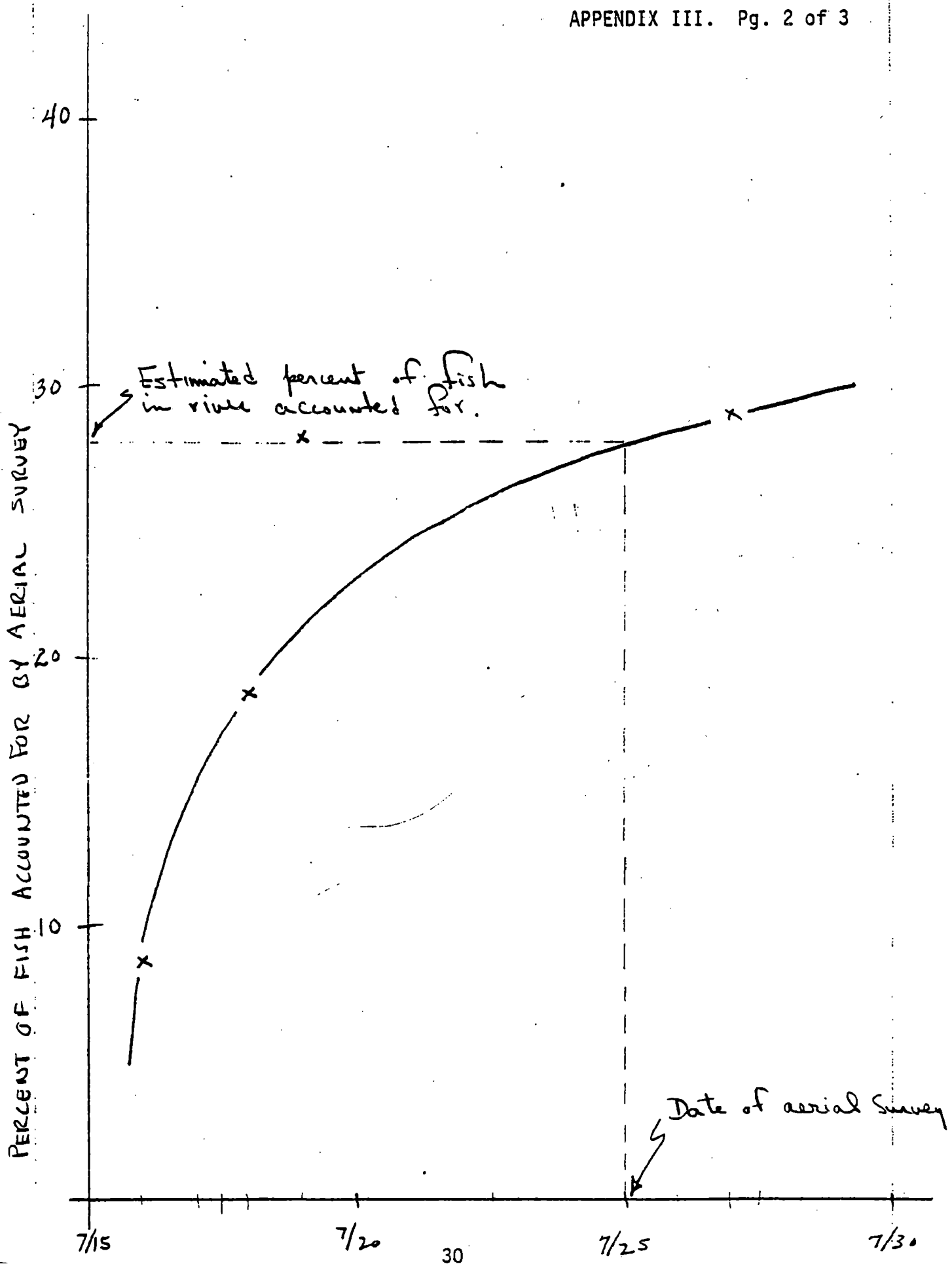
After another season of data, we may be able to develop a more complete method of estimation.

MCS/jg

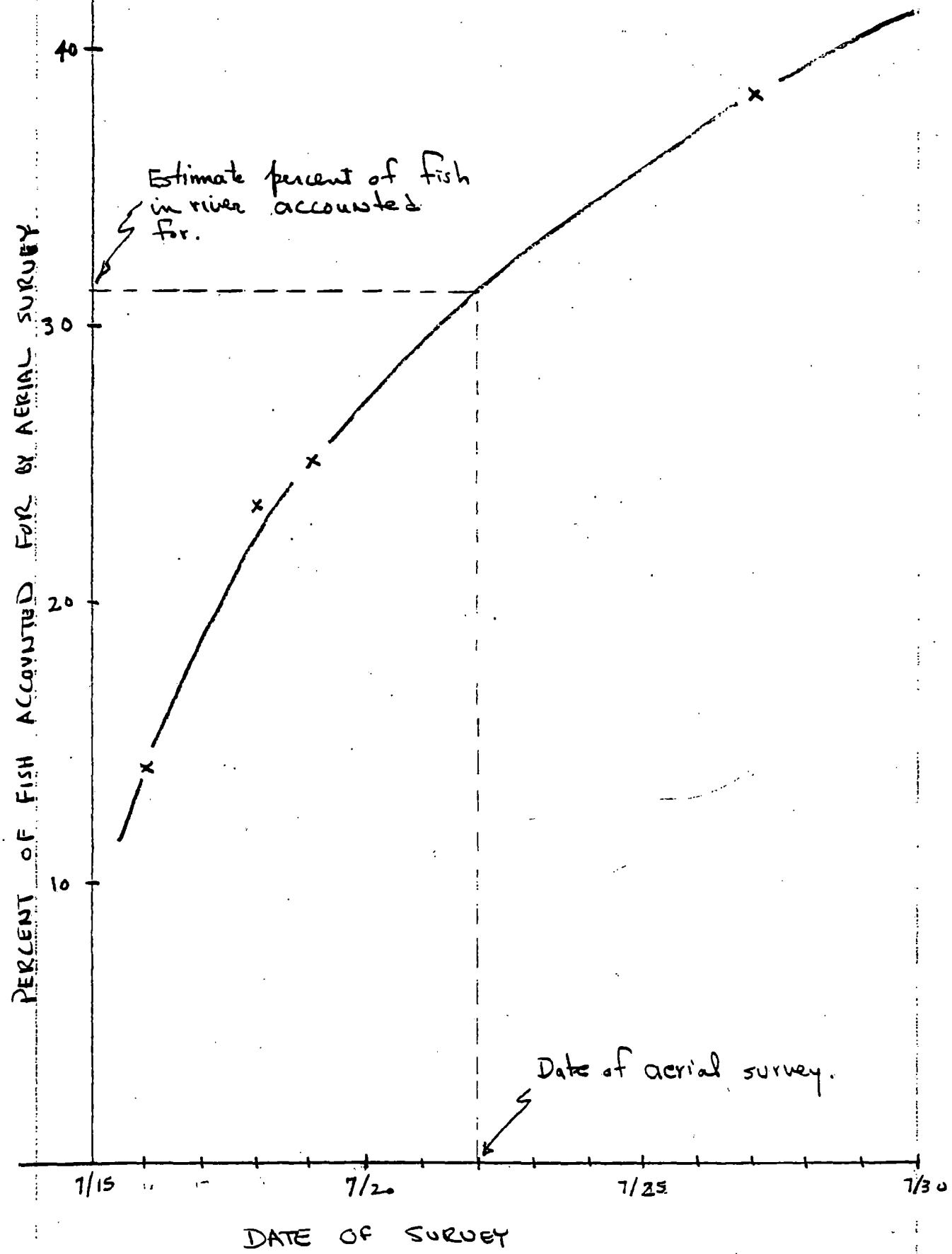
P.S. Am enclosing final data.

