Brian - FYI RPW
John A L

United States
Environmental Protection
Agency

Region 10
1200 Sixth Avenue
Seattle WA 98101

Alaska
Idaho
Oregon
Washington

EPA

File a copy in each of:
1990 Tech Support #3 and
1990 Feas. Study # 4

JUN 21 1990

RECEIVED JUN 27 1990

Reply to
Attn of: WD-139

MEMORANDUM

SUBJECT: Decision Memorandum - Interagency Agreement with U.S. Fish and Wildlife Service

FROM: John Armstrong John Armstrong
Office of Puget Sound

THROUGH: Jack Gakstatter, Chief JWG
Office of Puget Sound

TO: Ronald A. Kreizenbeck
Acting Director, Water Division

Attached is a proposed interagency agreement (IAG) between the Environmental Protection Agency (EPA) and the U.S. Fish and Wildlife Service (USFWS) for $36,500. Under this IAG, the USFWS will complete two tasks. The first task will be to evaluate a sampling technique for determining the distribution and abundance of forage fish in relation to marine birds and marine mammals. The second task will create a database of beach segment survey data for future use in restoration projects.

The IAG is in compliance with statutory authority and EPA policy requirements.

We request your signature on the attached IAG and your concurrence below:

Concurrence:

Ronald A. Kreizenbeck
Acting Director, Water Division

Non-Concurrence:

Ronald A. Kreizenbeck
Acting Director, Water Division

Attachment

COMMITMENT NOTICE

NOTE: Preparation and approval of this form does not constitute an obligation of money. The use of this form is intended to guarantee availability of money by reserving it for certain types of specified transactions.

THIS COMMITMENT TRANSACTION IN THE AMOUNT OF $ 36,500 (WHOLE DOLLARS) IS FOR:

☐ GRANT *(Number)* ☐ A PURCHASE REQUISITION ☐ A CONTRACT

☒ OTHER *(Specify)*:

DESCRIPTION OF PROJECT, GOODS, OR SERVICES
IAG To US Fish and Wildlife Service for a study of Forage fish distribution in relation to marine birds and marine mammals and for the development of a beach survey database

NAME OF GRANTEE/CONTRACTOR/VENDOR | EMPLOYER IDENT. NO. *(EIN)*

TASK, ROAP, OR OTHER LOCAL IDENTIFIER

SPECIAL COMMENTS OR INSTRUCTIONS

ALLOWANCE HOLDER APPROVALS *(Optional, at discretion of Allowance Holder)*

ALLOWANCE HOLDER TITLE: U S EPA Region 10

STAFF APPROVALS

SIGNATURE	DATE	PHONE
Jack Gakstatter, Chief, Office of Puget Sound / Jack H. Gakstatter	6/21/90	FTS 399-0966
Ron A. Kreizenbeck, Acting Director, Water Division	6/21/90	FTS 399-1237

RESPONSIBILITY CENTER TITLE: WATER DIVISION

FUNDS CERTIFICATION

PREPARED BY	APPROVED BY
SIGNATURE: Ellen Peterson	SIGNATURE: Ellen Peterson
DATE: 6-22-90	DATE: 6-22-90

FOR RESPONSIBILITY CENTER USE ONLY

Contract negotiator is ☐ is not ☐ authorized to exceed amount shown above by up to 10% without securing further approval for funds.

THE AMOUNT OF MONEY SHOWN IS:
☐ AN ORIGINAL COMMITMENT ☐ AN INCREASE TO A PREVIOUS COMMITMENT ☐ A DECREASE TO A PREVIOUS COMMITMENT

FINANCIAL DATA *(See instructions on reverse before filling out)* — APPROPRIATION:

FMO USE														DOCUMENT CONTROL NO.						ACCOUNT NUMBER										OBJECT CLASS				DOLLAR AMOUNT											
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
2									0	4	0			M	H	0	0	4	1	J	J	W	U	I	0	M	0	0	W	2	5	7 0	1 0						3	6	5	0	0	0	0
2									0	4	0																					0	0											0	0
2									0	4	0																					0	0											0	0
2									0	4	0																					0	0											0	0

EPA Form 2550-9 (Rev. 4-74) PREVIOUS EDITION IS OBSOLETE

United States Environmental Protection Agency
Washington, DC 20460

EPA

Interagency Agreement/ Amendment

Part 1 - General Information

1. EPA IAG Identification Number: DW14957002-01-0
2. Other Agency IAG ID Number *(if known)*:
3. Type of Action: New
4. Funding Location by Region: 10
5. Program Office Abbreviation:

6. Name and Address of EPA Organization
Environmental Protection Agency
Water Division
1200 Sixth Avenue
Seattle, Washington 98101

7. Name and Address of Other Agency
U.S. Fish and Wildlife Service
Contracting and General Services
1011 East Tudor Road
Anchorage, Alaska 99503

8. Project Title
Distribution and Abundance of Forage Fish in Relation to Marine Birds and Marine Mammals: Pilot Project and Development of a Beach Survey Database

9. EPA Project Officer (Name, Address, Telephone Number)
Brian Ross, Project Officer
EPA Alaska Operations Office
Room 537, Federal Building
Anchorage, Alaska 99513

10. Other Agency Project Officer (Name, Address, Telephone Number)
David Irons (907) 786-3376
(same as block # 7)

11. Project Period: 6/1/90 - 9/30/91

12. Budget Period: 6/1/90 - 9/30/91

13. Scope of Work (Attach additional sheets, as needed)

Attached.

14. Statutory Authority for Both Transfer of Funds and Project Activities
Economy Act of 1932 as amended; Clean Water Act

15. Other Agency Type: Federal

Funds	Previous Amount	Amount This Action	Amended Total
16. EPA Amount		36,500	
17. EPA In-Kind Amount			
18. Other Agency Amount			
19. Other Agency In-Kind Amount			
20. Total Project Cost		36,500	

21. Fiscal Information

Program Element	FY	Appropriation	Doc. Control No.	Account Number	Object Class	Obligation/Deobligation Amt.
JWUB2D		689/0108	MH0041	JJWU10M00W	25.71	36,500

Part II - Approved Budget		EPA IAG Identification Number DW14957002-01-0
22. Budget Categories	Itemization of This Action	Itemization of Total Project Estimated Cost to Date
(a) Personnel	$ 22,500	$ 22,500
(b) Fringe Benefits		
(c) Travel	1,000	1,000
(d) Equipment		
(e) Supplies	13,000	13,000
(f) Procurement/Assistance		
(g) Construction		
(h) Other		
(i) Total Direct Charges	$ 36,500	$ 36,500
(j) Indirect Costs: Rate % Base $		
(k) Total (EPA Share 100%) (Other Agency Share %)	$ 36,500	$ 36,500

23. Is equipment authorized to be furnished by EPA or leased, purchased, or rented with EPA funds? (Identify all equipment costing $1,000 or more) ☐ Yes ☒ No

24. Are any of these funds being used on extramural agreements? (See item 22f) ☐ Yes ☒ No

Type of Extramural Agreement ☐ Grant ☐ Cooperative Agreement ☐ Procurement (Includes Small Purchase Order)

Contractor/Recipient Name (if known)	Total Extramural Amount Under This Project	Percent Funded by EPA (if known)

Part III - Funding Methods and Billing Instructions

25. ☒ Funds-Out Agreement **(Note: EPA Agency Location Code (ALC) - 68010727)**

☒ Disbursement Agreement

☒ Repayment — Request for repayment of actual costs must be itemized on SF 1081 or SF 1080 and submitted to the Financial Management Center, EPA, Cincinnati, OH 45268:

☐ Monthly ☒ Quarterly ☐ Upon Completion of Work

☐ Advance — Only available for use by Federal agencies on working capital fund or with appropriate justification of need for this type of payment method. Unexpended funds at completion of work will be returned to EPA. Quarterly cost reports will be forwarded to the Financial Management Center, EPA, Cincinnati, OH 45268.

☐ Allocation Transfer-Out — Used to transfer obligational authority or transfer of function between Federal agencies. Must receive prior approval by the Office of the Comptroller, Budget Division, Budget Formulation and Control Branch, EPA Headquarters. Forward appropriate reports to the Financial Reports and Analysis Branch, Financial Management Division, PM-226F, EPA, Washington, DC 20460.

26. ☐ Funds-In Agreement

☐ Reimbursement Agreement ☐ Repayment ☐ Advance

☐ Allocation Transfer-In

Other Agency's IAG Identification Number	EPA Program Office Allowance Holder/Responsibility Center Number
Other Agency's Billing Address *(Include Agency Location Code or Station Symbol Number)*	Other Agency's Billing Instructions and Frequency

Part IV - Acceptance Conditions

EPA IAG Identification Number
DW14957002-01-0

27. General Conditions

The other agency covenants and agrees that it will expeditiously initiate and complete the project for which funds have been awarded under this agreement.

28. Special Conditions *(Attach additional sheets if needed)*

The U.S. Fish and Wildlife Service certifies: 1) that any indirect costs incurred and included in billings to EPA represent, in accordance with GAO principles, costs that would not have been otherwise incurred by the U.S. Fish and Wildlife Service, or 2) that statutory authority exists for charging other than the incremental costs of performance. If an audit determines that any direct or indirect costs charged to EPA are unallowable, EPA will be notified immediately following the resolution of the audit and EPA will be credited for those costs.

Part V - Offer and Acceptance

Note: 1) For Funds-out actions, the agreement/amendment must be signed by the other agency official in duplicate and one original returned to the Grants Administration Division for Headquarters agreements or to the appropriate EPA Regional IAG administration office within 3 calendar weeks after receipt or within any extension of time as may be granted by EPA. The agreement/amendment must be forwarded to the address cited in Item 29 after acceptance signature.

Receipt of a written refusal or failure to return the properly executed document within the prescribed time may result in the withdrawal of the offer by EPA. Any change to the agreement/amendment by the other agency subsequent to the document being signed by the EPA Action Official, which the Action Official determines to materially alter the agreement/amendment, shall void the agreement/amendment.

2) For Funds-in actions, the other agency will initiate the action and forward two original agreements/amendments to the appropriate EPA program office for signature. The agreements/amendments will then be forwarded to the appropriate EPA IAG administration office for acceptance signature on behalf of the EPA. One original copy will be returned to the other agency after acceptance.

EPA IAG Administration Office (for administrative assistance)	EPA Program Office (for technical assistance)
29. Organization/Address Environmental Protection Agency Grants Administration Section 1200 Sixth Avenue, MD-100 Seattle, Washington 98101	30. Organization/Address Environmental Protection Agency Alaska Operations Office Room 537, Federal Building Anchorage, Alaska 99515

Certification

All signers certify that the statements made on this form and all attachments thereto are true, accurate, and complete. Signers acknowledge that any knowingly false or misleading statement may be punishable by fine or imprisonment or both under applicable law.

Decision Official on Behalf of the Environmental Protection Agency Program Office

31. Signature	Typed Name and Title	Date
[signature]	Ronald A. Kreizenbeck Acting Director, Water Division	21 JUN 90

Action Official on Behalf of the Environmental Protection Agency

32. Signature	Typed Name and Title	Date
John H. Gakstatter	Jack Gakstatter, Chief Office of Puget Sound	6/21/90

Authorizing Official on Behalf of the Other Agency

33. Signature	Typed Name and Title	Date
	Paul Gertler NRDA Mgmt Team Representative	

TASK 1

RESTORATION STUDIES - PILOT PROJECT

Title

Pilot Project -- Distribution and abundance of forage fish in relation to marine birds and marine mammals in northeastern Prince William Sound.

Introduction

Many species of marine birds and marine mammals feed mainly on schooling forage fish (e.g., sandlance, capelin, and herring). Populations of some marine bird and marine mammal species in Prince William Sound have decreased during the past 18 years (Dwyer et al. 1975, Klosiewski, pers. comm.). The reasons for these declines are unknown, but may be related to food availability. If the *Exxon Valdez* oil spill negatively affected forage fish populations we might expect an accelerated decline of some marine bird and mammal populations. Marine bird and mammal species require appropriate habitat and food to maintain stable populations. If restoration studies repair or replace habitat damaged by oil, but sufficient food does not exist, then there will be no restoration of the target species.

Objective

I. Determine distribution and relative abundance of forage fish in relation to foraging and non-foraging marine birds and mammals.

Methods

This pilot study would be conducted in conjunction with an existing non-oil spill study being done in the northeastern portion of the Sound. Major equipment items such as boats could be shared with the ongoing study, thereby decreasing costs. The work would be concentrated in the area between Bligh Island and Glacier Island and would stress testing techniques that would be used in a fully funded study.

The objective of the study would be met using the following procedures. First, the precise area to be studied would be defined, within this area 20 to 30 random transects 1 KM in length would be chosen. These transects would be surveyed from 28 June to 15 August twice a day, every other day to determine the temporal and spatial variation of forage fish, marine birds, and marine mammals. Presence, behavior (i.e., foraging, flying, or resting), and exact location of marine birds and marine mammals would be recorded for a width of 200 meters along the transects. Presence of fish would be recorded with a chart recording fathometer. Species of forage fish in the area would be determined by collecting birds foraging on the fish and through the use of gill nets. Birds will be collected with a shot gun using # 4 steel shot. Stomachs will be removed immediately and will be preserved in alcohol. Dates, start and end times, local weather and sea conditions will be recorded for each transect. Exact locations of transects will be determined with the use of a LORAN and nautical charts. The degree of the temporal and spatial variability found in the pilot study would help determine the appropriate sample size and timing of surveys for a large scale study.

