FINAL

ENVIRONMENTAL ASSESSMENT/REGULATORY IMPACT REVIEW

FOR

AMENDMENT 21a - Revised

TO THE FISHERY MANAGEMENT PLAN FOR

THE GROUNDFISH FISHERY OF THE

BERING SEA AND ALEUTIAN ISLANDS

Prepared by the staffs of the

National Marine Fisheries Service
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North Pacific Fishery Management Council

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Background

In response to habitat concerns for blue king and korean hair crab, marine mammals, and seabirds, the Central Bering Sea Fishermen's Association initiated a proposal in 1989 to establish areas closed to trawling in the Pribilof Islands area. The intent of this proposal was to protect this unique habitat and ecosystem so that it could contribute long-term benefits to the fisheries surrounding the waters off the Pribilof islands area.

Fishing for groundfish using trawl gear is authorized in the waters off St. Paul, St. George, Walrus and Otter Islands (Pribilof islands area) under the FMP for groundfish in the BSAI and under regulations at 50 CFR 675. In addition to providing habitat for commercially important groundfish, the Pribilof islands area provides the necessary habitat for blue king crab, juvenile groundfish, Korean hair crab, marine mammals, seabirds and their prey species. The rocky benthos habitat immediately surrounding the Pribilof islands area provides essential food resources and protection for juvenile crab and fish species, which are prey species for marine mammals and seabirds.

NMFS trawl surveys indicate that from 1975-1993 the historic estimated abundance of blue king crab in the Pribilof islands area decreased significantly. The abundances of blue king crab populations decreased from 106 million in 1980, to 10 million in 1992 according to the estimated abundance obtained from NMFS trawl surveys. As a result of the decrease in crab abundance, the State of Alaska, Pribilof Island crab fishery has not been conducted since 1987. Continued trawling under the current FMP for groundfish in the Pribilof islands area could further jeopardize the productivity of marine resources living in this habitat and the essential food resources that it provides.

The Pribilof islands area contributes an essential food resource of prey species that allows for optimal foraging and breeding opportunities for marine resources dependent on the habitat in this area. Fish, crab, seabird, and marine mammal populations are dependent on the habitat that the Pribilof islands area provides. During the breeding season, approximately two-thirds of the northern fur seal population, and an estimated 88 and 92 percent of red-legged kittiwakes and Alaskan thick-billed murre, respectively, breed in the Pribilof islands area.

Potential exists for the groundfish trawl fishery to continue to disrupt the populations of fish, crab, seabirds, marine mammals, and their prey species. The blue king crab population could continue to be adversely affected by the use of trawl gear in the Pribilof islands area. Unlike other crab species, blue king crab populations do not extend uniformly across the Bering Sea shelf, but are found in isolated populations located in waters surrounding the Pribilof islands area, St. Matthew, and St. Lawrence Island. Juvenile blue king crab are dependent on this rocky habitat, and have a restricted distribution in the Bering Sea. The significant drop in the blue king crab populations initiated a proposed FMP amendment to establish a Pribilof island habitat conservation area to protect blue king crab and other marine resources dependent on this habitat.

At its September, 1991 meeting, the North Pacific Fishery Management Council (Council) requested that an analysis be prepared to identify those areas needing protection and analyze alternative options. The State of Alaska, Department of Fish and Game (ADFG) prepared an environmental assessment/regulatory impact review (EA/RIR) of this proposal to establish a Pribilof island habitat conservation area along with two additional halibut and salmon bycatch measures. Initially, this analysis and proposed amendment was part of Amendment 21 (50 CFR 14525). However, at its April 1992 meeting, the Council voted to move the Pribilof island area trawl closure forward as a separate analysis and management measure (Amendment 21a).

Amendment 21a, which proposed to establish a Pribilof islands habitat conservation area, was released for public review on October 29, 1992, and again in September 1993. During both review processes the Council recommended that additional alternatives be added. The purpose of the recommendation was to define the areas that would protect a majority of the species and habitat, while providing access to groundfish resources. These analyses identified areas of high blue king crab bycatch and low groundfish harvests. The Pribilof islands habitat conservation area was determined through an analysis that was based on both the distribution of crab and groundfish. As a result of this analysis, the proposed Pribilof islands habitat conservation area does not significantly impact fishermen as it incorporates the protection the marine resources dependent on this habitat while allowing for groundfish harvests.

At its December, 1993 meeting, the draft EA/RIR was reviewed by the Council and sent to the interested public for review. The Council considered the testimony and recommendations of its Advisory Panel (AP), Scientific and Statistical Committee (SSC), fishing industry representatives and the general public on

alternative habitat protection zones and how these areas were to be defined, established and managed during the April 1994 meeting and took action to establish an area surrounding the Pribilof island area as a habitat conservation area to prohibit the use of trawl gear. This EA/RIR, which was prepared by the Alaska Department of Fish and Game (ADFG), incorporated additional alternatives that were primarily based on the habitat and distribution of blue king crab. Alternative 8 of the EA/RIR was recommended by the Council during the April 1994 meeting. The following area, under Alternative 8 was recommended by the Council:

Pribilof Islands Habitat Conservation Area: Trawling is prohibited at all times in the EEZ within the area bounded by a straight line connecting the following pairs of coordinates in the following order:

(57 57.0', 168 30.0')
(56 55.2', 168 30.0')
(56 48.0', 169 2.4')
(56 34.2', 169 2.4')
(56 30.0, 169 25.2')
(56 30.0, 169 44.1')
(56 55.8', 170 21.6')
(57 13.8', 171 0.0')
(57 57.0', 171 0.0')
(57 57.0', 168 30.0')

This area was established based on the distribution and habitat of blue king crab in the NMFS annual trawl surveys, and on observer data. This area encompasses a major portion of the historic blue king crab distribution and incorporates data from years of low abundance and data from years when the population was expanding. The Pribilof islands habitat conservation area protects a majority of the crab habitat in the Pribilof islands area, while minimizing the area affecting trawl operations for groundfish.

The Council, through this amendment, intends to promote the conservation and management of the fishery resources and to further the objectives of the Magnuson Act. A proposed rule was published in the Federal Register on October 17, 1994 (59 FR 51177), and a technical amendment was published in the Federal Register on November 3, 1994 (59 FR 55076) as the first part in this rulemaking process to establish a habitat conservation zone surrounding the Pribilof island area. A final rule was prepared by the NMFS region on November 29, 1994.