* escapement past the tower after three additional days and expanding that estimate and the third by estimating the

RELATIONSHIP BETWEEN DATE OF AERIAL SURVEY AND PERCENT OF FISH (PASSING TOWER DURING FOLLING EIGHT DAYS) ACCOUNTED FOR BY AERIAL ESTIMATES TOGIAK TOWER TO Gechiak RIVER, 1966



RELATIONSHIP BETWEEN DATE OF AERIAL SURVEY AND PERCENT OF FISH (PASSING TOWER DURING FOLLOWING THREE DAYS) ACCOUNTED FOR BY AERIAL ESTIMATE TOGIAK TOWER TO ONGIVINUCK R., 1966



By: M. Nelson
Date: 11/16/82

OPTIMUM CONDITIONS FOR CONDUCTING AERIAL SURVEYS OF COMMERCIAL OPENINGS IN BRISTOL BAY

Ordinarily no single "rule of thumb" can be followed in selecting the best time to survey the fleet during a commercial opening. It usually depends on the type of information the observer is looking for (e.g. fleet distribution, initial catch success, total period catch, set net catches only, etc.). Although the same general rules apply to all districts, there are a few differences that should be considered before surveying an open period. A summary by district follows:

NAKNEK-KVICHAK DISTRICT:

If initial catch success or an idea of fleet distribution is desired the best time to fly is during the first hour to hour and a half after the period opens.

If a long closure has been in effect and/or test fishing has not provided a good idea of where the fish are concentrated in the district a second survey several hours after the opening will indicate shifts in the fleet distribution from one section to another from the outside to the inside of the district, etc.

If an extension of the period is contemplated or an estimate of the total catch is desired before the period is over a survey flown 1-1/2 hours after high water book time will provide a fair estimate of the period catches and by this time set nets from Johnston Hill to the entrance to Naknek River should be dry enough to include an estimate for them. Even later into the ebb will show more nets farther up toward Libbyville and Graveyard.

If no extension or immediate announcement is considered possible a good estimate of the period catch is possible just after the period closes.

EGEGIK DISTRICT:

The same general pattern applies to this district except that a survey intended for high water should be flown 1-1/2 hours before high water book time.

Fleet distribution and initial catch success is best observed an hour or so after the opening.

A survey 1-1/2 hours after high water book time on through the first half of the ebb also gives a good idea of how the fish are moving into the river since part of the fleet hangs near the inside line and drifts out if fish are abundant in the river mouth. By this time set nets are dry enough to permit an estimate of the total district catch. The best information is possible at this time especially if an extension is contemplated and a period catch estimate is needed before the period is over.

A survey immediately after the period closes will provide a good estimate of total period catch if no extensions of fishing are contemplated.

UGASHIK DISTRICT:

Similar criteria apply here except that high tide in the district is one hour before high water book time and one hour after book time for set nets at Ugashik Village.

Fleet distribution and initial catch success is best seen an hour or so after the opening.

If it is necessary to estimate the expected period catch prior to closing time then a survey at or just after high water book time will give the best results since set nets should be dry enough to get a good count and drift success is evident by this time.

A survey of the set nets at Ugashik Village on the ebb also provide an indication of whether there are fish in the river above the village. This should be flown at least 2 hours after high water book time.

NUSHAGAK DISTRICT:

Depends on what information is wanted. A survey from 1/2 to 1 hr. after the opening will show fleet distribution (and number), as well as initial fishing success. An estimate of total period catch based on catches is best made shortly after the period is over. However, it is often necessary or desirable to estimate the expected period catch prior to the closing time. In this case a survey about 1 hour after high water book time will show set net success on Clarks Point and Ekuk beaches. Igushik beach should be surveyed a little earlier, say at high water book time. In the case of a complete district survey, first proceed to Igushik beach and then on to Ekuk/Clarks Point beaches.

TOGIAK DISTRICT:

At low water if fleet distribution and number is required, or at high water if catch estimates are needed. This drift skiff fishery usually deliver their catch at the canneries at high water. We very seldom fly the Togiak area during open fishing periods, as the fleet is scattered and catches are usually low at any one time.

APPENDIX V

Bering Sea Herring Aerial Survey Index Area Maps Showing Bottom Profile Characteristics and Obstructions

NUSHAGAK INDEX (NUS-1)