The EPA person associated with this project is Brian Ross, OIL Spill Restoration Team, (907-271-2461). The USFWS personnel are Paul Gertler, Deputy Assistant Regional Director for Oil Spill (907-786-3579), Kent Wohl, Project Leader, Marine and Coastal Birds (907-786-3503), David Irons, Wildlife Biologist, Project Leader (907-786-3376), Mary Beth Decker, Biological Technician, Camp Leader (907-786-3443).

All data will be stored at the USFWS Anchorage office in the Migratory Birds division. David Irons (907-786-3376) may be contacted in order to retrieve the data.

Schedule: Complete report on the success of the pilot project by Sept. 30,1990

Task 2

ASSESSMENT OF BEACH SEGMENT SURVEY DATA FOR RESTORATION

INTRODUCTION/JUSTIFICATION:

There is a large collection of beach survey information obtained via the fall and spring surveys (walk-a-thon and S.A.T.). More is expected to be added when the 1990 fall survey is completed. These data are expected to complement the information obtained from ongoing studies by adding to the land and habitat database. This study will assist in further identifying restoration project sites, particularly in identification of potential acquisition of equivalent resources. Additionally, it should prove valuable in providing further information for analytical purposes in the development of the restoration planning matrix.

Subtasks:

A. Under guidance from the restoration planning workgroup and technical advisors obtain and translate to maps, pertinent beach survey information that is not currently available in hard copy.

B. Analyze possible trends in information for applicability to feasibility studies.

C. Create a data bank, via G.I.S. and d-base, for future reference use in restoration projects.

METHODS AND ANALYSES:

Research and map, using standard cartographic and G.I.S. techniques, all available information from the fall 1989, spring 1990 and fall 1990 walk-a-thon and S.A.T. surveys. Combined with other ongoing studies, this will provide further support in the selection process for specific restoration sites and habitats. It may also prove advantageous for documenting natural recovery processes that may be occurring.

SCHEDULE: Complete report on the success of the creation of the databank by Sept. 30, 1990

1990 Sandy

Brian

RPWG L

RESTORATION PILOT PROJECT REPORT: DRAFT 1

Distribution and abundance of forage fish in relation to foraging birds in Prince William Sound.

Mary Beth Decker and David B. Irons

Abstract

We examined the spatial and temporal variation & the distribution and abundance of fish relative to foraging marine birds in Prince William Sound, Alaska by conducting simultaneous surveys of schooling fish and foraging seabirds. We used inexpensive hydroacoustics to record abundance of fish. We did not find a correlation between the number of foraging birds and the total water column (8-200 ft.) fish abundance. However, we did find a correlation between birds and fish abundance restricted to the upper water column (8-50 ft.). The number of birds present was inversely correlated with fish depth. Both number of birds and fish abundance in the upper water column were greater on nearshore transects than on offshore transects. Mean fish abundance was different in each location; however, the number of foraging birds in each location did not differ significantly. Differences were not detected in number of foraging birds or fish abundance during flowing versus slack tides. The number of birds and fish abundance did not vary with respect to season. Sample sizes may not have been large enough to measure differences in foraging activity and fish abundance with respect to many of these variables. Fish depth is an important factor in availability of prey to foraging birds in

Prince William Sound. These results will assist in determining appropriate methods and sample sizes that would be used in a full scale study.

Introduction

Many species of marine birds and mammals in Prince William Sound feed primarily on schooling forage fish (e.g. Pacific sand lance, Pacific herring, capelin and walleye pollock). Populations of some marine bird and marine mammal species in Prince William Sound have decreased during the past 18 years (Dwyer et al. 1975, Klosiewski, pers. comm.) In 1990, Black-legged Kittiwakes produced fewer chicks than in past years (Irons, unpub. data) and Pigeon Guillemots had low reproductive success and the lowest growth rates ever recorded (Kuletz, unpub. data). The reasons for these declines are unknown, but may be related to prey availability. Marine birds and mammals require appropriate habitat and prey availability in order to maintain stable populations. If the Exxon Valdez oil spill adversely affected forage fish populations, we might expect an accelerated decline of some marine bird and mammal populations.

The main objectives of this pilot project were to examine spatial and temporal variation in the distribution and relative abundance ~~and~~ of forage fish, foraging birds and marine mammals. In addition to this, we also tested methods that could be used in a full scale study of prey availability in Prince William Sound.

We hypothesized that the availability of fish prey should be higher in nearshore habitats than in offshore habitats since much of the foraging activity of marine birds in Prince William Sound has been observed within 1 km from shore (Irons, Kuletz, unpub. data). We also hypothesized that prey availability in certain locations may be greater than in others based on observations of radio-tagged Black-legged Kittiwakes flying through Valdez Arm to get to foraging grounds in Tatitlek Narrows and Glacier Island (Irons, unpub. data) In addition, we hypothesized that tidal processes may affect distribution and abundance of marine birds and their prey. North~~west~~eastern Prince William Sound consists of a series of fjords and passes with very irregular bottom topographies. Tides, with ranges of up to 6 m in Prince William Sound, provide a significant source of energy in such a system (Muench and Schmidt 1975). Aggregations of zooplankton have been found where strong tidal currents interact with steep underwater topography (Brown et al. 1979). Areas with tidally generated flow gradients have been shown to be important foraging sites for marine birds (Vermeer et al. 1987, Brown and Gaskin 1988). We predicted that similar events could occur in our study site. Finally, we hypothesized that prey availability would vary throughout the season. Pacific herring migrate into deeper water during the fall (Hourston 1958) becoming less available to marine birds.

Methods

Our study was conducted in the northeastern portion of Prince William Sound from 28 June to 16 August 1990. Transects were established in three locations; Valdez Arm, Glacier Island and Tatitlek Narrows (Fig. 1). For the entire coastline within each of the three locations, transects were set up perpendicular to the coast and were each separated by 200 meters. Two types of transects were surveyed: nearshore (0-500 m from shore) and offshore (1000-1500 m from shore). Eight randomly chosen transects were surveyed in one of the three locations per day. Four of these transects were surveyed during flowing tides (2 nearshore, 2 offshore) and the other four (2 nearshore, 2 offshore) were surveyed during a slack water period (+/- 30 min around high or low tide). We defined three seasons; early (28 June to 22 July), mid (26 July to 4 Aug) and late (5 Aug to 16 Aug). Each location was sampled twice during each season. Our sampling regime was based on a three-way analysis of variance design using distance from shore, tide and season as factors, blocked by location.

The transects were surveyed in a 7.6 meter Boston Whaler at a speed of 3 naut. mi./hr. The boat was equipped with a Sitex-Honda chart recording fathometer for measuring fish distributions and abundance (model HE 32, 200 kHz) and LORAN-C for locating transects. Before starting each survey, the date, time, sea state, sea surface temperature, weather conditions, visibility, wind speed and direction were recorded.

Presence, behavior, exact location and time of observation of marine birds and mammals were recorded for a width of 200 meters along each transect. All bird behaviors associated with foraging (plunge diving, surface feeding, sitting on the water, flying in a circular pattern over an area) were combined for these analyses. All marine mammals were recorded but their distributions in relation to prey abundance have not been analyzed yet and will be included in a subsequent draft.

The hydroacoustic surveys recorded fish schools in the upper 200 feet of the water column. Due to acoustical noise in the surface layer, the upper 8 feet was excluded from the analysis. Fish abundance per transect was determined by overlaying the fathometer output with a transparent 6.5 mm square grid (Fig. 2). The registrations in each square were visually graded on a scale of 0-9 (e.g., Safina and Burger 1985, Piatt in press). Each square represents to 40 meters in length along the transect and 4.25 meters in depth. Mean fish abundance per transect was calculated by dividing the sum of the abundance grades by the total number of graded squares in the transect (Piatt in press). The vertical position of the school on the chart corresponds to a location in the water column, thus allowing for calculation of median school depth for each transect. Due to fathometer gain-setting error, we have no early season fish abundance data; however we do have foraging bird data for this period.

In addition to the data collected on our randomly chosen transects, observations of active foraging flocks in our sampling area were made opportunistically. Every time a foraging flock was encountered, we recorded the exact location of the flock, number and species composition and behaviors of marine birds and mammals. We also documented distribution and abundance of schooling fish below the flock with the chart recording fathometer. When possible, Black-legged Kittiwakes and schooling fish were collected from active feeding flocks to determine the species of prey fish in our study area.

Preliminary results

We have not yet completed the analysis of the data; however, for the purpose of this preliminary report, we will present simple linear regressions and graphical comparisons of foraging bird and fish data. We have used Kruskal-Wallis to test for differences in presence of birds or fish in nearshore and offshore transects, during slack and flowing tides, between locations, and between seasons. This analysis does not account for interactions between variables and it should be used only for preliminary investigation of patterns in the data.

The number of foraging birds was not correlated with fish abundance in the whole water column (Fig. 3, SYSTAT Linear regression $r = 0$, $P < .88$). The number of foraging birds was correlated with fish abundance when abundance was calculated for only upper water column (8-50 feet) (Fig. 5, SYSTAT Linear regression, $r = .066$, $P < .02$). A comparison of the number of foraging birds observed per transect and median depth of fish schools showed a inverse relationship between foraging activity and fish depth (Fig. 4, SYSTAT Linear regression $r = -.178$, $P < .02$). When fish are present on a transect, the abundance of fish in the upper water column is correlated with the number of foraging birds observed (Fig. 6, SYSTAT Linear regression r =.202, P<.01).

The mean number of foraging birds was greater on nearshore transects than on offshore transects (Fig. 7, SYSTAT Kruskal-Wallis =1266.0, P=0). Mean fish abundance in the total water column was not different on nearshore and offshore transects (Fig. 8, SYSTAT Kruskal-Wallis=1006.5, P<.12); however, mean fish abundance in the upper water column was greater on nearshore transects than on offshore transects (Fig. 9, SYSTAT Kruskal-Wallis=1006.0, P<.05). Differences were not detected in the presence of foraging birds or fish abundance during flowing versus slack tides (Figs. 10, 11 and 12). The mean number of foraging birds was not different in each of the three locations surveyed (Fig. 13, Kruskal-Wallis=.43, P<.8). Mean fish abundance was different in each location with transects around Glacier Island having the greatest abundance (Fig. 14, Kruskal-Wallis=8.39, P<.015); however mean fish abundance for only the upper water column was not different in the three locations we surveyed (Fig. 15). The apparent differences in fish abundance between Glacier Island and Tatitlek Narrows decrease when analysis is restricted to the upper water column alone. Fish abundance throughout the study area did not vary significantly between the mid and late season (Figs. 16 and 17, Kruskal-Wallis, P<.36 and P<.37) for either the whole or upper water column. There was no difference in the mean number of foraging birds between seasons (Fig. 18, Kruskal-Wallis=2.03, P<.36).

Our opportunistic observations of active foraging flocks in our study area but not recorded on our randomly chosen transects demonstrated that more foraging flocks formed per day in Tatitlek Narrows than in Valdez Arm or Glacier Island (Fig. 19). The number of birds in a foraging flock was not significantly correlated with the median depth of the school (Fig. 20, $r = .113$, $P < .14$); however, 71% of the foraging flocks were found associated with fish schools having a median depth less than 20 feet. All foraging flocks were found within 600 meters from shore.

In the foraging flocks sampled, Black-legged Kittiwakes fed on primarily Pacific herring and Pacific sand lance approximately 80-120 mm in length. Analysis of stomach contents is currently in progress.

Preliminary conclusions

In this study, we found a significant correlation between foraging marine birds and fish abundance in the upper water column (< 50 ft.); however, there was no correlation when fish abundance to 200 ft. was considered. Our data suggests that the depth of the fish school is an important factor related to the availability of prey to surface feeding and diving birds in Prince William Sound. It is likely that fish nearer the surface are easier for the birds to detect. This is also supported by the differences in bird abundance on nearshore and offshore transects. Although we did not find a difference in total water column fish abundance between near and offshore areas, nearshore transects had relatively more fish in the upper 50 feet than offshore transects. This implies that the prey are more available to marine birds in nearshore waters.

Tidal processes do not appear to influence large scale foraging activity and fish abundance. Tidally generated prey aggregations and foraging behavior are very site specific (Vermeer et al. 1987, Decker unpub. data from Prince William Sound) and may be difficult to detect in a randomized sampling design.

Glacier Island had the highest mean abundance of fish, but much of the fish in this location were found below 50 feet. Glacier Island and Tatitlek Narrows have similar measures of fish abundance in the upper water column.

We did not observe large foraging aggregations on our randomly chosen transects; however, while we were surveying in Tatitlek Narrows, we encountered numerous foraging flocks. Flocks in our study site were generally ephemeral, usually numbering fewer than 100 individuals and lasting sometimes for only a few minutes. The fact that we did not observe these small scale aggregations on our surveys suggests that our transect design was inadequate or that our sample sizes were too small.