Purpose of the Proposed Action

The stated purpose of the proposed action is to eliminate trawl activities in areas of importance to blue king crab and Korean hair crab stocks so that these stocks may build to and be maintained at exploitable levels, and seabird and marine mammal populations may increase to levels sustainable by a habitat undisturbed by bottom trawl activities. In addition, the proposal contends that elimination of bottom trawl activities in IPHC Area 4C or a similar area will reduce bycatch of juvenile halibut and crab. Bottom trawling is alleged to be destructive to the habitat of these animals including their prey species, as well as to the animals themselves including their juvenile stages.

Alternatives Considered

Revised Amendment 21a (December 1993) includes analysis of the following alternatives:

Alternative 1: Status quo -no area closures adjacent to the Pribilof Islands.

Alternative 2: Close IPHC Area 4C to bottom trawling.

Alternative 3: Close IPHC Area 4C to all trawling.

Alternative 4: Close waters within a 25-mile zone around the islands to bottom trawling.

Alternative 5: Close waters within a 25-mile zone around the islands to all trawling.

Alternative 6: Close waters within IPHC Area 4C West of 169 W. to bottom trawling.

Alternative 7: Close waters within IPHC Area 4C West of 169 W. to all trawling.

Alternative 8: **(PREFERRED)** Close an area defined by crab habitat.

Alternative 9: Close an area defined by crab habitat when a limit of 1 percent of estimated blue king crab abundance is reached.

Alternative 10: Close an area defined by crab habitat when a limit of 20,000 king crab is reached.

Alternative 11: Close an area defined by crab habitat when a limit is reached. Maintain a subarea permanently closed to trawling.

Summary of Analysis

Results based on the Bering Sea Bycatch Model indicated no discernible differences among Alternatives 1 - 7 in groundfish catch and bycatch levels. In other words, the alternatives did not differ greatly from status quo. Remaining differences could still be attributed to the method of accumulating catches used in the model. However, the scale of model specific differences have been reduced to the smallest level possible. Alternatives 2 - 7 would limit access by trawlers to the area south of the Pribilof Islands between the 200 m and 100 m depth contours, which is not important blue king crab habitat, but is important to the pollock and Pacific cod fisheries.

Through spatial display of NMFS annual trawl surveys; foreign, joint venture, and domestic observer data; and the directed commercial crab catch, the analysis of Alternative 8 provides an understanding of blue king crab habitat, trawl fishing effort and the distribution or feeding areas of other marine species. Analysis of this information was used to delineate an area for closures that provides trawl access to the majority of groundfish resources in the Pribilof Islands area, yet affords habitat protection for blue king crab. The boundary selected does not encompass the entire range of blue king crab in the area, but does surround the habitat with highest blue king crab concentrations. Included in the boundary is habitat vital to juvenile blue king crab, populations of red king crab, populations of Korean hair crab, and some of the area important to foraging seabirds.

The boundary in Alternative 8 was selected to allow trawl access to the edge of the 100 m contour and the groundfish resources to the east and north of the Pribilof Islands. The boundary was also drawn with straight edges and as few corners as possible in order to facilitate ease of closure enforcement. Analysis has shown little or no impact on pollock or Pacific cod fisheries and a small impact on flatfish fisheries.

The overall impact of the alternatives on groundfish fisheries is expected to be small in relation to Alternative 1, status quo. The impact on king crab stocks, Korean hair crab stocks, and seabird foraging under Alternative 8 is expected to provide the most beneficial results and contain no negative impacts when compared with Alternative 1.

The benefits to crabs, seabirds, and marine mammals under Alternative 8 are reduced in Alternative 9 because of continued access to the area by trawlers until the limit based on 1 percent of blue king crab abundance is attained. The benefits of Alternative 8 are reduced by lesser amounts under Alternatives 10 and 11 because of generally lower limit constraints and continued

protection of a portion of the area defined for closure under Alternative 8. Alternative 11 would allow an increased bycatch of king crab over Alternative 8 for marginal increases in groundfish catch. Alternatives 9, 10, and 11 all allow greater access to groundfish, but the increased harvest opportunities are minimal in comparison to the increased bycatch of crab that occurs when vessels operate in the area defined for closure in Alternative 8.

- Alternative 8 closure area is defined by critical blue king crab habitat.
- A small amount of groundfish catch comes from the closure area defined in Alternative 8, however, this is the area of highest crab bycatch.
- The Pribilof Islands blue king crab population remains depressed while St. Matthew and St. Lawrence populations have rebounded.
- Closure area generally has higher halibut bycatch rates than surrounding areas.
- The closure area will protect important foraging areas for seabirds.
- All alternatives allow increased king crab bycatch for small gains in groundfish catch when compared to Alternative 8.

1.0 INTRODUCTION

1.1 Management Background

The eastern Bering Sea groundfish fisheries in the exclusive economic zone (EEZ) are managed under the Fishery Management Plan of the groundfish fisheries in the Bering Sea/Aleutian Islands (BSAI) Area. The fishery management plan (FMP) was prepared by the Council under the Magnuson Fishery Conservation and Management Act (Magnuson Act). The BSAI groundfish FMP was approved by the Secretary of Commerce (Secretary) and became effective in 1982.

Actions taken to amend FMPs or implement other regulations governing the groundfish fisheries must meet the requirements of Federal laws and regulations. Among the most important of these are the National Environmental Policy Act (NEPA), the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA) Executive Order (E.O.) 12291 and the Regulatory Flexibility Act

(RFA).

NEPA, E.O. 12291 and the RFA require a description of the purpose and need for the proposed action as well as a description of alternative actions that may address the problem. This information is included in Section 1 of this document. Section 2 contains information on the biological and environmental impacts of the alternatives as required by NEPA. Impacts on endangered species and marine mammals are also addressed in this section. Section 3 contains a Regulatory Impact Review (RIR) which addresses the requirements of both E.O. 12291 and the RFA that economic impacts of the alternatives be considered. Section 4 specifically addresses the impacts of the proposed action on small businesses.

This Environmental Assessment/Regulatory Impact Review (EA/RIR) addresses the proposal to prohibit trawling in specified areas in the waters surrounding the Pribilof Islands to protect the habitat of blue king and Korean hair crab, seabirds, marine mammals, and their prey.