KILLIKAK SECTION

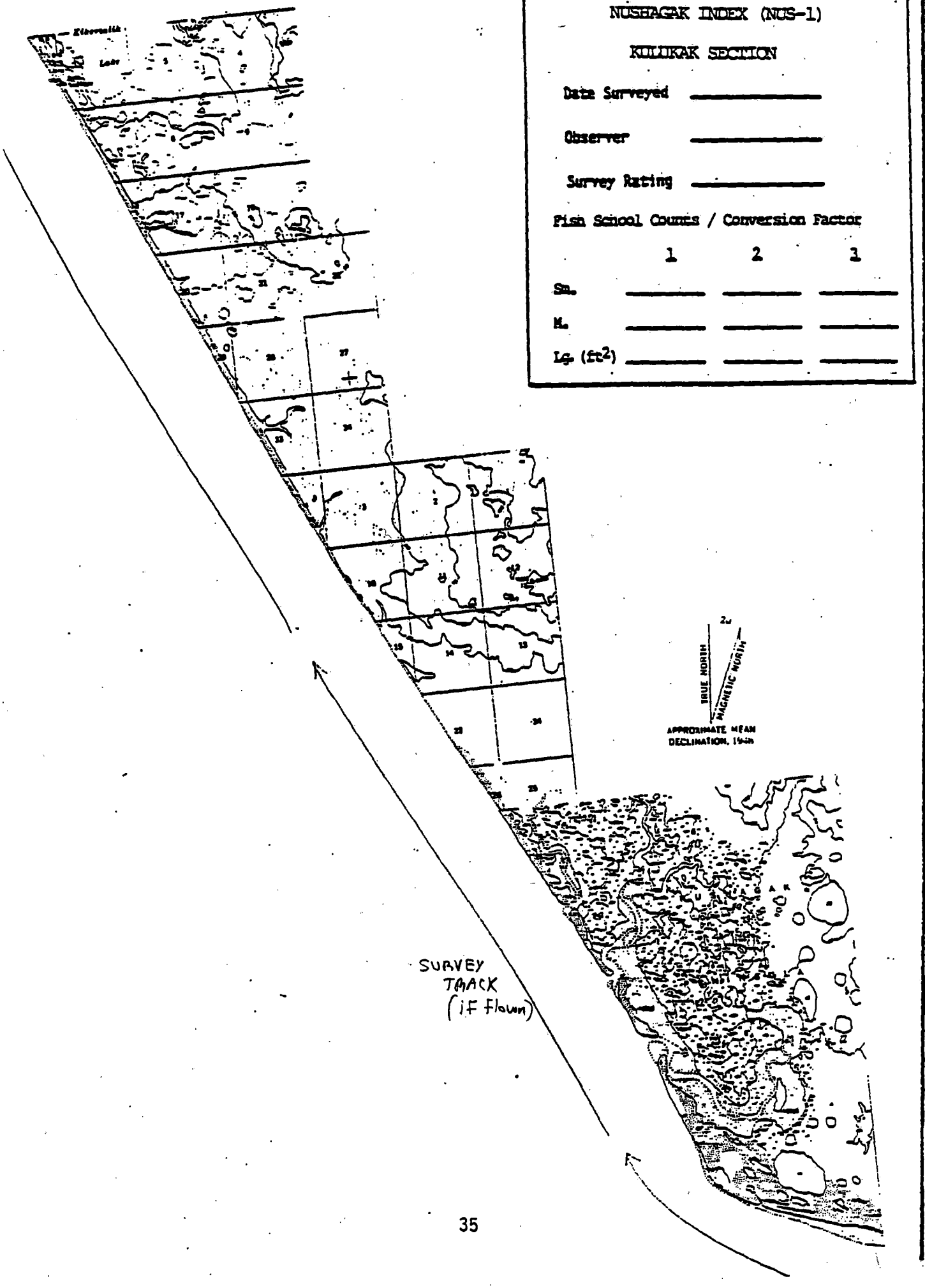
Date Surveyed _____

Observer _____

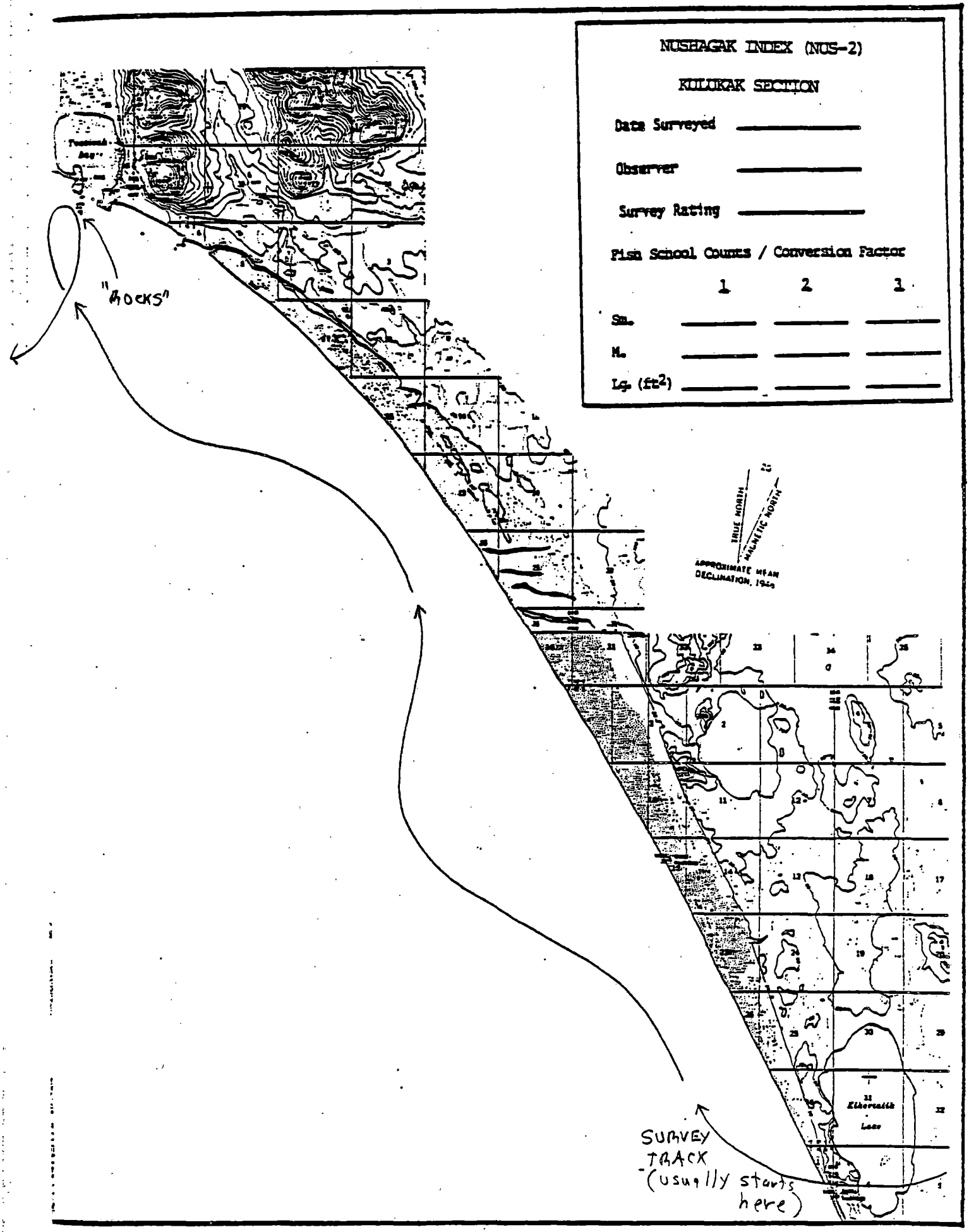
Survey Rating _____

Fish School Counts / Conversion Factor

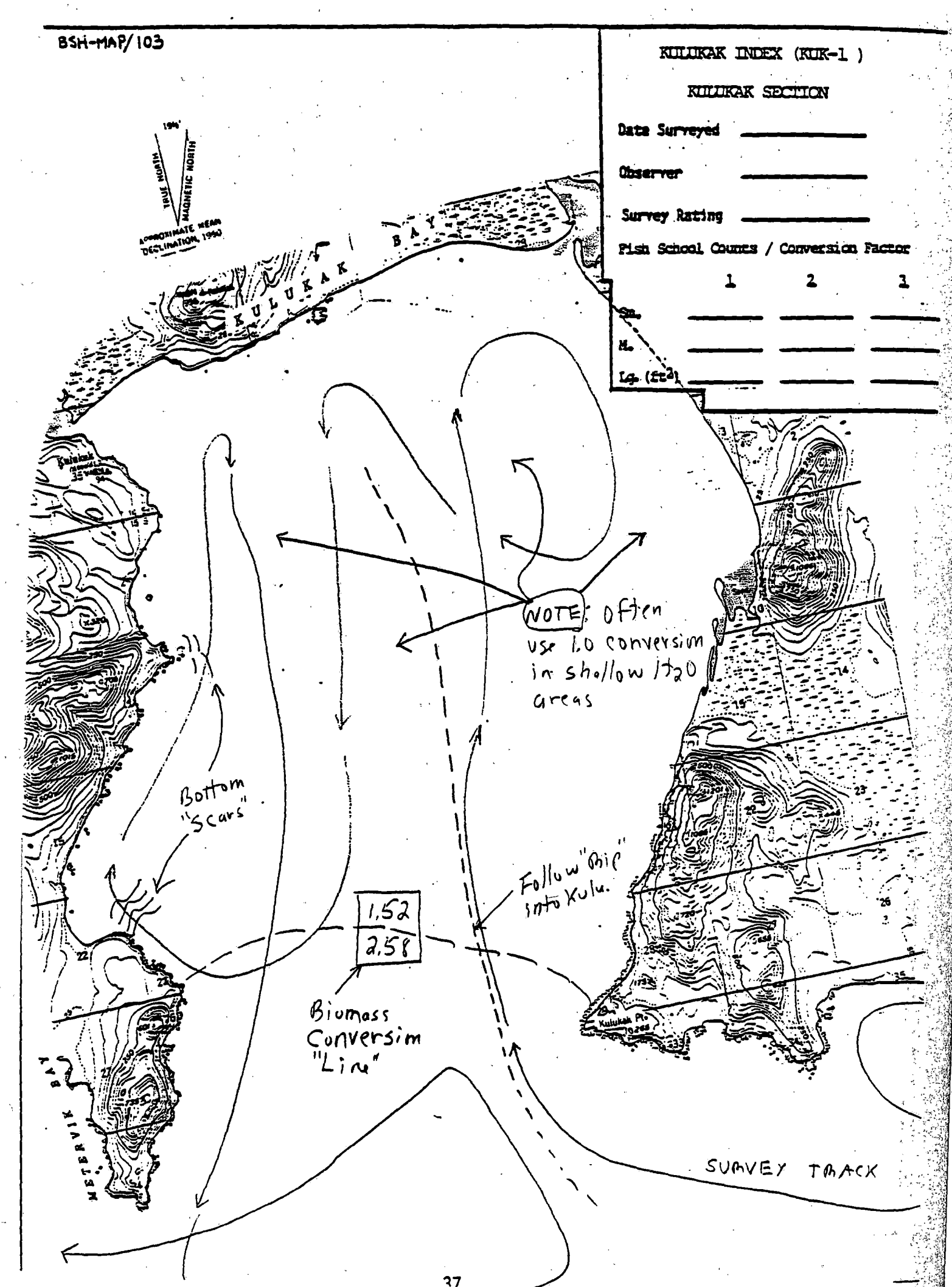
	1	2	3
Sm.			
M.			
Lg. (ft^2)			