This small scale pilot study revealed many interesting patterns in the relative distribution and abundance of marine birds and their prey. These data are needed to design a full scale project to investigate prey availability for marine birds and mammals. In order to address the long term impacts of events such as a major oil spill, we need to understand the processes that affect prey availability of marine bird and mammal populations. Continuing more extensive surveys of prey distributions around breeding colonies would provide more base line data necessary for monitoring the distribution, availability and restoration of prey in Prince William Sound. Employing more sophisticated equipment for measuring prey abundance (ie. BIOSONICS) capable of distinguishing more precisely between target sizes will help to estimate what percentage of the biomass in the water column can be utilized by seabirds. The information gathered from this type of study could be used in conjunction with what is known about energetic requirements of populations of predators feeding on schooling fish to determine what resources are needed to sustain or recover populations of marine birds and mammals in Prince William Sound.

Figure Legends

Fig. 1 Study area in northwestern Prince William Sound, Alaska.

Fig. 2 Fathometer output with transparent grid.

Fig. 3 Relationship between log of foraging birds and log of fish abundance per transect.

Fig. 4 Relationship between log of foraging birds and median depth of school.

Fig. 5 Relationship between log of foraging birds and log of fish abundance in upper water column.

Fig. 6 Relationship between log of foraging birds and log of fish abundance in upper water column for transects that had fish present.

Fig. 7 Mean number of foraging birds on nearshore and offshore transects.

Fig. 8 Mean fish abundance on nearshore and offshore transects.

Fig. 9 Mean fish abundance in upper water column on nearshore and offshore transects.

Fig. 10 Mean number of foraging birds during slack and flowing tides.

Fig. 11 Mean fish abundance during slack and flowing tides.

Fig. 12 Mean fish abundance in upper water column during slack and flowing tides.

Fig. 13 Mean number of foraging birds on transects in Valdez Arm, Glacier Island and Tatitlek Narrows.

Fig. 14 Mean fish abundance on transects in Valdez Arm, Glacier Island and Tatitlek Narrows.

Literature cited

Brown, R. G. B., and D. E. Gaskin. 1988. The pelagic ecology of the Grey and Red-necked Phalaropes *Phalaropus fulicarius* and *P. lobatus* in the Bay of Funday, eastern Canada. Ibis 130:234-250.

Dwyer, T. J., P. Islieb, D. A. Davenport, L. J. Haddock. 1975. Marine bird populations in Prince William Sound, Alaska. Unpublished USFWS Report. Anchorage, Alaska.

Hourston, A. S. 1958. Population studies on juvenile herring in Barkley Sound, British Columbia. J. Fish. Res. Bd. Canada 15(5): 909-960.

Muench, R. D., and C. M. Schmidt. 1975. Variations in the hydrographic structure of Prince William Sound. IMS Report R75-1.

Piatt, J. F. In Press. The aggregative response of Common Murres and Atlantic Puffins to schools of capelin. Studies in Avian Biology. No. 14.

Safina, C. and J. Burger. 1985. Use of sonar and a small boat for studying foraging ecology of seabirds. Colonial Waterbirds 11(2): 234-244.

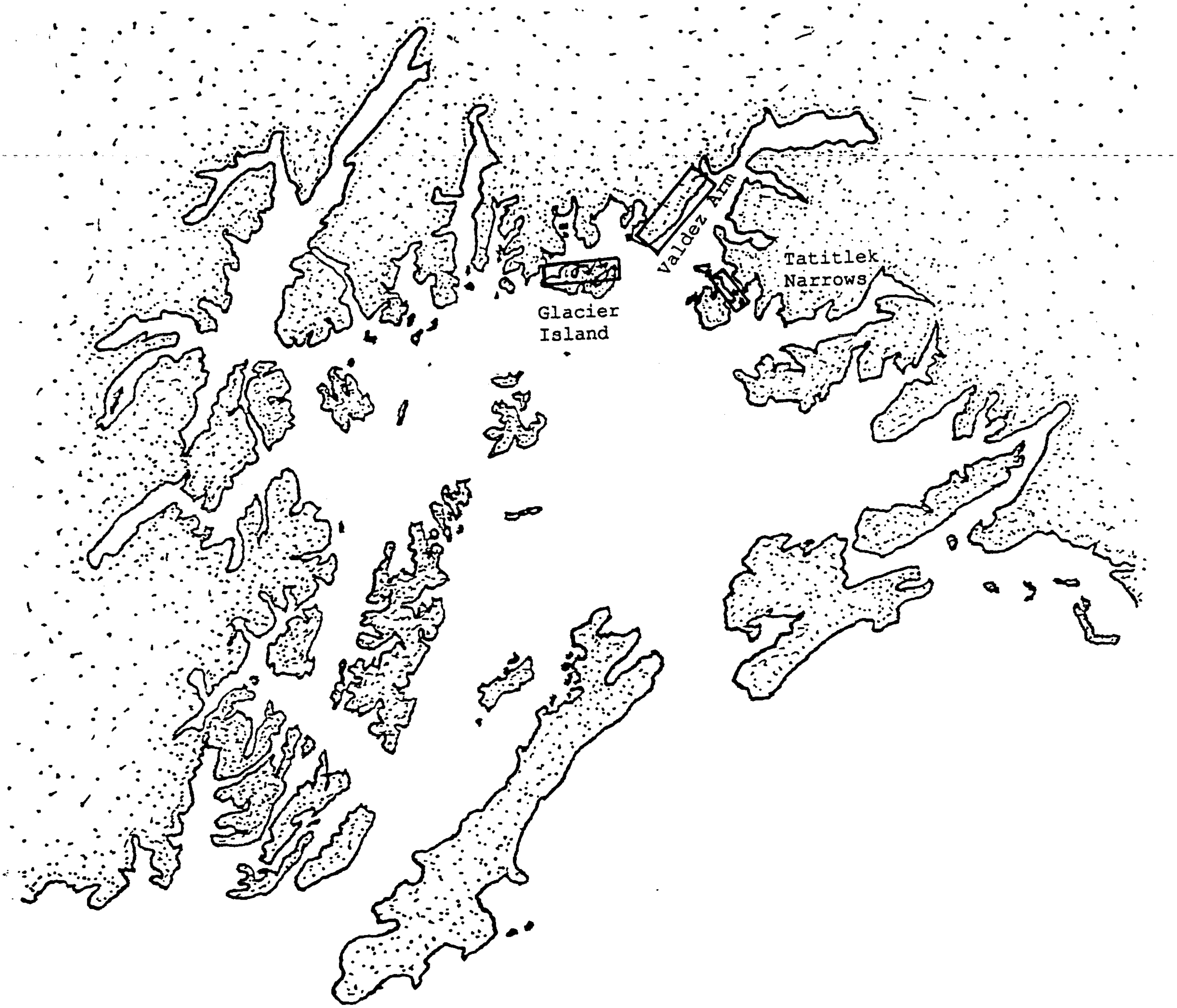

Fig. 1 Study area in northeastern Prince William Sound, Alaska.

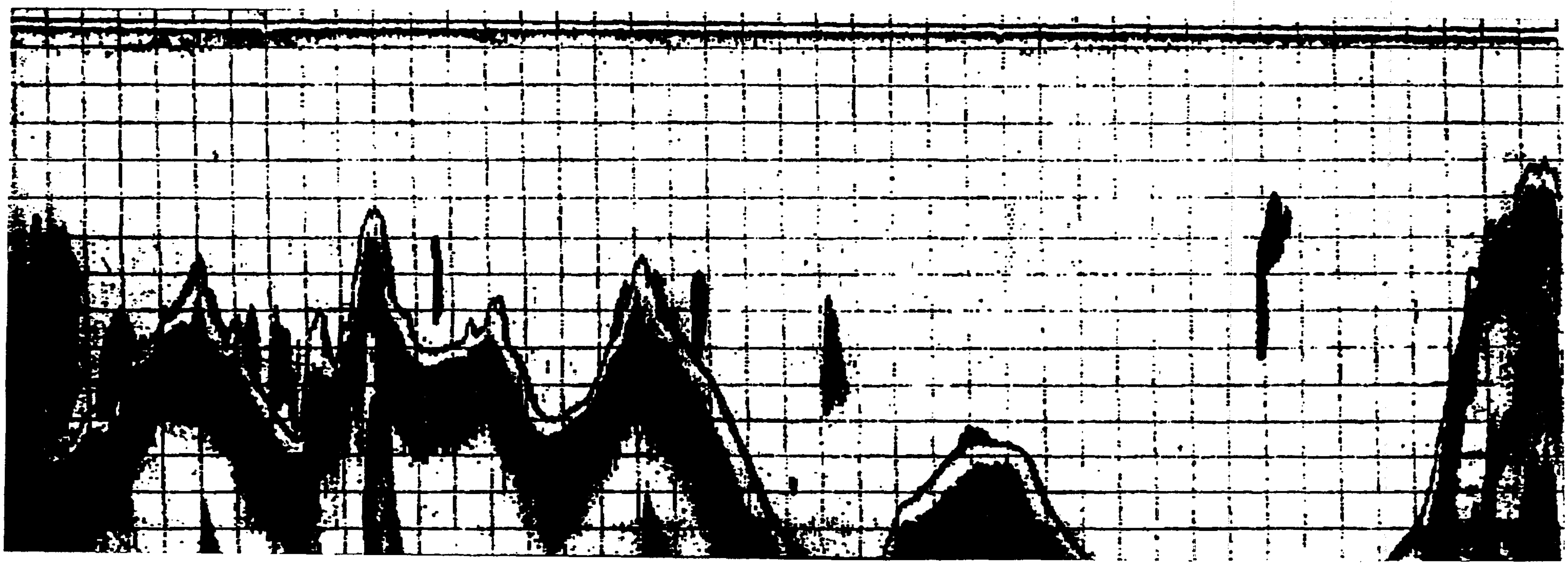

Fig. 2 Fathometer output with transparent grid.

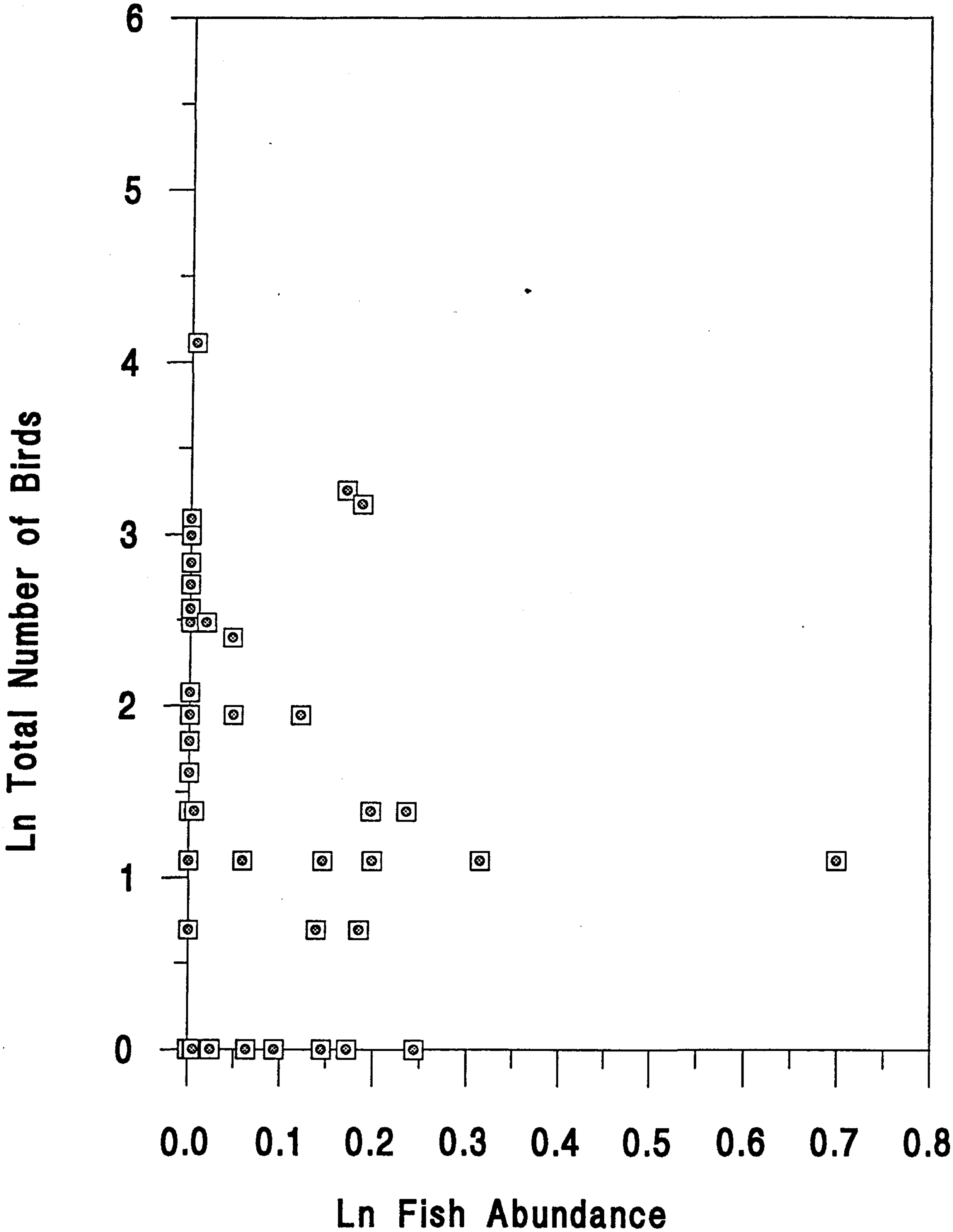

Fig. 3 Relationship between log of foraging birds and log of fish abundance per transect.