The Council solicits public recommendation for amending the BSAI groundfish FMP on an annual basis. Amendment proposals are then reviewed by the Council's GOA and BSAI groundfish FMP Plan Teams (PT), Plan Amendment Advisory Group (PAAG), Advisory Panel (AP), and Scientific and Statistical Committee (SSC). These advisory bodies make recommendations to the Council on which proposals merit consideration for plan amendment.

Amendment proposals and appropriate alternatives accepted by the Council are analyzed by the Groundfish Plan Team or other staff analytical teams for their efficacy and for their potential biological and socioeconomic impacts. After reviewing this analysis, the Council, Advisory Panel (AP), and Scientific and Statistical Committee (SSC) will make recommendations as to whether the amendment alternatives should be changed in any way, whether and how the analysis should be refined, and whether to release the analysis for general public review and comment. If an amendment proposal and accompanying analysis is released for public review, the AP, SSC, and the Council consider subsequent public comments before the Council decides whether to submit the proposals to the Secretary for approval and implementation.

This document analyzes one proposal that was part of the original Amendment 21 to the BSAI groundfish FMP. Initially, Amendment 21 addressed three priority bycatch issues established by the Council during its January 1992 meeting. These were (1) halibut bycatch limits for the trawl and non-trawl fisheries, (2) chinook salmon bycatch limits for the trawl fisheries, and (3) trawl closures around the Pribilof Islands. At its April 1992 meeting, the Council reviewed a draft analysis of the third

proposal, expanded the scope of the proposal to include different areas of closure, and requested additional analysis.

The Council reviewed the expanded analysis at its September 1992 meeting and voted to send it out for public review with minor additions. Rather than taking final action on the amendment at the December 1992 meeting, the council requested that staff provide additional analysis for further review, especially given that the original investigator was no longer with the primary reporting agency. This additional analysis was presented at the September 1993 Council meeting and, with additional information and alternatives, allowed to go out for public review.

1.2 Purpose of the Document

This document provides background information and assessments necessary for the Secretary to determine if the amendment is consistent with the Magnuson Act and other applicable laws. It also provides the public with information to assess the alternatives that are being considered and to comment on the alternatives. These comments will enable to Council and Secretary to make more informed decisions concerning the resolution of the management problems being addressed.

1.2.1 Environmental Assessment

One part of the package is the environmental assessment (EA) that is required by NOAA in compliance with the National Environmental Policy Act of 1969 (NEPA). The purpose of the EA is to analyze the impacts of major federal actions on the quality of the human environment. The EA serves as a means of determining if significant environmental impacts could result from a proposed action. If the action is determined not to be significant, the EA and resulting finding of no significant impact (FONSI) would be the final environmental documents required by NEPA. An environmental impact study must be prepared if the proposed action may significantly affect the human environment.

Actions taken to amend FMPs or implement other regulations governing the groundfish fisheries must meet the requirements of Federal laws and regulations. Among the most important of these are NEPA, the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA) Executive Order (E.O.) 12866 and the Regulatory Flexibility Act (RFA).

NEPA REQUIREMENTS: ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

An EA must include a brief discussion of the need for the proposal, the alternatives considered, the environmental impacts of the proposed action and the alternatives, and a list of document preparers. The purpose and alternatives were discussed in Sections 1.2 and 2.4, and the list of preparers is in Section 4. This section contains the discussion of the environmental impacts of the alternatives including impacts on threatened and endangered species and marine mammals.

Environmental Impacts of the Alternatives

The environmental impacts generally associated with fishery management actions are effects resulting from (1) overharvest of fish stocks that might involve changes in predator-prey relationships among invertebrates and vertebrates, including marine mammals and birds, (2) physical changes as a direct result of fishing practices affecting the sea bed, and (3) nutrient changes due to fish processing and discarding fish wastes into the sea. A summary of the effects of the 1994 groundfish total allowable catch amounts on the biological environment and associated impacts on marine mammals, seabirds, and other threatened or endangered species are discussed in the final environmental assessment for the 1994 groundfish total allowable catch specifications.

1.2.2 REGULATORY IMPACT REVIEW: ECONOMIC AND SOCIOECONOMIC IMPACTS OF THE ALTERNATIVES

This section provides information about the economic and socioeconomic impacts of the alternatives including identification of the individuals or groups that may be affected by the action, the nature of these impacts, quantification of the economic impacts if possible, and discussion of the trade offs between qualitative and quantitative benefits and costs.

The requirements for all regulatory actions specified in E.O. 12866 are summarized in the following statement from the order:

> In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are

difficult to quantify, but nevertheless essential to consider. Further, in choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environment, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.

This section also addresses the requirements of both E.O. 12866 and the Regulatory Flexibility Act to provide adequate information to determine whether an action is significant under E.O. 12866 or will result in significant impacts on small entities under the RFA.

E. O. 12866 requires that the Office of Management and Budget review proposed regulatory programs that are considered to be significant. A significant regulatory action is one that is likely to:

(1) Have an annual effect on the economy of $100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;

(2) Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;

(3) Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs or the rights and obligations of recipients thereof; or

(4) Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in this Executive Order.

A regulatory program is "economically significant" if it is likely to result in the effects described above. The RIR is designed to provide information to determine whether the proposed regulation is likely to be "economically significant."

1.3 Description of the Groundfish Fisheries

The most recent description of the groundfish fishery is contained in the Draft Economic Status of the Groundfish Fisheries off Alaska, 1994. The draft includes information on the catch and value of the fisheries, the numbers and sizes of

fishing vessels and processing plants, and other economic variables that describe or affect the performance of the fisheries.

2.0 CLOSE AREA AROUND THE PRIBILOF ISLANDS TO TRAWLING

2.1 Proposal Background

In October, 1989, and again in August, 1991, the Central Bering Sea Fishermen's Association (CBSFA) proposed a prohibition on bottom trawl fishing in International Pacific Halibut Commission (IPHC) Area 4C. At the September 1991 meeting, the Council requested that the State of Alaska prepare an analysis of the proposal. The proposal was analyzed subsequently and presented to the Council in April 1992. The Council requested that alternative areas be considered for prohibition of trawling and the analysis with seven alternatives was accepted and released for public review at the September 1992 Council meeting. Additional analysis was requested during the December 1992 Council meeting, and the Advisory Panel provided a list of items for consideration. The amendment was again presented at the September 1993 Council meeting and approved to be released for public review with the inclusion of information concerning halibut bycatch, 1993 trawl survey information, and three additional alternatives. The Council requested that all previous alternatives as well as the added alternatives be presented in the amendment.