SURVEY TRACK (IF Flown)


NUSHAGAK INDEX (NUS-2)
KULUKAK SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1
2
3
Sm.
M.
Lg. (ft²)
"ROCKS"
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 19
SURVEY TRACK (usually starts here)

BSH-MAP/103


KULUKAK INDEX (KUK-1)
KULUKAK SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1
2
3
Sm.
M.
Lg. (ft²)
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1980
KULUKAK BAY
NOTE: often use 1.0 conversion in shallow H2O areas
Bottom "Scars"
Follow "Bar" into Kulu.
1.52
2.58
Biomass Conversion "Line"
SURVEY TRACK
METERVIK BAY

METERVIK INDEX (MET-1)

KULUKAK SECTION

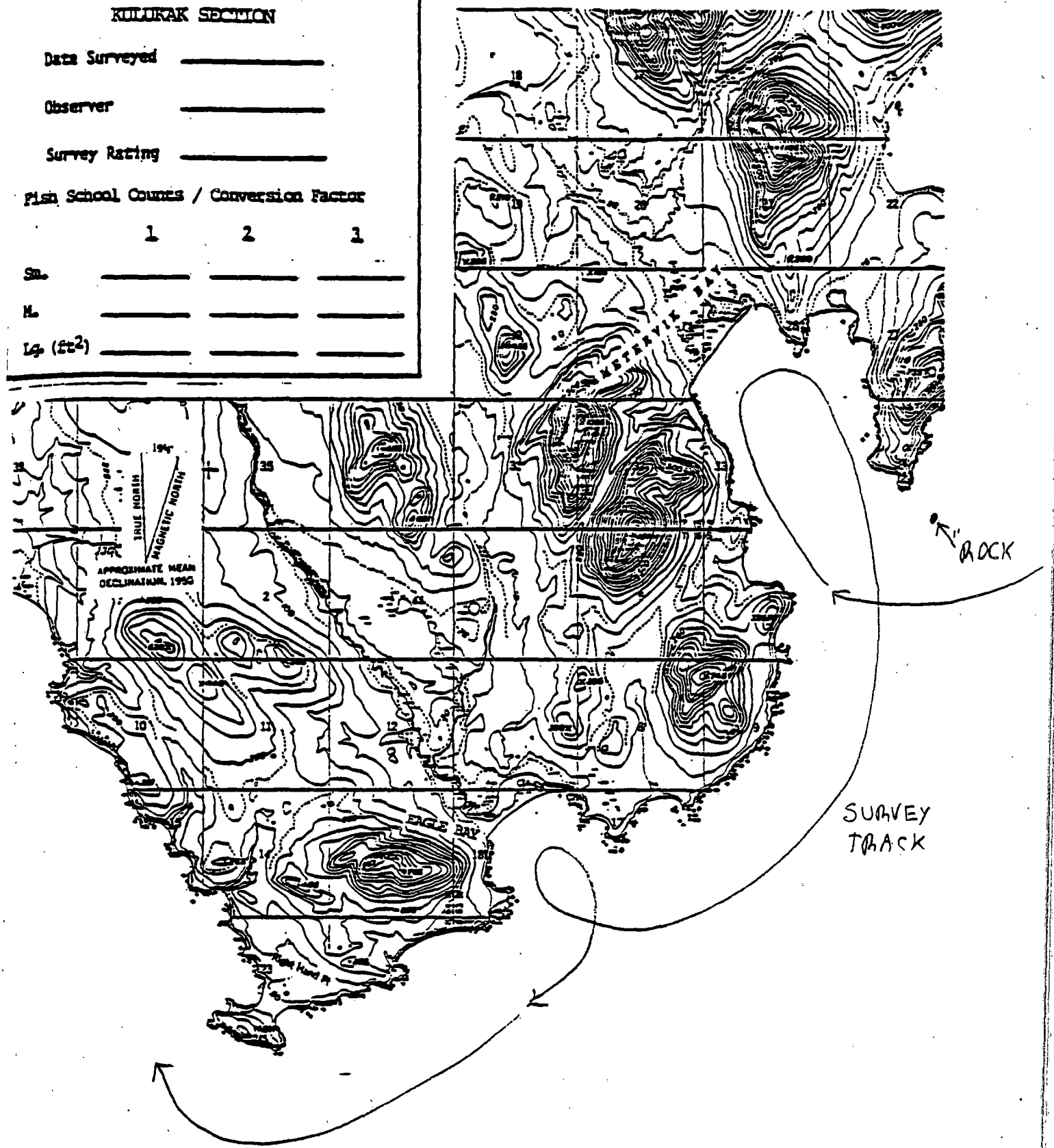
Data Surveyed _____

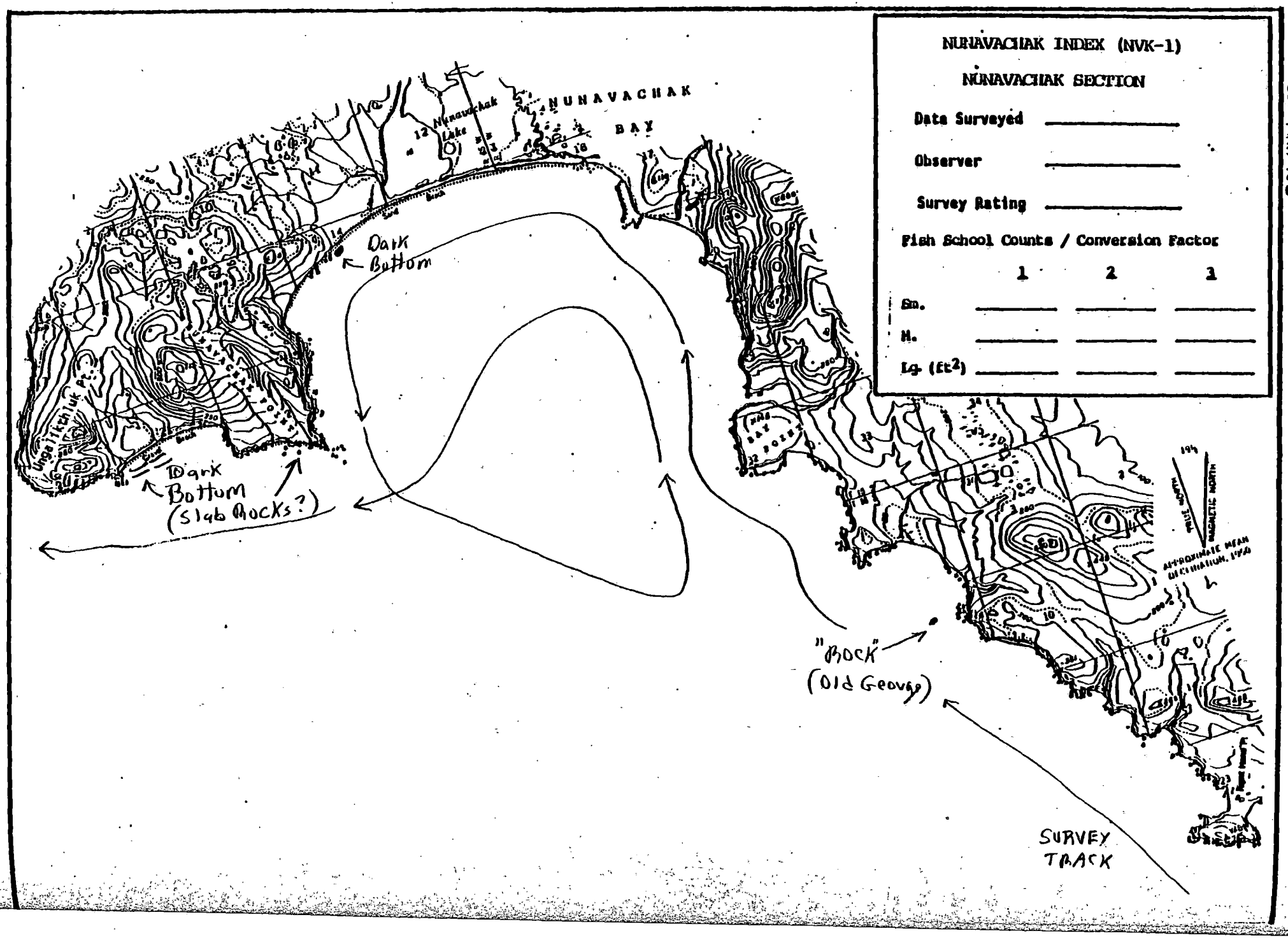
Observer _____

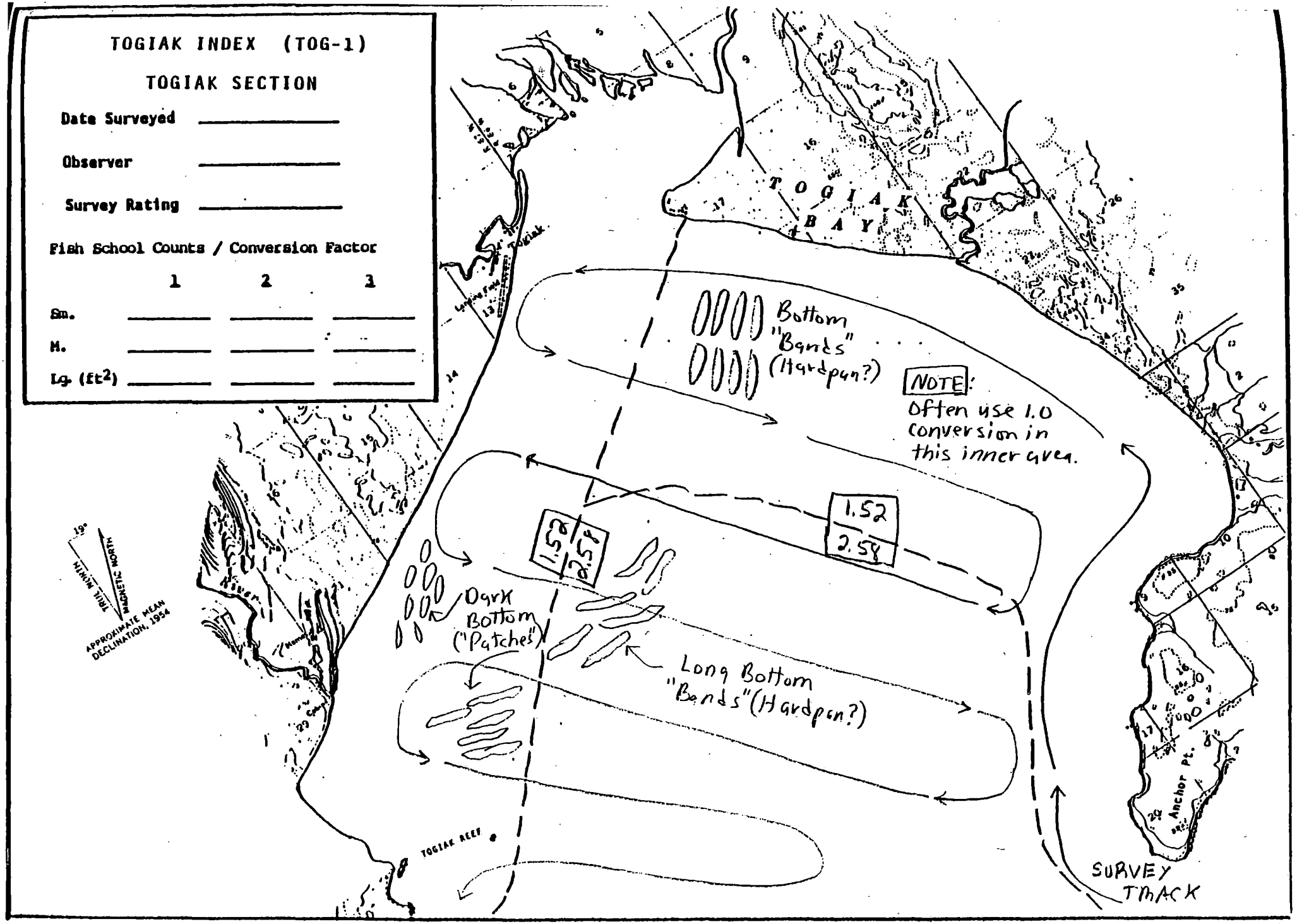
Survey Rating _____

Fish School Counts / Conversion Factor

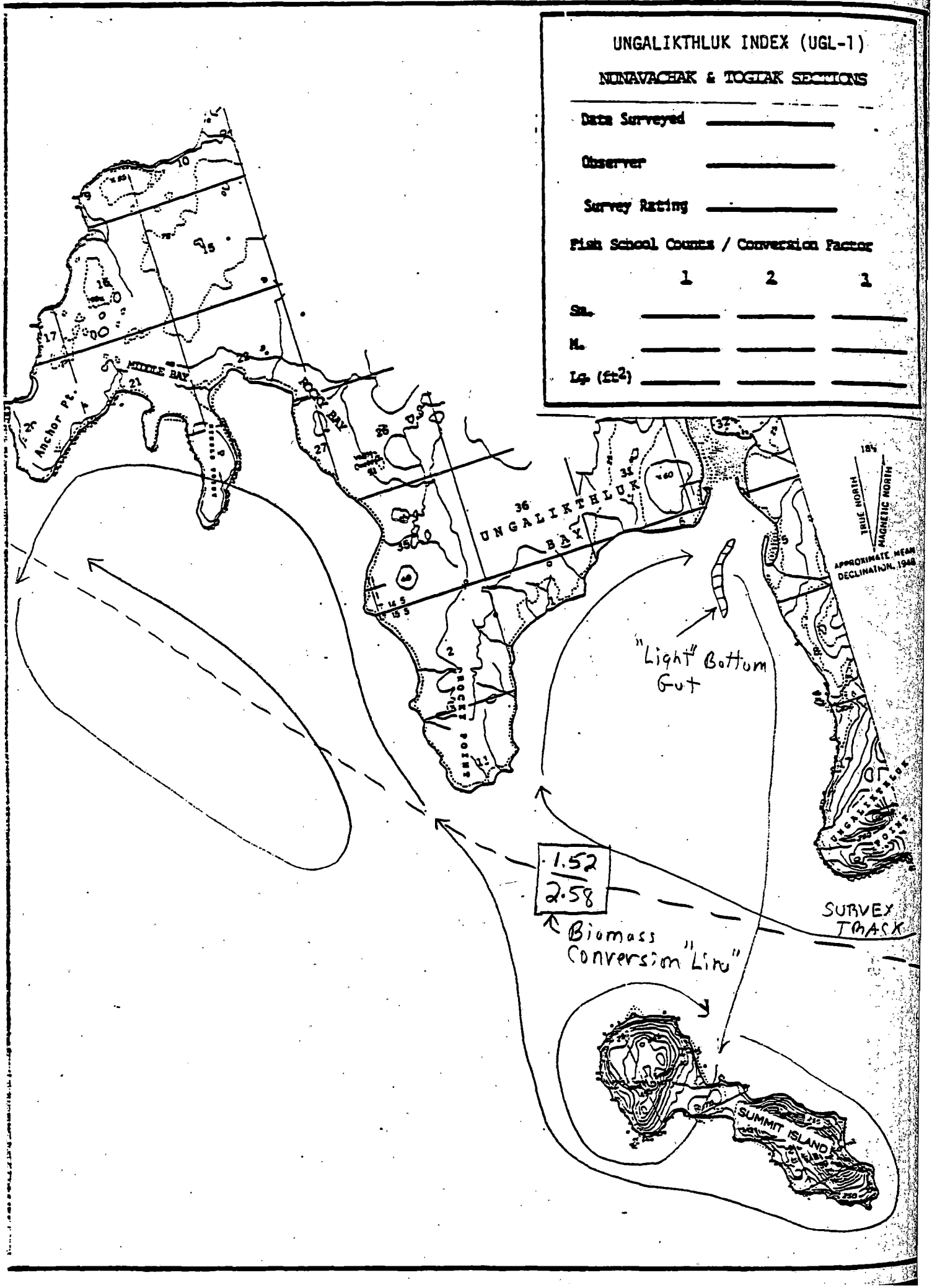
	1	2	3
Sm.			
M.			
Lg. (ft^2)			