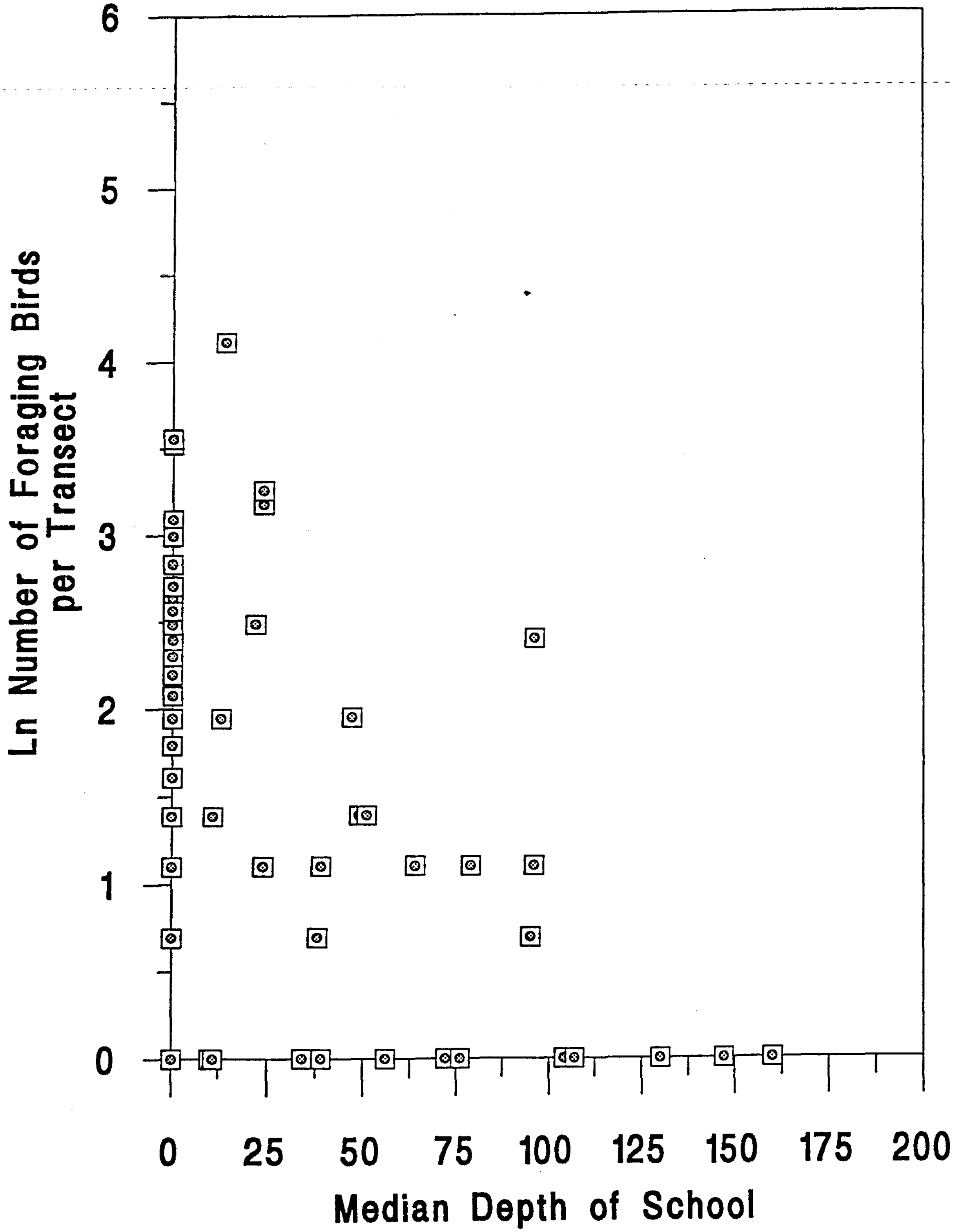

Fig. 4 Relationship between log of foraging birds and median depth of school.

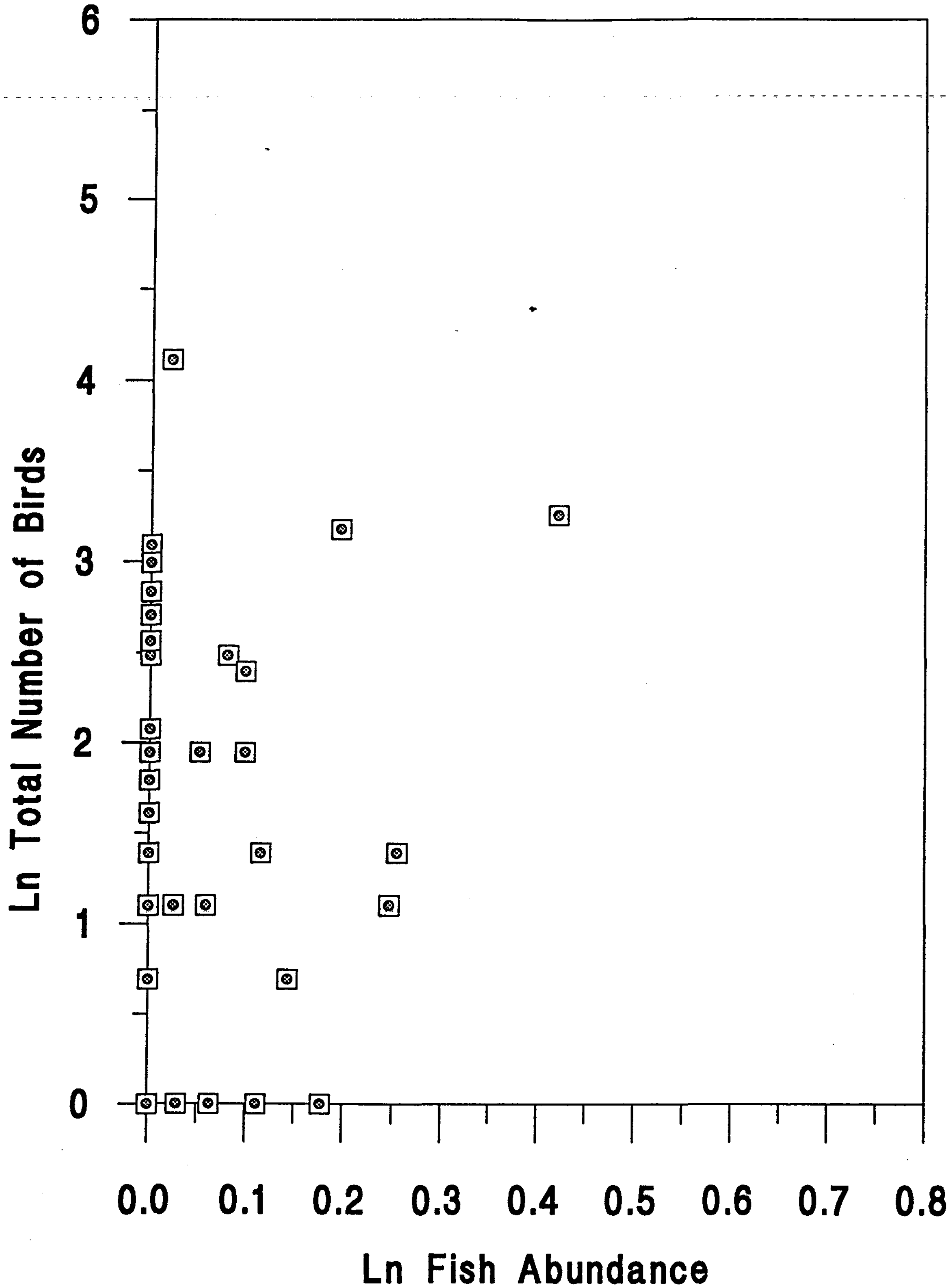

Fig. 5 Relationship between log of foraging birds and log of fish abundance per transect in upper water column (< 50 ft.).

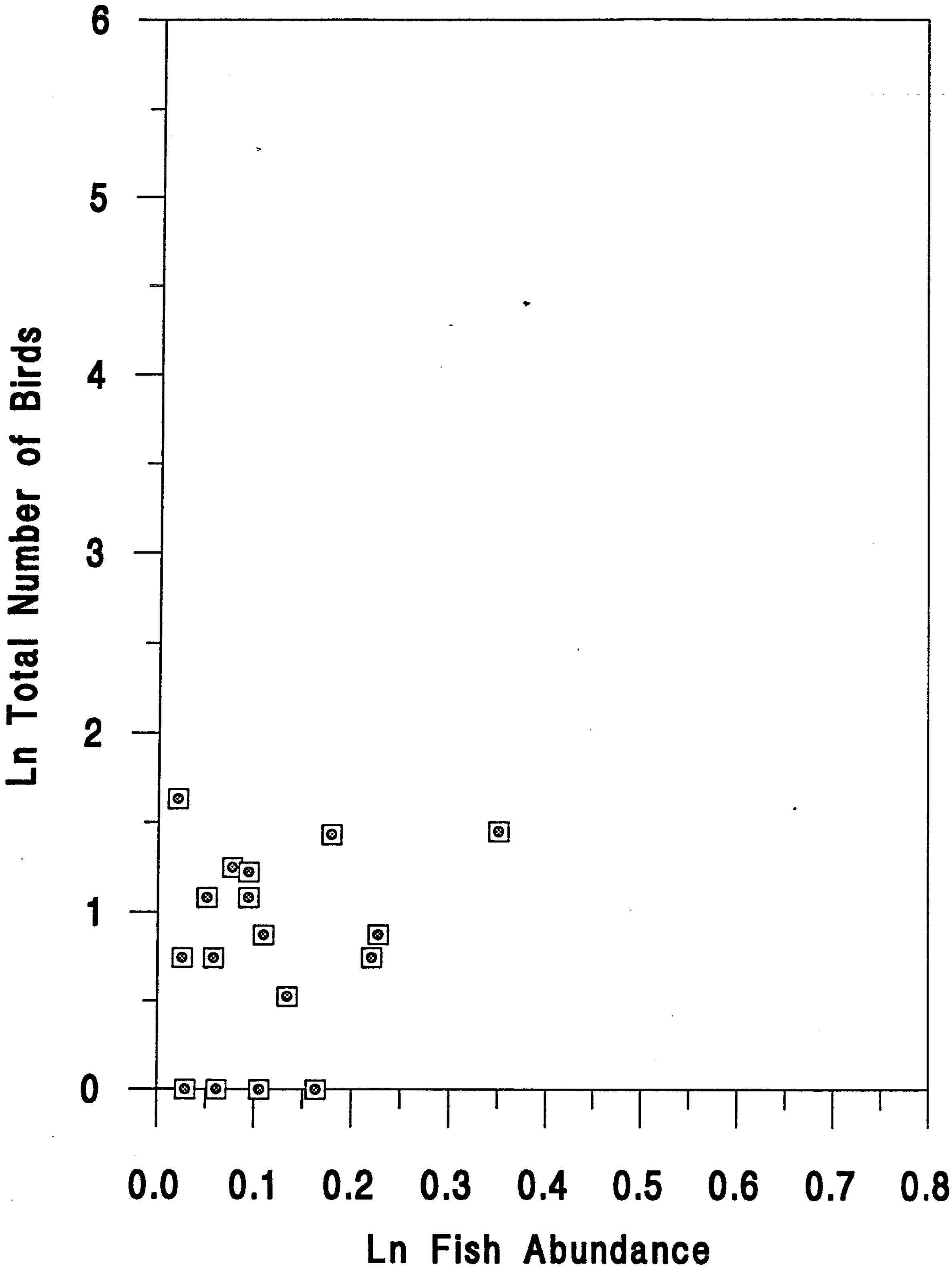

Fig. 6 Relationship between log of foraging birds and log of fish abundance in upper water column (< 50 ft.) for transects that had fish present.