2.2 Purpose of and Need for the Proposed Action

The IPHC Area 4C lies between 56°20'N and 58°N latitude and 168°W and 171°W longitude, enclosing about 8,100 square nautical miles (28,000 square kilometers) and including the Pribilof Islands with St. George near the southern boundary and St. Paul near the center of the area (see Figure 2.1). According to the CBSFA, the Pribilof Islands and surrounding waters encompassed by IPHC Area 4C represent important habitat for marine mammals, seabirds, blue king crab (*Paralithodes platypus*) and Korean hair crab (*Erimacrus isenbeckii*). Trawling is alleged to be destructive to the habitat and ecosystem of these animals including their prey species, as well as to the animals themselves including their juvenile stages. In addition, bottom trawling is acknowledged to have relatively high bycatch of prohibited species such as halibut and king and tanner crabs.

The stated purpose of the proposed action is to eliminate trawl activities in areas of importance to blue king crab and

Korean hair crab stocks so that these stocks may build to exploitable levels, and seabird and marine mammal populations may increase to levels sustainable by a habitat undisturbed by bottom trawl activities. In addition, the CBSFA contends that elimination of trawl activities in IPHC Area 4C or a similar area will reduce bycatch of juvenile halibut and crab.

2.3 Alternatives for Pribilof Islands Area Trawl Activities

The October 29, 1992, version of this amendment, which was released for public review, included seven alternatives for consideration by the Council. The alternatives addressed closure zones of differing sizes, and addressed closure to trawling or to all trawling. The seven alternatives, including status quo, are as follows:

Alternative 1:	Status quo, allow trawling around the Pribilof Islands.
Alternative 2:	Close IPHC Area 4C to bottom trawling.
Alternative 3:	Close IPHC Area 4C to all trawling.
Alternative 4:	Close the area within 25 nm of the beach around the Pribilof Islands to bottom trawling.
Alternative 5:	Close the area within 25 nm of the beach around the Pribilof Islands to all trawling.
Alternative 6:	Close IPHC Area 4C west of 169°W to bottom trawling.
Alternative 7:	Close IPHC Area 4C west of 169°W to all trawling.

An additional alternative, Alternative 8 (preferred), was presented to the Council in September 1993. Alternative 8 is based on the AP request that the area defined for possible closure to trawling be based on locations of blue king crab habitat, and not on artificial latitudinal and longitudinal degrees nor on an arbitrary distance from shoreline.

During the September 1993 Council meeting, the following three additional alternatives were requested. Alternative 9 would close the area defined under Alternative 8 after king crab (all species) bycatch exceeded 1 percent of the previous year's estimated blue king crab abundance. Alternative 10 would similarly close the area defined under Alternative 8 after king crab (all species) bycatch exceeded 20,000 crab. Alternative 11

would be similar to Alternatives 9 and 10, with a core area near the Pribilofs (approximately defined by the 60 meter depth range) closed permanently to trawling.

A summary of the additional alternatives is as follows:

Alternative 8: **(preferred)** Close an area around the Pribilof Islands defined by blue king crab habitat.

Alternative 9: Close an area around the Pribilof Islands defined by blue king crab habitat and triggered by a king crab limit defined as 1 percent of the prior year's blue king crab abundance.

Alternative 10 Close an area around the Pribilof Islands defined by blue king crab habitat and triggered by a 20,000 king crab limit.

Alternative 11 Close an area around the Pribilof Islands defined by blue king crab habitat after a limit is reached, but maintain a core area permanently closed to bottom trawling.

The analysis of the current amendment has spanned several years and two different authors. The first seven alternatives were analyzed largely using the Bering Sea Bycatch Model. After refinement and several iterations, the economic data presented by the Bycatch Model predicted negligible economic impacts due to any of the seven alternative closures. The estimation of impacts that are negligible is either accurate, or the Bycatch Model inadequately addresses the finer spatial detail required for the necessary analysis. However, a more adequate substitute is not currently available, especially for the economic analysis.

The first seven alternatives were analyzed by model runs in 1992. Because the differences among the alternatives were seen to be marginal, the use of the Bycatch Model was not continued in the analysis of Alternatives 8 - 11, and the analyses of Alternatives 1 - 7 were not updated for this revised amendment.

2.4 Analysis of the Alternatives:

Operation of the BSAI groundfish trawl fisheries under each of the alternatives would have direct and indirect effects on the groundfish stocks and economically important bycatch species as well as marine mammal and seabird populations. The direct effects result from fishing operations and can be estimated

quantitatively for groundfish catch and bycatch in the BSAI. Quantitative estimates of the likely effects on mammal and bird populations in the areas around the Pribilof Islands resulting from fishing under each alternative are not possible. Information on blue king crab near the Pribilof Islands was available from NMFS' trawl surveys in the Bering Sea and the NMFS' groundfish observer data base.

A fishery simulation model developed by Smith (1989) and Funk (1990) and modified for use in analyzing earlier amendments (Anonymous, 1991b) was modified and used by Alaska Department of Fish and Game staff to make quantitative estimates of the likely consequences of Alternatives 1 - 7. Staff from the Alaska Commercial Fisheries Entry Commission developed relative cost and return parameters for directed fishery species and bycatch, and produced estimates of value for the alternatives considered here. Model parameters were based on 1990 and 1991 data. Detailed discussion of the methods for making catch and value estimates is found in the EA/RIR for Amendment 21. For alternatives 1 - 7, the model was modified to simulate a daily fishery within each month. Each iteration of the model accumulated 1/30 of the monthly catch, and each iteration was compared to the TAC.

Alternatives 1 - 7 indicated negligible differences among alternatives in terms of directed groundfish catch and bycatch levels in the BSAI. Therefore, the analysis is presented in terms of the status quo (Alternative 1) and Alternatives 2 - 7 combined into a single section.

The analysis of Alternatives 8 - 13 differed from the analysis of Alternatives 1 - 7 in that a Geographical Information System (GIS) was employed both to define the area for closure and to analyze differences inside and outside of the closure area. The Bering Sea Bycatch Model was not used for Alternatives 8 - 13.