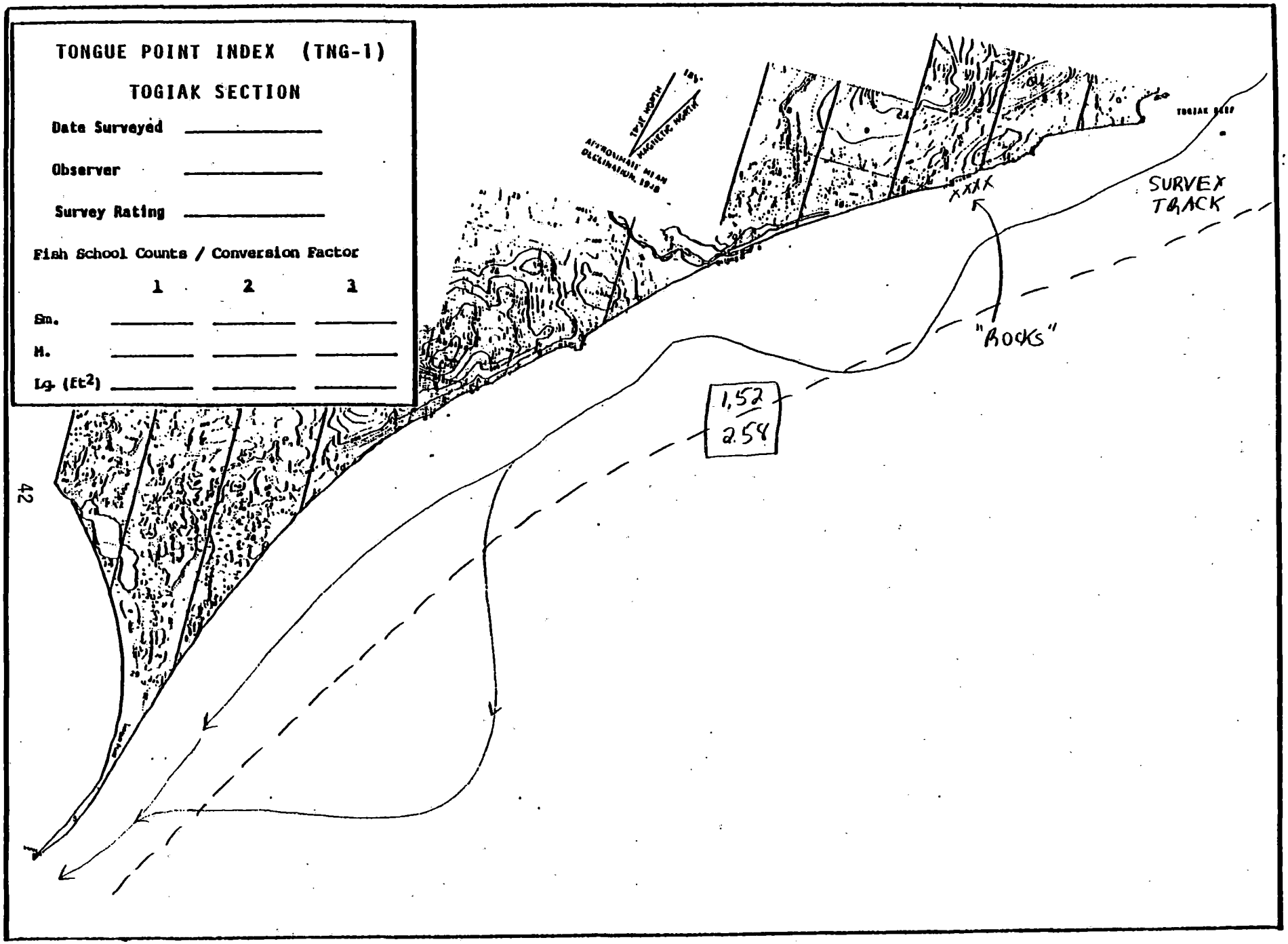


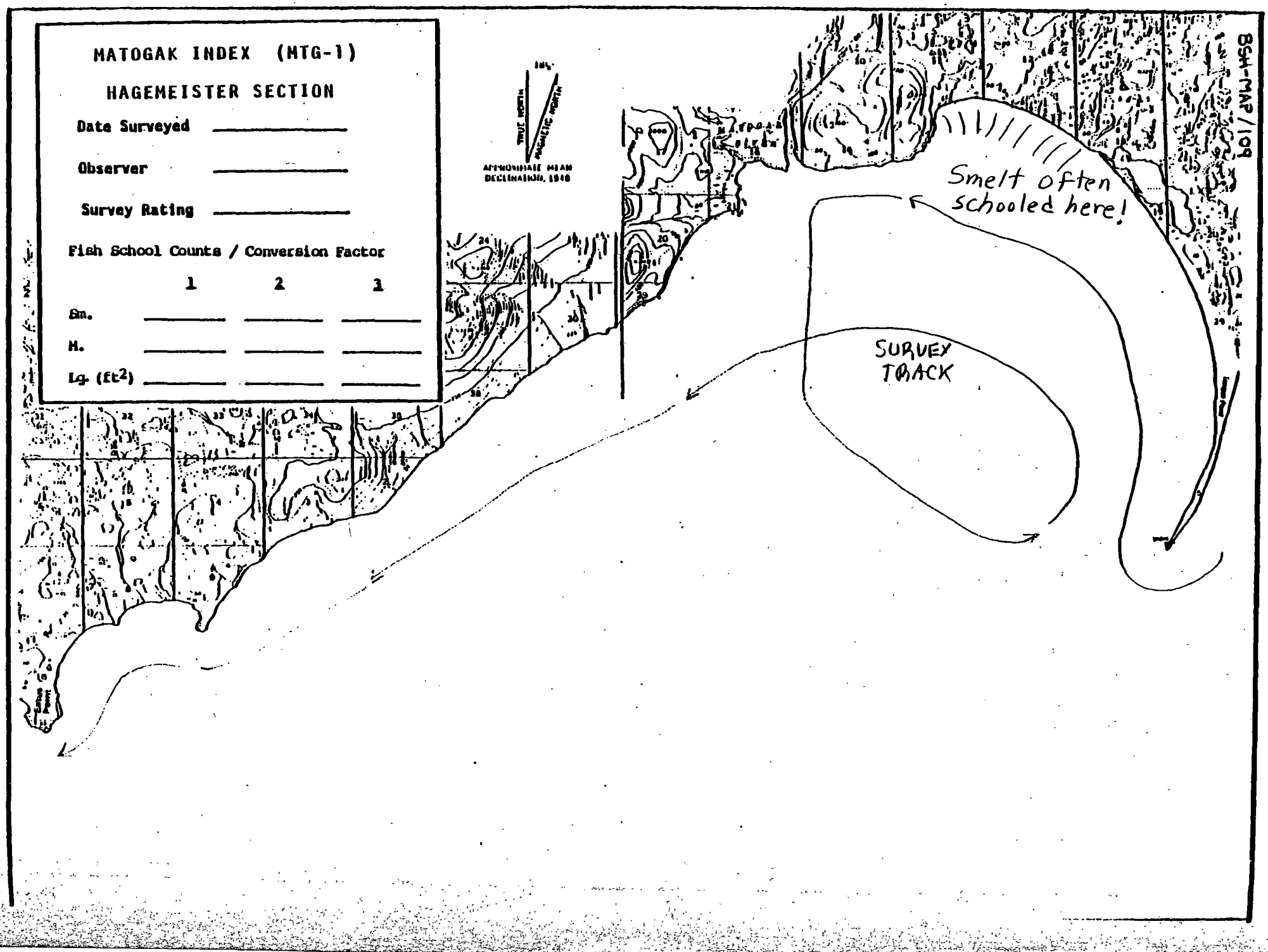

NUNAVACHIAK INDEX (NVK-1)
NUNAVACHIAK SECTION
Date Surveyed _____
Observer _____
Survey Rating _____
Fish School Counts / Conversion Factor
1 2 3
Sm. _____ _____ _____
M. _____ _____ _____
Lg (Ft²) _____ _____ _____
NUNAVACHIAK BAY
Nunavachiak Lake
Ungalikthluk Pt.
Dark Bottom
Dark Bottom (Slab Rocks?)
"Rock" (Old Geovga)
SURVEY TRACK
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1984

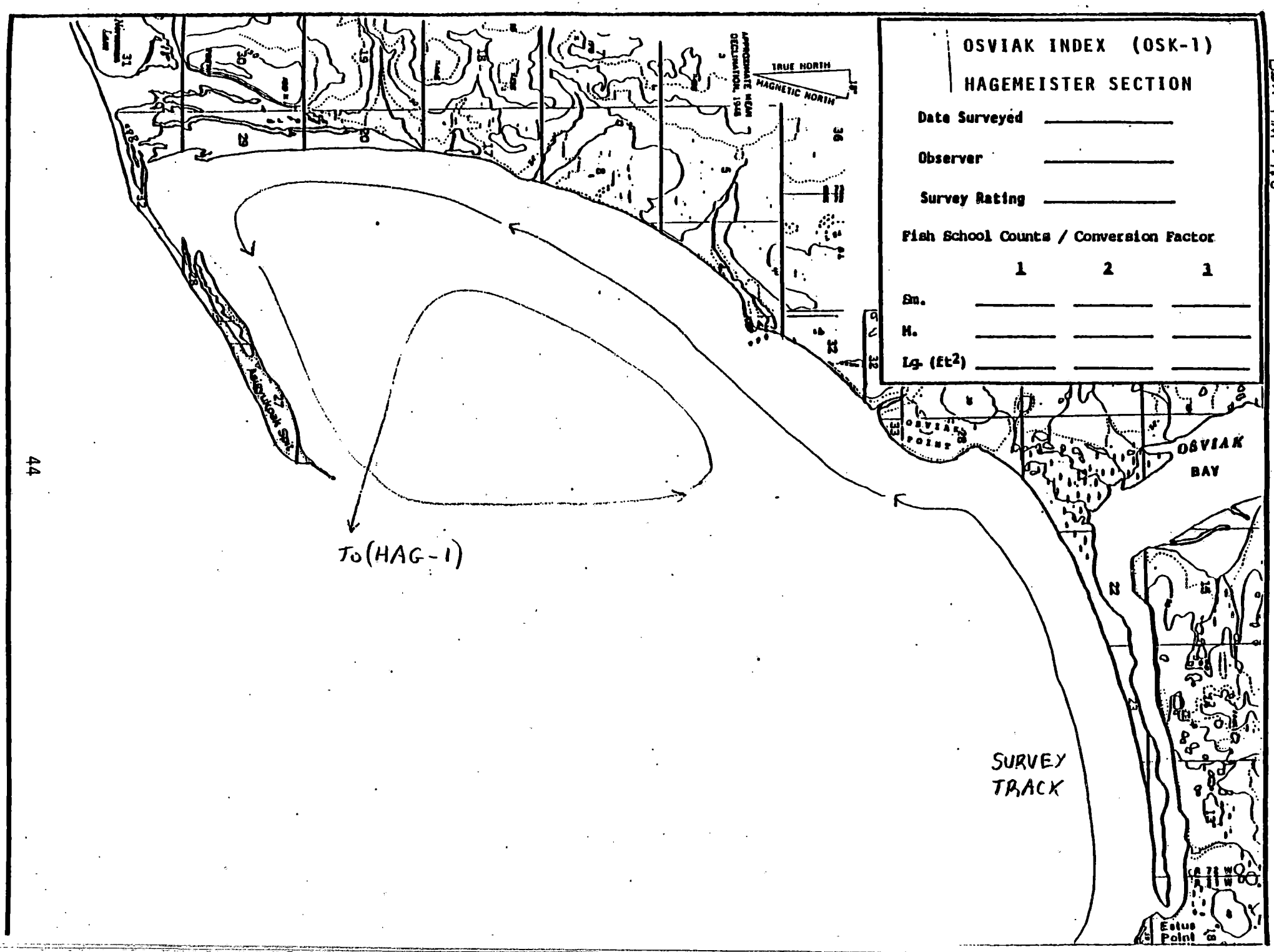

TOGIAK INDEX (TOG-1)
TOGIAK SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1 2 3
Sm.
M.
Lg. (Ft²)
TOGIAK BAY
Bottom "Bands" (Hardpan?)
NOTE: Often use 1.0 conversion in this inner area.
1.52
2.58
1.52
2.58
Ogrk Bottom ("Patches")
Long Bottom "Bands" (Hardpan?)
TOGIAK REEF
SURVEY TRACK
Anchor Pt.
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1954

BSH-MAP/106


UNGALIKTHLUK INDEX (UGL-1)
NUNAVACHAK & TOGIAK SECTIONS
Data Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1