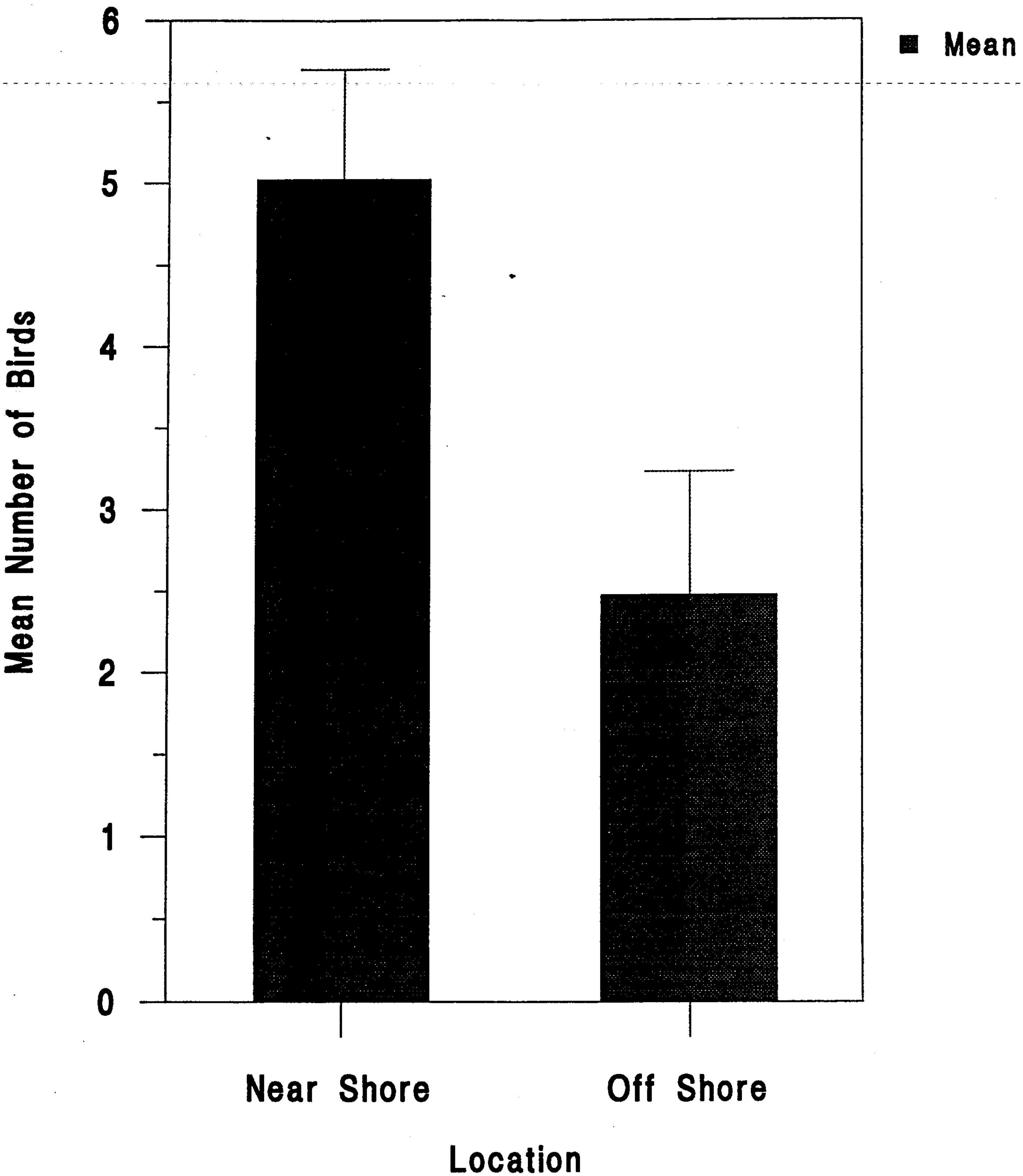

Fig. 7 Mean number of foraging birds on nearshore and offshore transects.

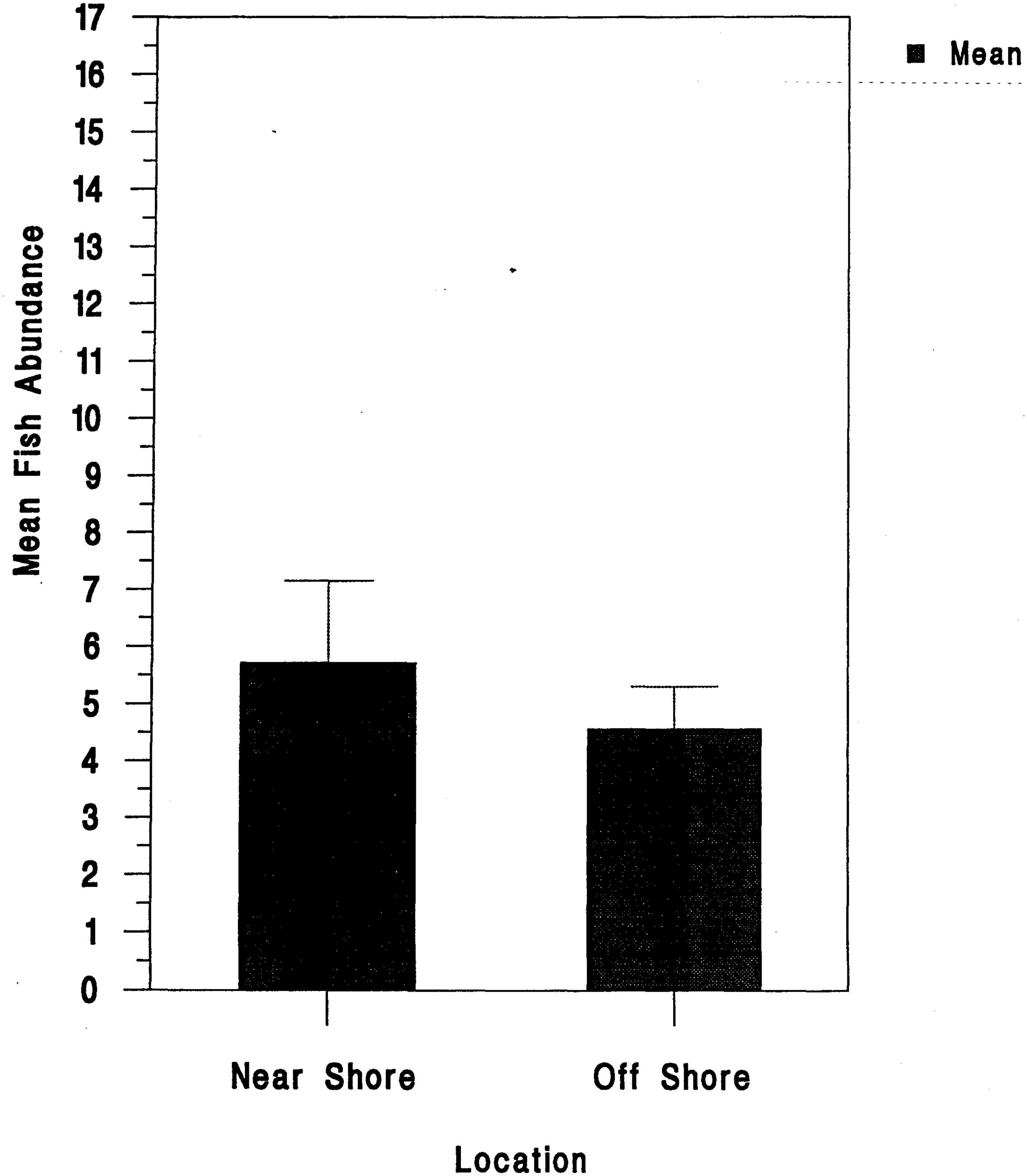

Fig. 8 Mean fish abundance on nearshore and offshore transects.

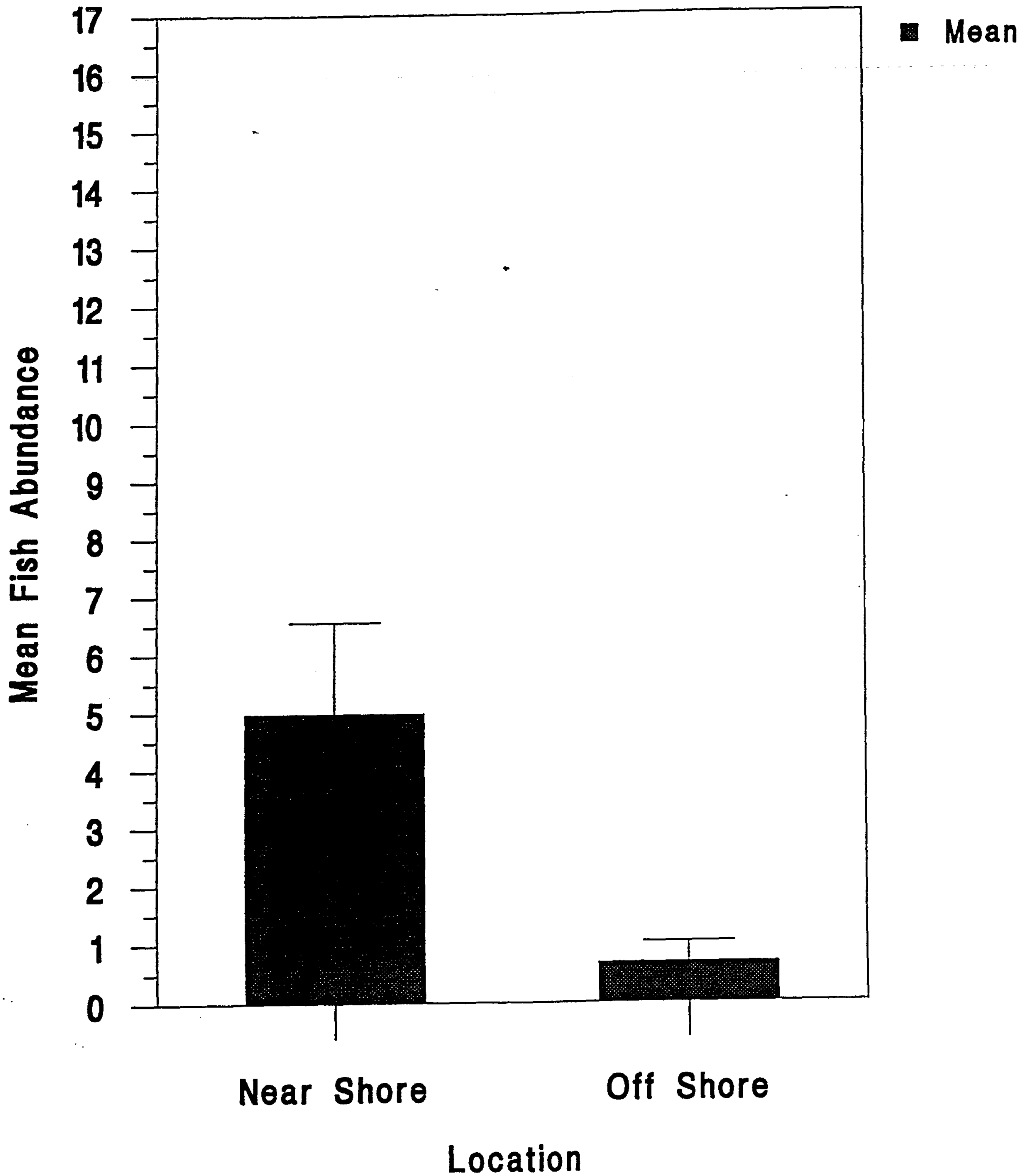

Fig. 9 Mean fish abundance in upper water column (< 50 ft.) on nearshore and offshore transects.

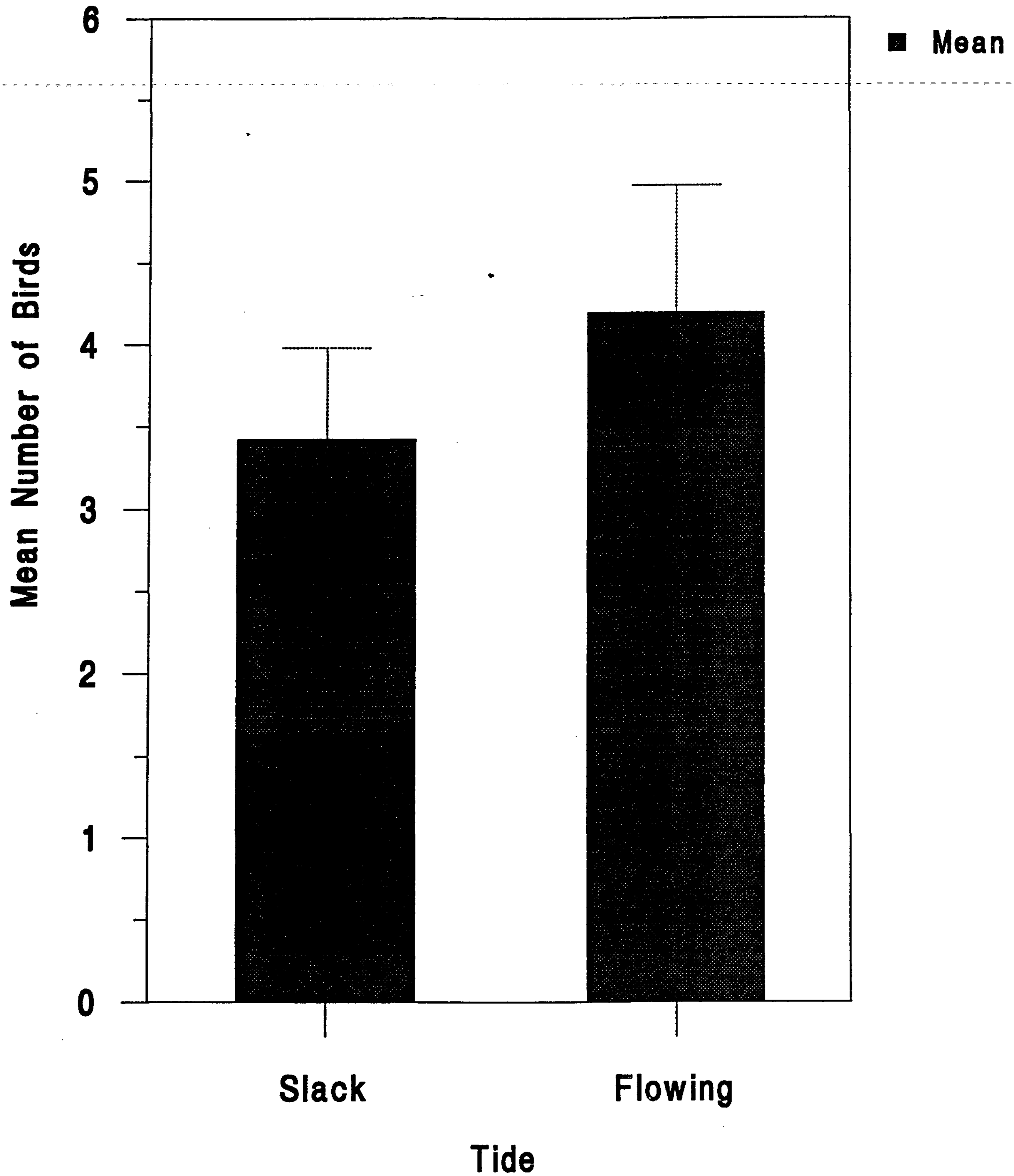

Fig. 10 Mean number of foraging birds during slack and flowing tides.