2.4.1 Analysis of Alternative 1: Status quo, allow trawling in the areas around the Pribilof Islands

At present, directed trawl fisheries for groundfish occur in the areas around the Pribilof Islands under the general regulations for the Bering Sea and Aleutian Islands. In the absence of changes in regulations, the current pattern of trawl fishing would be expected to continue into the future, with variation in directed catch and bycatch due to shifts in resource locations, weather, and market factors. Details of the estimated economic baseline values under status quo can be found in the October 29, 1992, version of Amendment 21a. To summarize the catch and economic information predicted by the Bering Sea Bycatch model under status quo conditions, directed trawl gear catch

represented 18 percent of the total groundfish catch for IPHC Area 4C and 24 percent of the gross value, whereas all trawling represented virtually all of the catch and value for the area. Compared to directed fisheries in the entire BSAI, trawling in IPHC Area 4C represented less than 2 percent of the total catch and value, while all trawling in IPHC Area 4C accounted for 9 percent of the catch and 7 percent of the value of the total groundfish in the BSAI. Under the status quo, management strategies and enforcement practices would not change. Therefore management and enforcement costs would not be expected.

2.4.2 Analysis of Alternatives 2 - 7: Closure of IPHC Area 4C, closure of a 25 mi radius around the Pribilof Islands, Closure of IPHC Area 4C west of 169°W.

For the analysis of Alternatives 1 - 7, population levels for directed fishery species and bycatch species under quota were assumed to be optimized by the respective quotas established for the BSAI, and were not affected by the alternatives considered for trawl activities in the areas around the Pribilof Islands. Direct effects of the alternatives were measured by changes in catch levels and associated values for directed fishery and bycatch species in the BSAI as a whole. The effects of the alternatives were estimated under two different scenarios with respect to the effectiveness of the vessel incentive program. Scenario 1 assumes the vessel incentive program to be completely effective. Scenario 2 assumes there is no effective vessel incentive program, which results in higher bycatch rates and lower groundfish catch levels than Scenarios 1. Alternatives were compared within a given scenario.

Subsequent results indicated no discernible differences among alternatives in groundfish catch and bycatch levels as shown in Tables 2.1 and 2.2, and Figure 2.2. Remaining differences could still be attributed to the method of accumulating catches used in the model, however, the scale of model specific differences have been reduced to the smallest level possible.

2.4.3 Analysis of Alternative 8 (PREFERRED): Area defined by crab habitat

2.4.3.1 Background:

The Pribilof Islands lie within IPHC Area 4C, as described above, and are within 20 nm of the 200 m contour, which defines

the Bering Sea shelf (Figure 2.1). The more southerly island, St. George, is bounded immediately to the east, south, and west by a 100 m contour, which extends to the north and west and passes to the west of St. Paul Island. St. Paul Island is also surrounded by shallower isobaths, such as the 60 m and 40 m isobaths shown in Figure 2.1.

Blue king crab in the Bering Sea are present as unique populations located at the Pribilof Islands, St. Matthew Island, and St. Lawrence Island. The Pribilof Island population centers in the area between and surrounding the Pribilof Islands. Blue king crab do not extend uniformly across the Bering Sea shelf as do red king crab, but are found in isolated populations, and although blue and red king crab prefer the same habitat types, the two do not generally co-occur (Somerton, 1985). Legal blue king crab are found at an average depth of 36.7 fm, and an average temperature of 0.6° C, while legal red king crab are found at an average depth of 33.5 fm and an average temperature of 3.71° C (Stevens, et al. 1992). The female blue king crab spawns biennially so that the effective spawning population is less than the number of individuals present in a given year (Stevens, et al. 1992).

The rocky habitat immediately surrounding the Pribilof Islands is important to juvenile blue king crab. Armstrong et al. (1985) found that juvenile king crab were generally distributed between the 40 and 60 m isobaths around St. Paul Island, and to the east of St. George Island. The highest concentrations of juveniles were found in cobble habitat covered with shell hash immediately to the north and east of St. Paul Island, and similar habitat and juvenile crab numbers were found to the east of St. George Island. Concerning the importance of this habitat, Armstrong et al. (1985) noted:

> The very restricted distribution of juvenile king crab around the Pribilof Islands and apparent dependence of this early life history stage on particular benthic material makes the overall life history of this species somewhat precarious.

Abundance estimates of Pribilof Island blue king crab for the years 1974-1992 are presented in Figure 2.3 (from: Stevens et al. 1992), which also provides estimates of directed king crab catch. The abundance of blue king crab tended to increase during the period 1974-78 from 20.9 million to 47.1 million crab, and increased dramatically in 1980 to a high of 102.7 million crab. The estimated abundance was very low from 1984-1988 (between 1.2 and 4.8 million crab), and has marginally increased from those lower levels since 1989 to between 6.7 and 8.0 million crab. It is interesting to note that the majority of blue king crab in the high 1980 estimate, or approximately 101 million crab, were large

females (Figure 2.4), so that the high abundance did not necessarily reflect the fishable population of legal male crab. The number of legal males was low to non-existent in the mid-1980's but has increased somewhat in 1990-1992. In recent years, female and juvenile crab have made up the majority of the population. Since their protection holds the promise of stock recovery, actions that maximize crab bycatch savings are important.

The first reported blue king crab catches in the Pribilof Islands area were .174 million crab in 1973. Catches were approximately 0.8 million crab during 1977-79, and catches peaked in 1980 and 1981 at 1.5 and 1.2 million crab, respectively (Figure 2.3)(From: Spalinger and Jackson, 1993). Thereafter, landings dropped to between .04 million and .09 million crab between 1984 and 1987. The Pribilof Islands blue king crab fishery has not been conducted since 1987. Although 1990, 1991, and 1992 survey information indicated potentially fishable populations, the error associated with the survey estimates, the expected large amounts of effort and the difficulties inherent in managing a remote, derby-type fishery resulted in decisions by the State managers not to open the fishery.

2.4.3.2 Distribution of Blue King Crab

The distribution of Pribilof Island blue king crab was investigated by spatial display of NMFS' annual trawl surveys; foreign, joint venture, and domestic observer data; and directed commercial crab catch. The results of these analyses were used to delineate an area for closure with borders that considered blue king crab habitat, trawl fishing effort, and the distribution or feeding areas of other marine species.