2
3
Sm.
M.
Lg. (ft²)
MIDDLE BAY
Anchor Pt.
FOOX BAY
UNGALIKTHLUK BAY
ROCKY POINT
"Light" Bottom Cut
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1948
1.52
2.58
Biomass Conversion "Line"
SURVEY TRACK
SUMMIT ISLAND


TONGUE POINT INDEX (TNG-1)
TOGIAK SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1 2 3
Sm.
M.
Lg. (Ft²)
TRUE NORTH
MAGNETIC NORTH
ASTRONOMIC MEAN DECLINATION, 1948
TOGIAK REEF
XXXX
SURVEY TRACK
"ROCKS"
1,52
2.54
42
BSH-MAP/106


MATOGAK INDEX (MTG-1)
HAGEMEISTER SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1 2 3
Sm.
M.
Lg. (ft2)
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1948
Smelt often schooled here!
SURVEY TRACK
BSH-MAP/109


OSVIAK INDEX (OSK-1)
HAGEMEISTER SECTION
Date Surveyed
Observer
Survey Rating
Fish School Counts / Conversion Factor
1 2 1
Sm.
M.
Lg. (Ft²)
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1948
To (HAG-1)
SURVEY TRACK
OSVIAK BAY
OSVIAK POINT
Estus Point

PYRITE POINT INDEX (PYR-1)