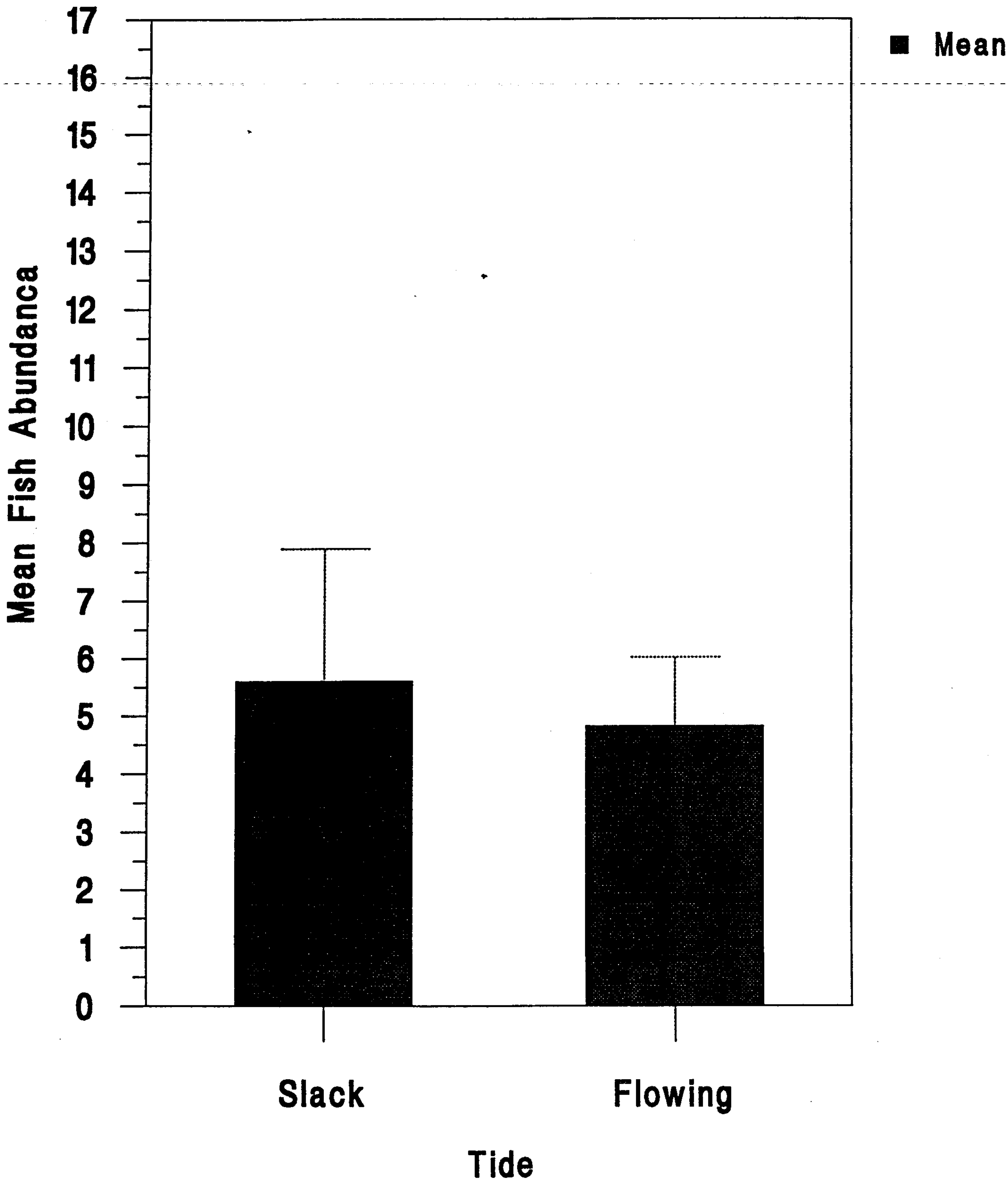

Fig. 11 Mean fish abundance during slack and flowing tides.

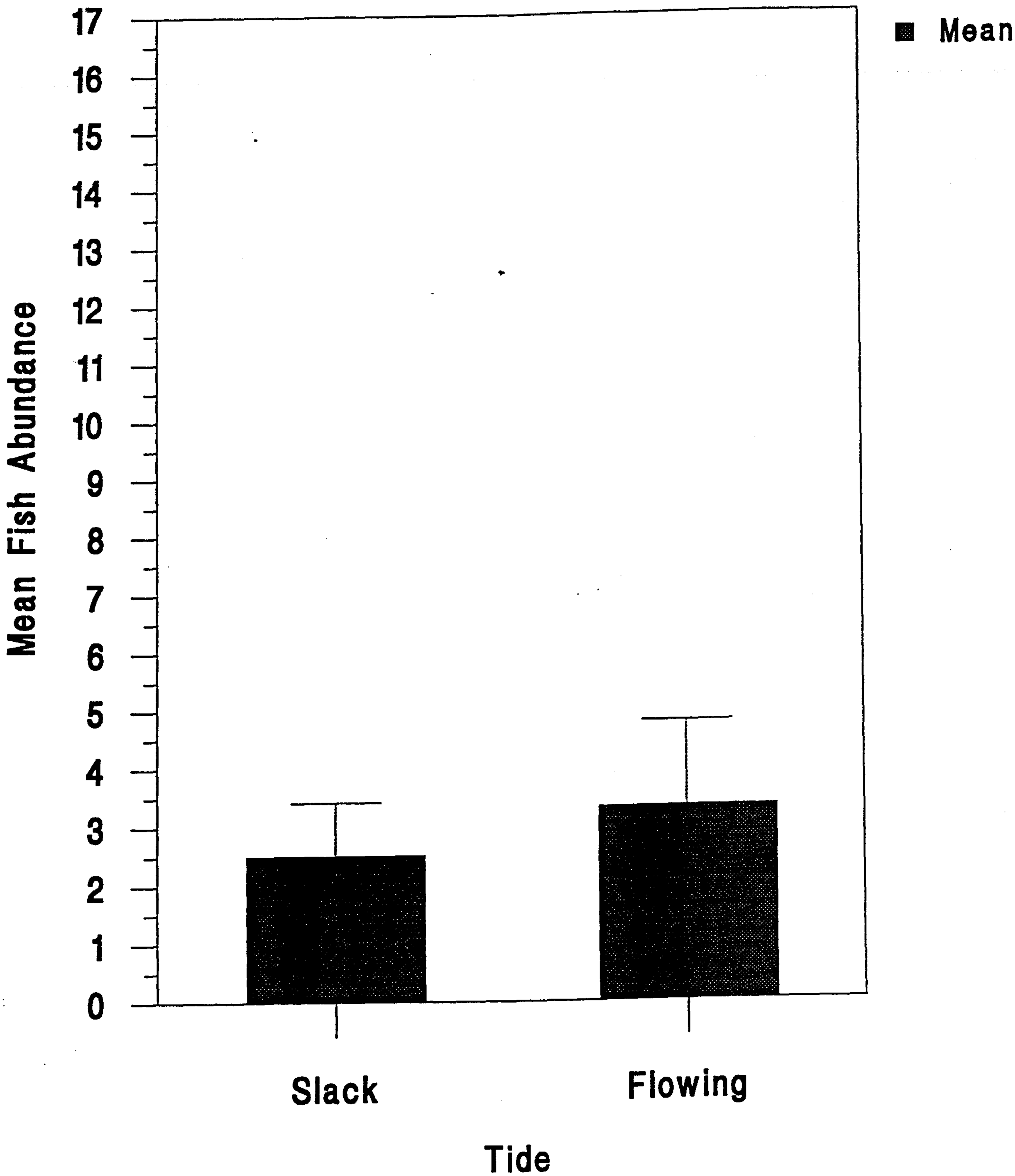

Fig. 12 Mean fish abundance in upper water column (< 50 ft.) during slack and flowing tides.

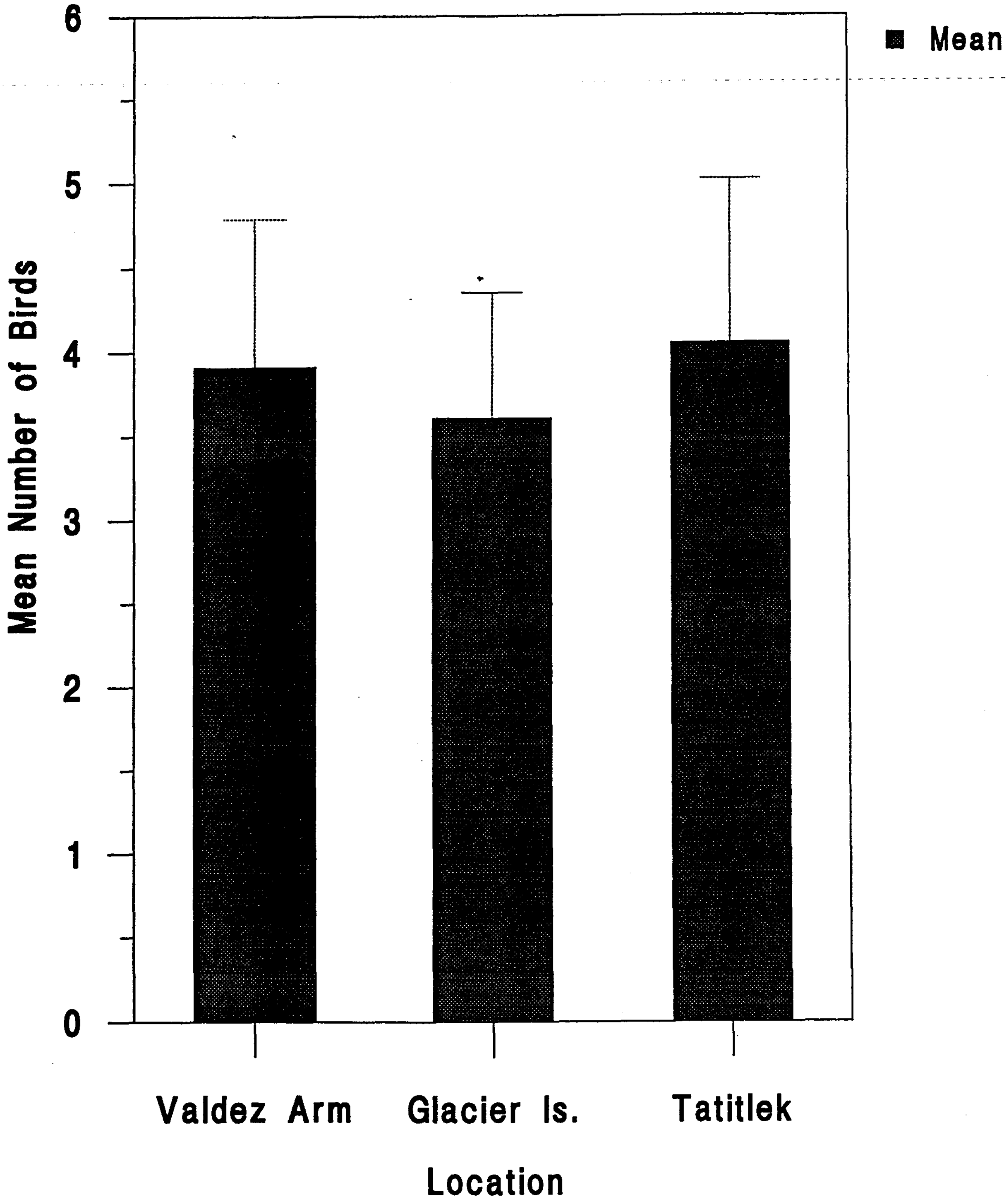

Fig. 13 Mean number of foraging birds on transects in Valdez Arm, Glacier Island, and Tatitlek Narrows.