2.4.3.2.1 NMFS Annual Trawl Survey:

The location and unexpanded number of blue king crab encountered in the NMFS' annual trawl survey of the Bering Sea are provided in Appendix A, covering the years 1975-1993. The annual trawl survey, as weather and time permit, makes tows at the center of 20 nm by 20 nm squares across the eastern Bering Sea. The trawls are often increased near the Pribilof Islands so that multiple tows are represented within the 20 nm by 20 nm squares. The area covered by the annual surveys within the context of the Pribilof Islands has been fairly consistent from year to year (Figure A.1) with the exception that during the years 1975-1979 the upper right corner of the map, at 58° latitude and north, and at 169° W. longitude and to the east of

this longitude was not included. The additional figures in Appendix A (Figures A.2 - A.20) present the number of blue king crab encountered in annual NMFS' surveys by haul and also represent the number of juvenile (<110 mm carapace length), pre-recruits (110-134 mm), adult male crab (>135 mm), and small (<90 mm carapace length), and large (>90 mm) female crab. The size of each circle represents the number of blue king crab and is relative to the size of the key at the bottom of each map which equals 200 crab.

The estimated abundance of blue king crab, expanded from actual counts to the surveyed 20 nm by 20 nm squares, can be found in the previous version (October 29, 1992) of this document. The actual trawl counts are presented in this version to indicate the precise location and relative number of blue king crab encountered by the survey. The actual counts and locations were chosen so that the definition of the spatial data was at the individual tow level and not expanded to 20 nm by 20 nm blocks. Again, the data is presented to relay the relative number of blue king crab in the area. The NMFS' trawl surveys are difficult in the rocky area surrounding the Pribilof Islands, and there is often a high degree of variability in projected abundance estimates because of the inability of the trawl to sample accurately the bottom under these rocky conditions.

The annual trawl survey indicated a high number of blue king crab of all ages in the area between and to the east of the Pribilof Islands in 1975 (Figure A.2). During the years 1975-1978 the distribution of blue king crab was generally between the two islands and surrounding St. Paul Island. High numbers of large and small female king crab were apparent between the islands in the late 1970's.

In 1979 the surveys encountered blue king crab further to the north and west of St. Paul Island than in previous surveys (the area surveyed was similar from year to year). In 1980, the year of the highest directed king crab catch, a large number of large females and some legal males were found in the survey between the islands and to the north and east of St. Paul Island. This spatial distribution, especially to the north and east of St. Paul Island, continued through 1985, although fewer crab were encountered at any given station in each subsequent year. The marked decline in abundance beginning in 1984 is very apparent in the figures (e.g., Figures A.11-A.15).

Although the distribution of crab to the north and east of St. Paul Island was still evident during the period 1984-1988, low abundance was indicated by the low number of crab encountered in individual hauls. In general, the hauls nearest St. Paul Island tended to contain the highest number of crab. During this period the range of crab tended to withdraw to a closer proximity

with the Pribilof Islands. The major crab classes during this period were large and small female crab.

In 1989, a high number of crab were encountered near St. Paul Island. During the years 1990-1993, the number of crab increased as did the range of blue king crab which extended to the north and east of St. Paul Island. Although the 1991 and 1992 NMFS surveys of the Pribilof blue king crab stocks indicated a surplus of legal males, state managers chose not to open the directed fishery for the following reasons: (1) the error associated with survey estimates is often high; (2) the potential exists for high fishing effort from a large number of vessels entering the fishery; and (3) there is no means to protect the stocks from potential overharvest when low guideline harvest levels are set for a "derby" style fishery. A guideline harvest level for red king crab was been set for the 1993/94 season. Red king crab and *C. bairdi* Tanner crab survey catches are presented in Figures A.21 - A.25, and A.26 - A.29, respectively.

2.4.3.2.2 Observer data:

Groundfish observers on foreign, joint venture, and domestic vessels have annually taken detailed samples of a subset of hauls in order to determine the species composition of the catch and the bycatch composition in the selected hauls. The hauls for which blue king crab have been identified are presented in Appendix B in a format similar to the presentation of the survey data above. However, there are two important differences between the two map sets. First, the scale has been reduced from 200 crab to 50 crab in order to resolve the small number of crab often encountered in individual hauls. The second difference is that the data from the observed vessels is more dependant on the distribution of effort than on the distribution of crab. The surveys were made over a continuous grid so that the abundance in one area could be compared to the abundance in another. In presenting the observer data, however, the location of encountered crabs is dependant on where the vessels happened to be fishing.

Although it is difficult to know when king crab species were identified consistently by observers aboard foreign fishing vessels, 1982 was the first year blue king crab were counted under the larger king crab species complex. Blue king crab encountered in the 1982 foreign fishery were located in approximately the same area as shown by the survey in that year (Figures B.1 and A.9). The fishing effort in 1982 was located in the major area of king crab occurrence detected in the annual survey, near and between the Pribilof Islands. Although annual effort has not been indicated in the maps, the effort in the

1983-1985 foreign fishery had shifted further to the north and east, avoiding the area near the Pribilof Islands where the survey had found blue king crab. Thus multiple hauls of low crab bycatch during those years appeared further to the north than the surveys indicated for the same years. The appearance of blue king crab in areas not indicated by the surveys could be due to some seasonal shift in the population, misidentification of red king crab as blue king crab, or the shifted intensity of effort in the area. Bob Otto of NMFS indicated that he was not surprised that blue king crab would be located further to the north and east, and postulated that the appearance of the crab in that area was due to fishing intensity (Bob Otto, NMFS, personal communication, September, 1993). The hauls with the largest number of blue king crab remained closer in proximity to the Pribilof Islands.

Large numbers of blue king crab were not encountered until 1989 (joint venture fishery, Figure B.11) and 1991 (domestic fishery, Figure B.13), the period when stocks began to rebound. The location of high bycatch was situated to the east and north of the Pribilof Islands.

In the foreign fisheries, blue king crab were identified mainly within hauls for flatfish and bottom trawl pollock (Figure B.14). In the joint venture fisheries, most of the blue king crab were encountered in the "other" flatfish fishery. In the 1991 domestic fishery, the bottom trawl for pollock and "other" flatfish fisheries encountered the largest number of blue king crab.