HAGEMEISTER SECTION

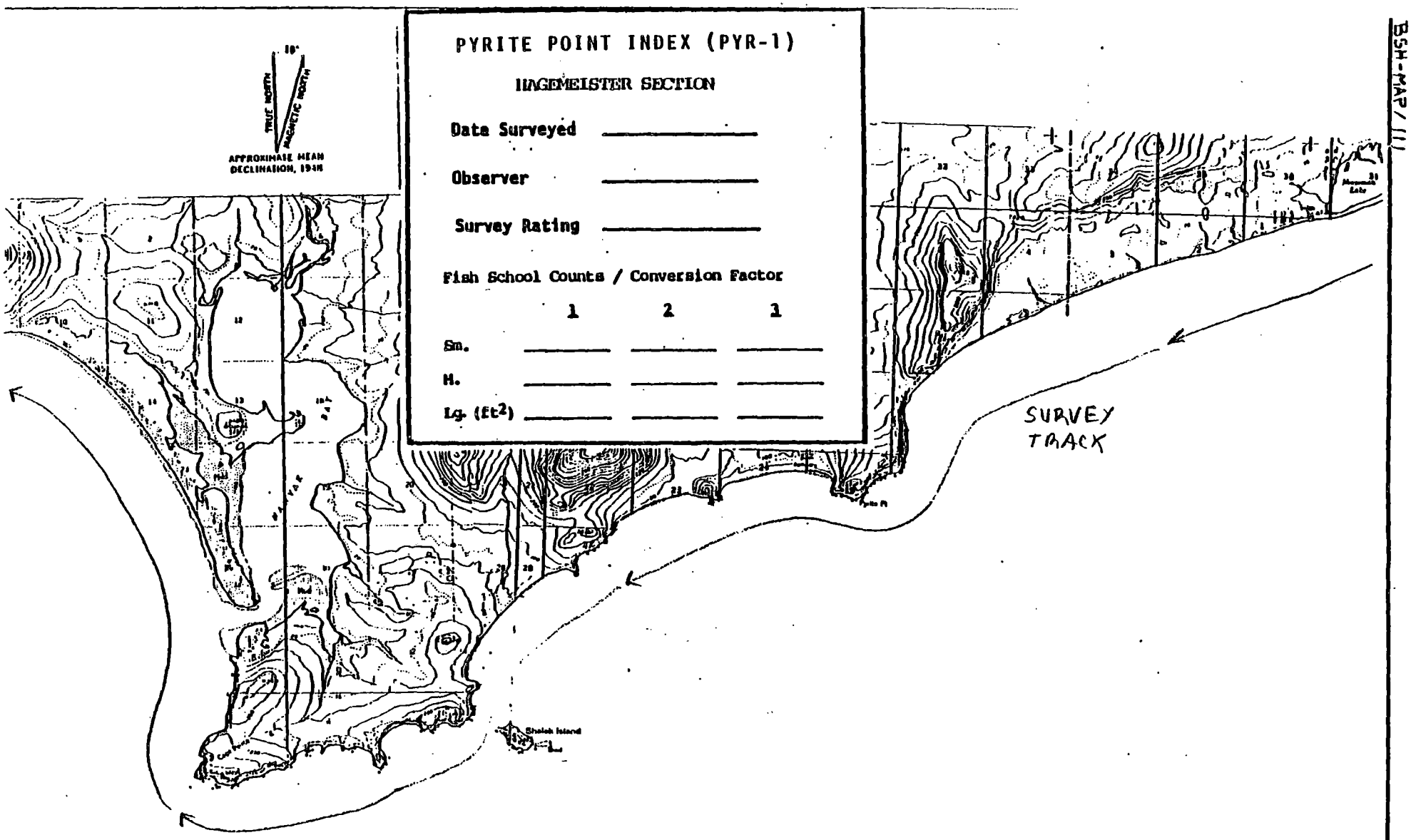
Date Surveyed _____

Observer _____

Survey Rating _____

Fish School Counts / Conversion Factor

	1	2	1
Sm.			
M.			
Lg. (Ft^2)			



CAPE NEWENHAM INDEX (CN-1)

HAGEMEISTER SECTION

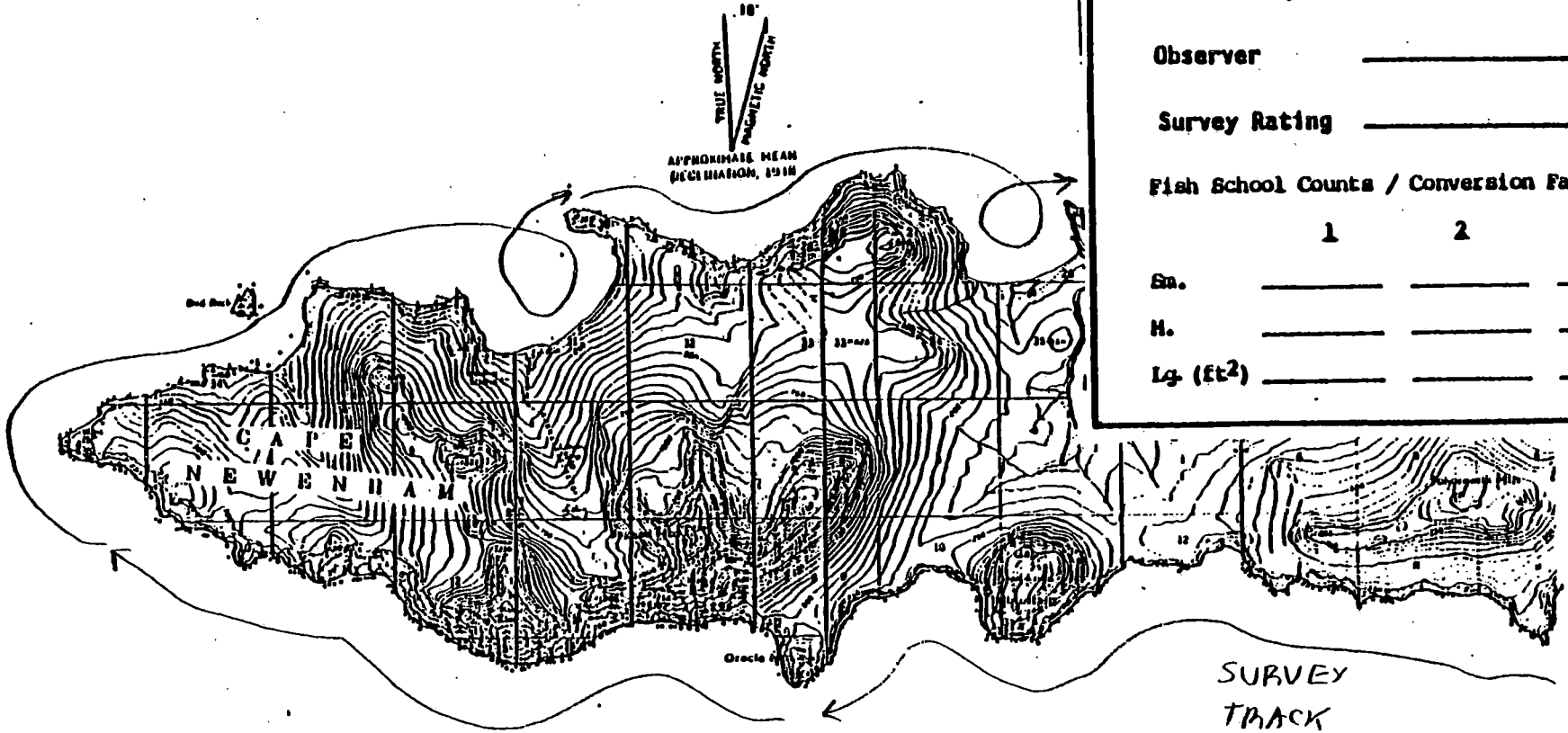
Data Surveyed _____

Observer _____

Survey Rating _____

Fish School Counts / Conversion Factor

	1	2	1
Sm.			
M.			
Lg. (ft^2)			



HAGEMEISTER INDEX (HAG-1)

HAGEMEISTER SECTION

Date Surveyed _____

Observer _____

Survey Rating _____

Fish School Counts / Conversion Factor

	1	2	3
Sm.			
M.			
Lg. (ft^2)