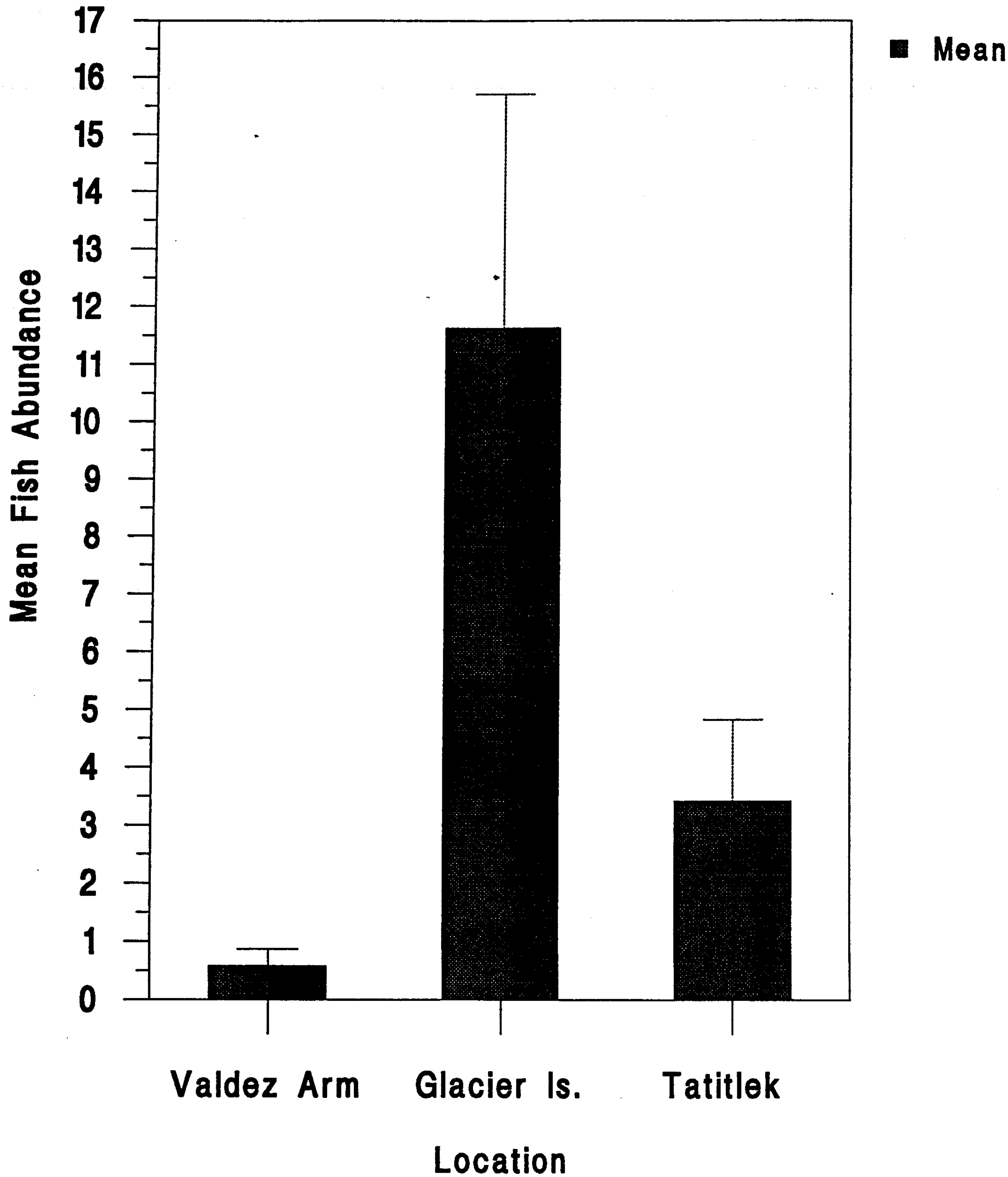

Fig. 14 Mean fish abundance on transects in Valdez Arm, Glacier Island, and Tatitlek Narrows.

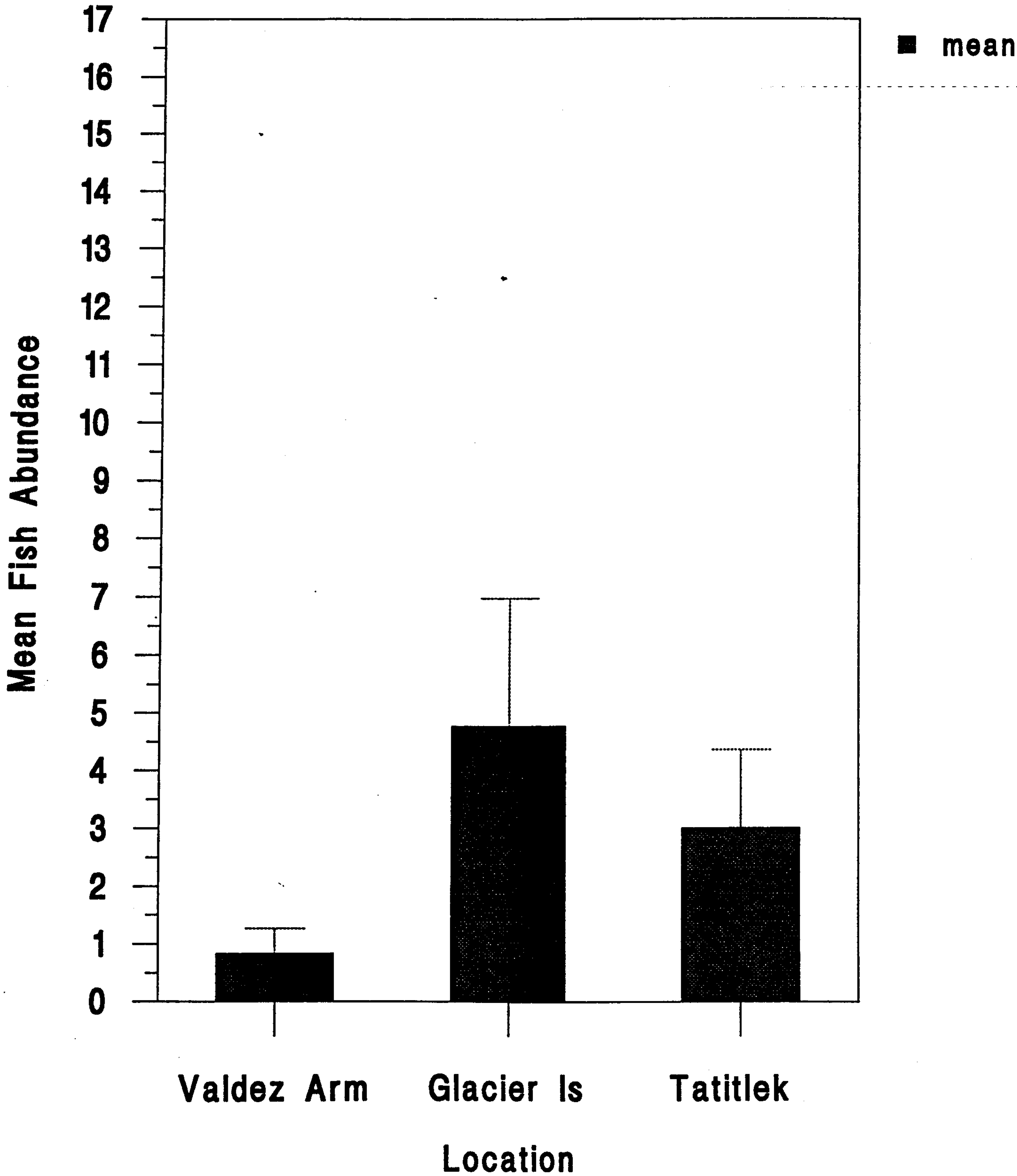

Fig. 15 Mean fish abundance in upper water column (< 50 ft.) on transects in Valdez Arm, Glacier Island, and Tatitlek Narrows.

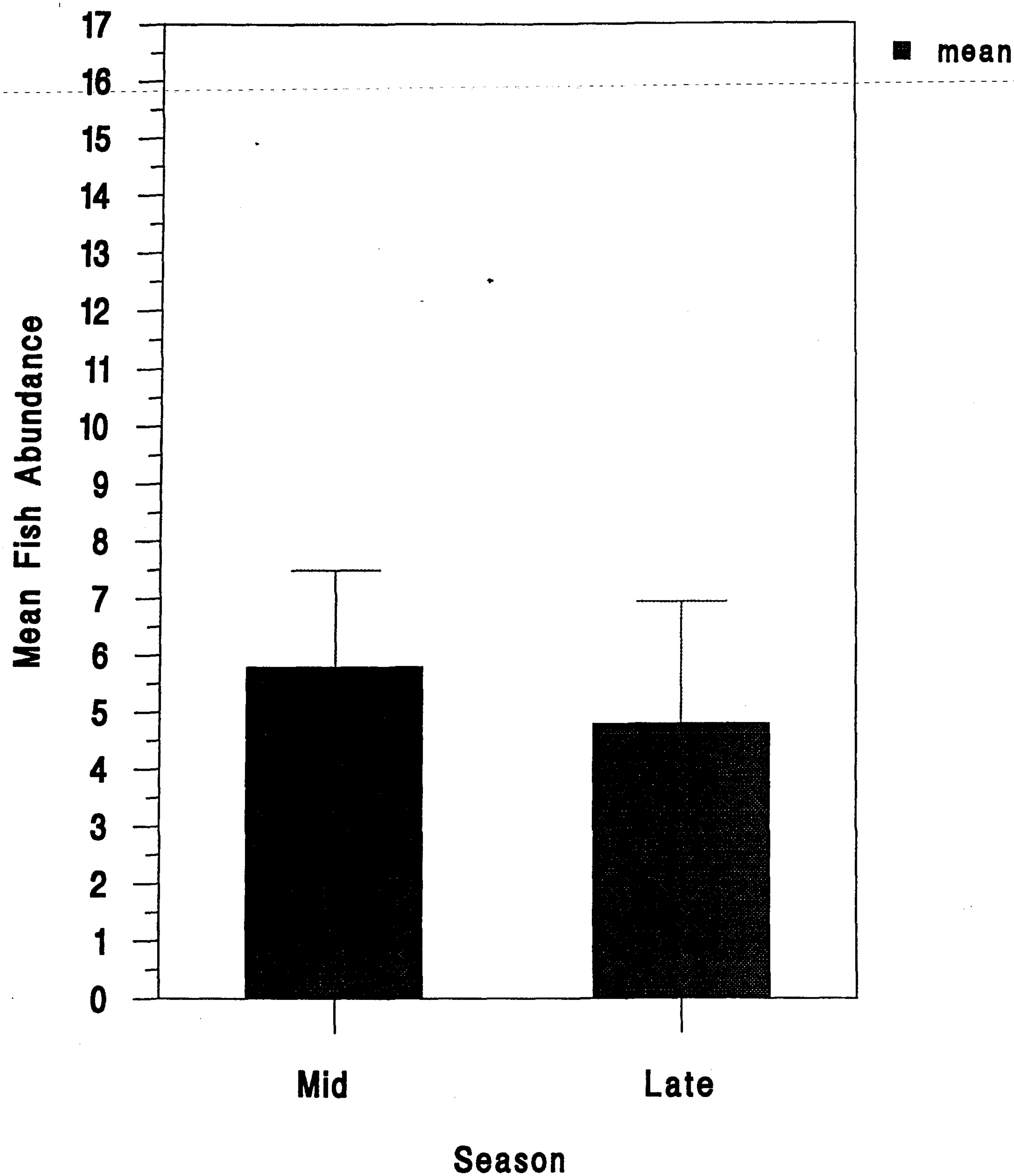

Fig. 16 Mean fish abundance during mid and late seasons.

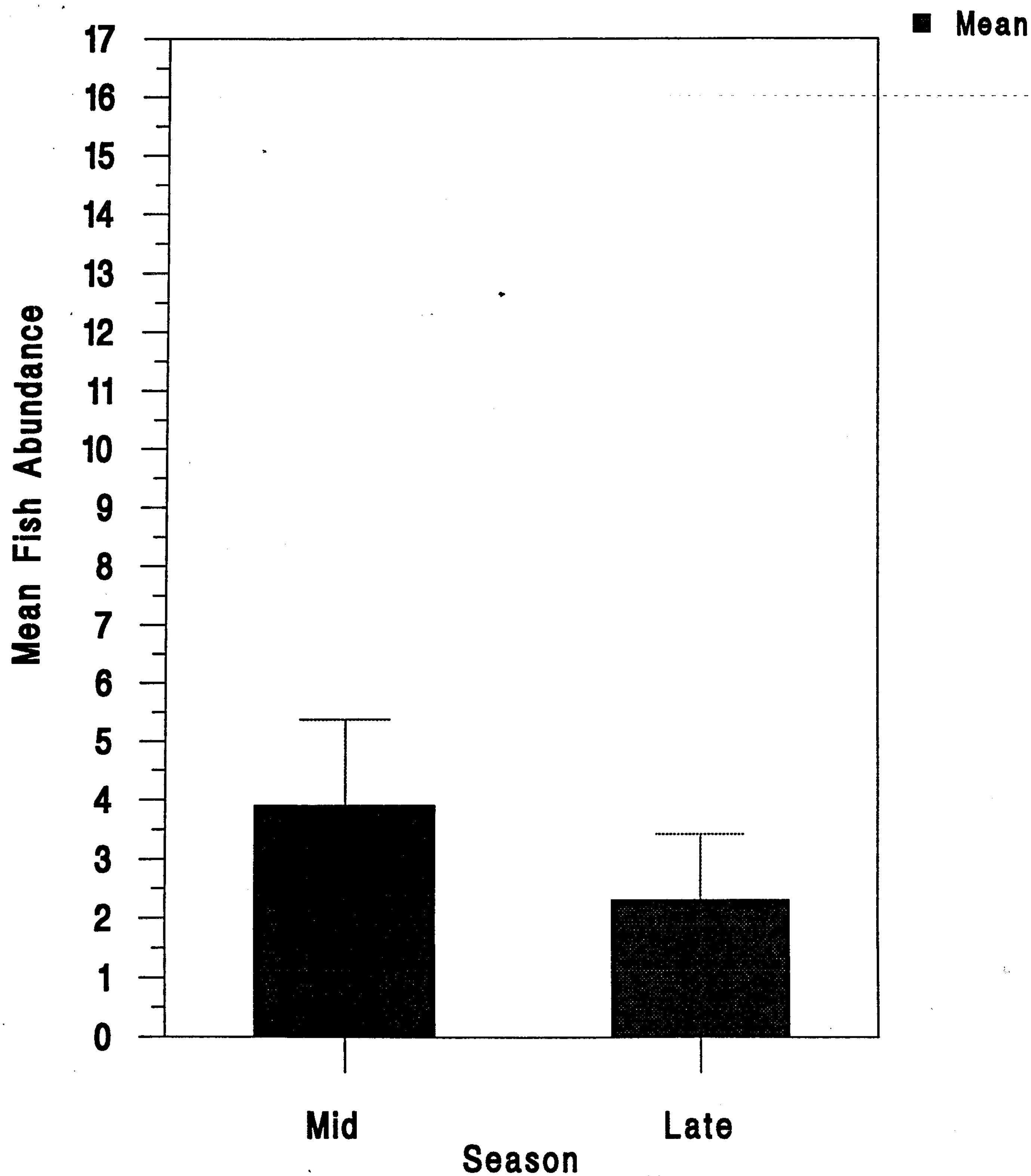

Fig. 17 Mean fish abundance in upper water column (< 50 ft.) during mid and late season.