2.4.3.2.3 Domestic Directed Blue King Crab Fishery:

Blue king crab were detected by observers on foreign vessels in locations further to the north and east than the annual NMFS' survey indicated for the same years. This occurrence of blue king crab more to the north and east could possibly have been due to seasonal shifts in the distribution of the blue king crab population. The winter season directed commercial catch data was examined in order to determine whether the population shifted to the north and east during the winter season as the observer data might suggest or whether the interception of crab was due to the high concentration of groundfish fishing effort in the area. The directed catch of blue king crab in the 1982/83 and 1983/84 seasons (October - March) was plotted by 1/2° latitude by 1° longitude statistical area blocks (Figures 2.5 and 2.6). The blocks in the figures begin at 168° W. longitude as the eastern boundary, and at 56° N. latitude as the southern boundary. A comparison of these figures with Figures A-9 and A-10 demonstrates that during the winter months the bulk of the

harvestable population remained within the same areas blue king crab were located in the summer NMFS annual surveys. There does not appear to be a change in seasonal distribution of the crab, and the detection of blue king crab to the north and east of these concentrations by observers on foreign vessels was due to the large amount of effort in the area.

2.4.3.3 Boundary Selection:

Based on the distribution of blue king crab seen in the NMFS' annual trawl surveys and as indicated by observer data, a boundary was constructed which encompassed the major portion of blue king crab distribution during most years, but would have the least impact on trawl fisheries. The boundary defined in Figure 2.7 should be compared with the distribution and numbers of crab historically encountered as presented in Appendix A. The boundary protects the range of blue king crab in years of low abundance as well as protecting the core population during periods of population expansion.

The distribution of blue king crab often exceeds the boundary that has been defined, however, the core population appears to center within the boundary. Care was taken in drawing the boundary to protect crab habitat, while at the same time minimizing the area affecting bottom trawl operations. Access to the 100 m shelf contour was provided to the south and west of the Pribilofs; the northwest area apparently receives little fishing effort; and the eastern boundary shifted westward from the farthest extent of crab distribution.

The coordinates of the points defining the closure area are as follows in decimal degrees:

Latitude	Longitude
56.5	169.735
56.93	170.36
57.23	171.0
57.95	171.0
57.95	168.5
56.92	168.5
56.8	169.04
56.57	169.04
56.5	169.42

2.4.3.4 Effects of closure boundary:

Fishing effort in the domestic fisheries has concentrated on the Bering Sea shelf for the flatfish fisheries, and in the area along the shelf break for the directed pollock and Pacific cod trawl fisheries. In the context of the Pribilof Islands and the area proposed for closure, the trawl fisheries defined as flatfish[1] and other flatfish[2] generally occur to the north of 57.5° latitude and to the west of 170° longitude. The locations of individual observed hauls in the flatfish fisheries over the years 1990-92 are provided in Figure 2.8. This figure also indicates the distribution of hauls which occurred within the proposed closure area. As a part of the flatfish fishery which extends along the Bering Sea shelf, there has been a concentration of fishing effort within the northwest corner of the proposed area. The distribution of effort in all other bottom and pelagic trawl fisheries is provided in Figure 2.9. This figure highlights the concentration of effort in 1990-92 within the area between the 200 m contour and the 100 m contour. Few of the trawls in these fisheries occurred within the proposed area of closure.

In order to quantify the amount of groundfish that was taken within the proposed closure boundaries, the groundfish catch and king crab bycatch from three areas were compared. These areas were the entire Bering Sea, a general Pribilof Island area portrayed in most of the maps in this document (56° to 58.5° latitude and 167° W. to 172° W. longitude), and the boundary proposed for closure (Figure 2.7). Table 2.3 provides the percentage of the total observed Bering Sea groundfish catch and the percentage of the total observed king crab bycatch that were taken from the general Pribilof Island area, and from the proposed closure area during 1991 and 1992. The metric tons of groundfish and number of crab are presented in Figures 2.10 - 2.13. The highest metric tons of groundfish were taken in the pelagic trawl for pollock, the bottom trawl for pollock, and the bottom trawl for flatfish fisheries (Figures 2.10 and 2.11). The largest number of crab were taken in the flatfish fisheries and the bottom trawl for pollock fishery (Figures 2.12 and 2.13).

In general, a small proportion of the groundfish catch taken in the Pribilof Island area was taken in the area defined for closure. In 1992, 20.8 percent of the total observed groundfish

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[1] Flatfish = rock sole, yellowfin sole and other flatfish where yellowfin sole and other flatfish are greater than rocksole in number.

[2] Other flatfish = other catch where rocksole is greater in number than yellowfin and other flatfish.

catch was taken in the Pribilof Island area, and only 1.81 percent of the catch was taken within the area proposed for closure. Similarly during 1991, 10.95 percent of the total observed Bering Sea groundfish catch was from the Pribilof Island area, and 1.64 percent was taken within the proposed closure area. The two target fisheries with the highest percentage of total Bering Sea groundfish taken within the defined area of closure were the flatfish fishery (10.05 percent in 1992 and 1.63 percent in 1991) and the "other" flatfish fishery (16.89 percent in 1992 and 14.35 percent in 1991).

In contrast, the majority of the crab encountered in the Pribilof Island area were taken within the proposed closure zone (Figures 2.12 and 2.13). As can be seen in Table 2.3, 32.67 percent of the total observed Bering Sea king crab (all species) bycatch was taken in the Pribilof Island area in 1992, and the majority of this bycatch was taken in the proposed closure area which represented 26.42 percent of the total Bering Sea king crab bycatch. In 1991, 29.85 percent of the total Bering Sea bycatch came from the Pribilof Islands area, and 20.96 percent from the area proposed for closure. Within individual fisheries, virtually all of the king crab bycatch in the general Pribilof area came from within the proposed closure zone. The 1992 flatfish fishery had 47.01 percent of its king crab bycatch within the Pribilof Islands area and 36.25 percent within the closure zone; the "other" flatfish had 47.67 percent in the Pribilof Islands area and 46.62 percent within the closure zone; and the Pacific cod fishery took 45.45 percent of its total Bering Sea bycatch of crab within the Pribilof Islands area, and all of these crab were taken within the proposed closure zone. In 1991, the "other" flatfish fishery took 38.92 percent of its total bycatch in the Pribilof Islands area and 29.36 percent in the closure zone. Fewer crab were encountered by the flatfish fishery (13.7 percent Pribilof area, 10.0 percent closure zone), but more were encountered by the bottom trawl for pollock (44.25 percent Pribilof area, 30.04 percent closure zone) and the pelagic trawl for pollock (74.35 percent Pribilof area, 63.64 percent closure zone) fisheries.

The mean groundfish catch per tow and the mean number of king crab intercepted per tow for the entire Bering Sea, for the general Pribilof Islands area and for the proposed closure area are presented in Table 2.4. When examining Table 2.4, it should be noted that the mean values for larger areas include the observations for smaller areas. For example, the mean groundfish value for the general Pribilof Islands area includes all of the observations for the closure area, and the mean groundfish value for the entire Bering Sea includes all of the observations from the general Pribilof Islands area.