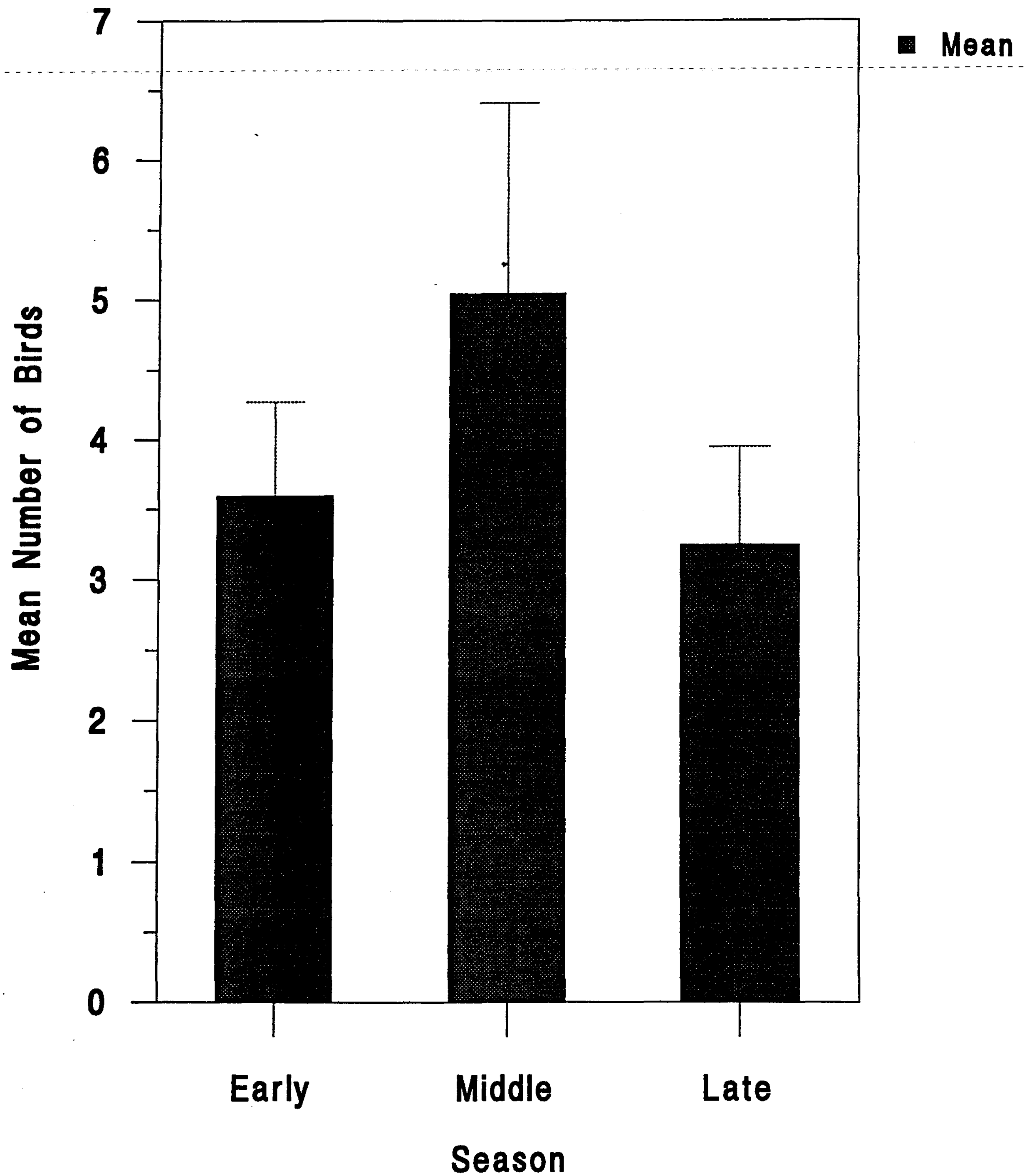

Fig. 18 Mean number of birds per transect during early, mid and late seasons.

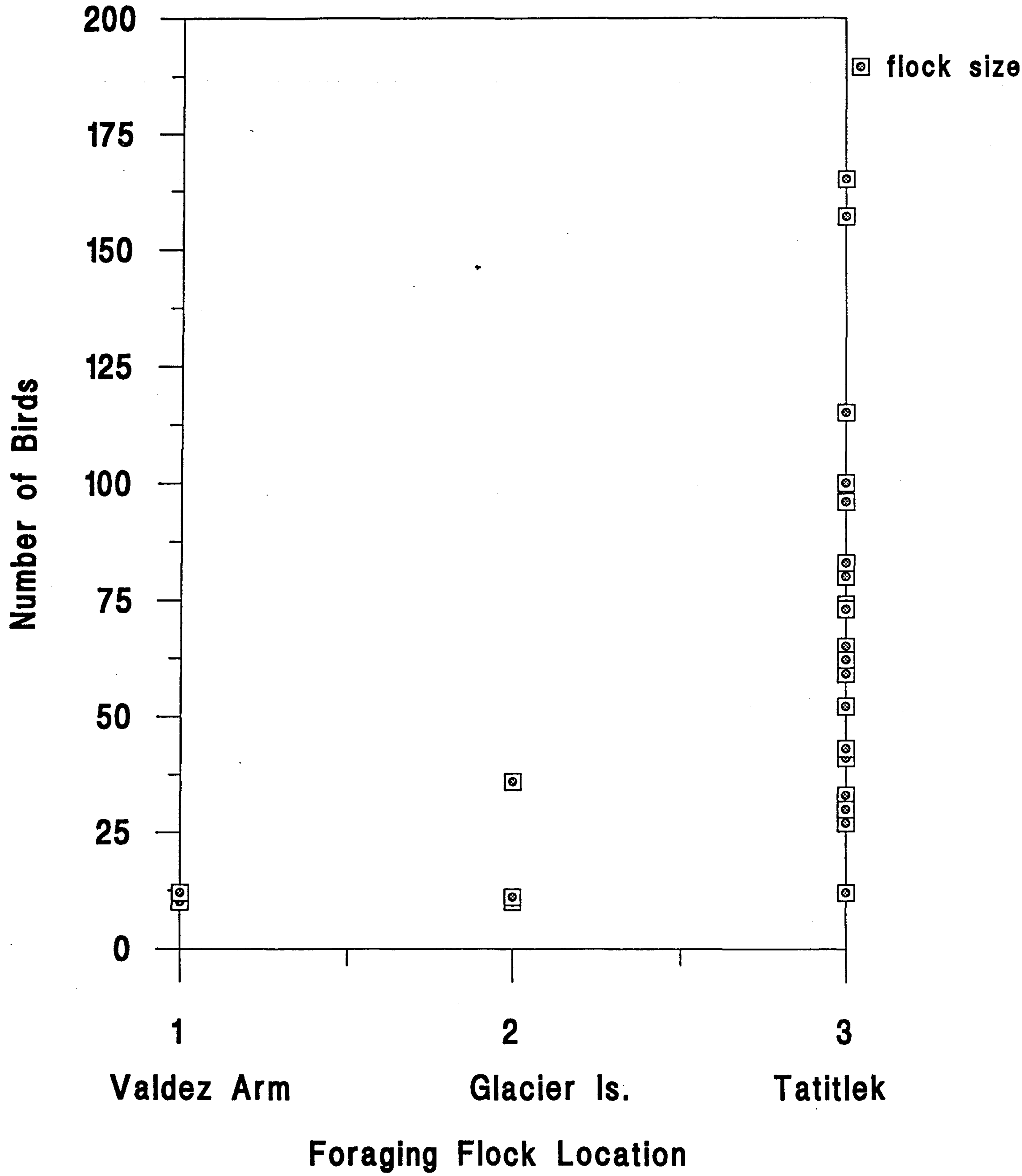

Fig. 19 Total Number of birds per foraging flock at each location.

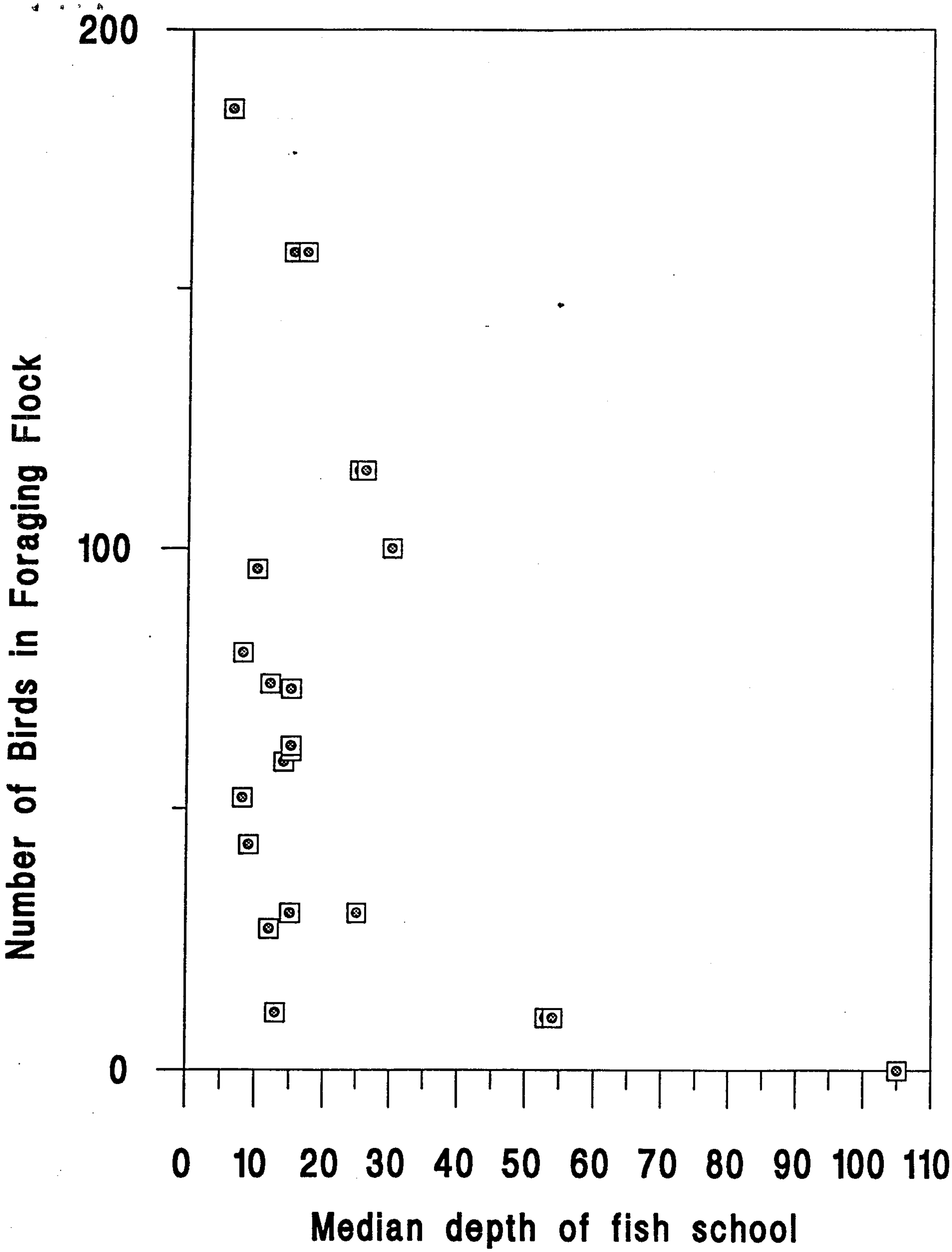

Fig. 20 Relationship between number of birds in a foraging flock and the median depth of school.