In all cases, the mean groundfish catch from the area defined for closure was similar to or less than the mean groundfish catch within the general Pribilof Islands area and in the entire Bering Sea. For instance, the mean groundfish catch in 1992 for all fisheries in the Bering Sea was 36.65 tons/tow, within the general Pribilof area the mean catch was 37.73 tons/tow, and within the area proposed for closure the mean catch was 16.69 tons/tow. In 1991, the mean groundfish catch for all target fisheries in the Bering Sea was 36.12 tons/tow, within the Pribilof Islands area the mean catch was 27.43 tons/tow, and within the proposed closure area, the mean catch was 23.24 tons/tow. The mean bycatch of king crab per tow was often substantially greater within the area defined for closure than in any of the larger spatial definitions (note that the turbot and Atka mackerel fisheries have high mean bycatch outside of the Pribilof area but low crab bycatch overall, Table 2.3). Specifically, the mean bycatch of king crab for all target fisheries in 1992 was 4.92 crab/tow for the entire Bering Sea, 7.96 crab/tow in the general Pribilof Islands area, and 32.66 crab/tow in the defined closure area. In 1991, the mean bycatch of king crab for all target fisheries was 2.92 crab/tow in the entire Bering Sea, 6.03 crab/tow within the general Pribilof area, and 23.94 crab/tow within the proposed closure area.

2.4.3.5 Economic Impacts:

As was stated in the introduction, the Bering Sea Bycatch Simulation model was intended to examine time or area closures which would effect fisheries over large areas. The subsequent model runs for the closure of the area around the Pribilof Islands indicated minimal impacts under any given alternative. This could be due to the relatively small spatial scale of the proposed alternatives, which the model could not approximate, or reflect a fairly accurate minimal economic impact.

Based on the NMFS' survey data, as well as the NMFS' observer data, it is expected that the proposed closure area would reduce the amount of exploitation on all stages of blue king crab life history. Given that trawl gear can disturb or disrupt bottom habitat, and that blue king crab are especially dependent on a limited and specific bottom type in the juvenile stages, it is likely that the cessation of habitat disruption would be of general benefit to the crab. Since blue king crab are not ubiquitous across the Bering Sea shelf, but rather are concentrated at the Pribilof Islands, St. Matthew Island, and St. Lawrence Island (Somerton, 1985), it is apparent that the crab are dependent upon specific locations for population health and that protection within the small localized area would have the desired larger benefits to the stock.

The proposed boundaries have taken crab distribution into account and have also considered the fishing areas required by various target fisheries. It is expected that the proposed closure area would have little impact on the pollock and Pacific cod fisheries (less than 3 percent of the Bering Sea groundfish was taken within this area by these fisheries, see Table 2.3). The fisheries most likely to be impacted by the proposed area would be the flatfish fisheries. At most, the area represents 17 percent of the entire Bering Sea catch of the "other" flatfish fishery, and 10 percent of the flatfish fishery.

The major concern of reducing the proposed boundary from its current definition would be the displacement effect which a closure would have on the area. Given a defined boundary, vessels are likely to fish to the boundary edge. If the boundary does not adequately protect the prohibited stock, the intensity of fishing effort at a critical portion of the species habitat originally within the proposed boundary would have magnified detrimental effects on the species in question.

The effect of a closure on the flatfish fisheries is, in all probability constrained to a certain period of time when the fishing might be better in the closed area than elsewhere. The flatfish fisheries, including the yellowfin sole and rocksole fisheries have a high amount of associated crab bycatch and groundfish discard. In 1992, the yellowfin sole and rocksole fisheries discarded 96,000 and 72,000 king crab, respectively (Pacific Associates, 1993). In addition, 38 percent of the yellowfin sole groundfish catch in 1992 was discarded and 23 percent of the yellowfin sole caught as directed catch was discarded. A portion of these discards result from the derby nature of the current fishery and some discards are associated with roe fisheries. Similarly, 61 percent of the groundfish caught in the rock sole fishery was discarded and 45 percent of the rock sole caught as directed catch was discarded. Groundfish fisheries operate to maximize net returns from retained species but do not necessarily account for the social and/or ecological costs of discarding practices. These discarding practices are mediated only by the relative market value of the species composition of the catch and the internalized costs of sorting and disposing of the undesired catch. There is currently no mechanism to account for alternative values to discarded fish.

Alternative 8 would not have a significant economic impact on the fishery industry because less than 3 percent of the Bering Sea groundfish is harvested in the Pribilof islands area and opportunity to harvest fish traditionally caught in this area can occur elsewhere in the Bering Sea. Therefore, the Assistant General Counsel of the Department of Commerce certified to the Chief Counsel for Advocacy of the Small Business Administration that this action would not have a significant economic impact on

a substantial number of small entities .

Alternative 8 has been determined to be not significant for purposes of the E.O. 12866.

2.4.4 Analysis of Alternative 9: Closure of area defined by blue king crab habitat when 1 percent of previous year's blue king crab abundance is reached.

This alternative, to implement a closure of the defined area (Figure 2.7) after attainment of a predefined limit of king crab, was requested by the Advisory Panel during the September 1993 Council meeting. Some of the assumptions that have been made for this alternative are as follows: (1) that the limit is determined based on 1 percent of the previous year's estimated blue king crab abundance in the Pribilof Islands District (ADF&G management area, west of 168° West and north to 58° 39' North), which does not precisely coincide with the Pribilof Islands area presented in this analysis (extending east to 167° West and north to 58° 30' North); (2) that the bycatch of king crab of all species is accumulated towards the prohibited species limit (PSC); and (3) that the area over which the king crab bycatch is accumulated for application of the PSC is the same as the general Pribilof Islands area referred to in this amendment.

As will be discussed below, there were several concepts associated with this alternative that need to be highlighted. First, the impacts of a closure of the Pribilof Islands area based on a limit were difficult to assess because the NMFS observer data required possibly inaccurate expansion to unobserved hauls. Second, the estimated abundance of blue king crab has a high degree of variability and imprecision as noted by NMFS and ADF&G scientists. The habitat populated by the Pribilof Islands blue king crab is very rocky and difficult to sample with the trawls used in the annual Bering Sea groundfish survey. The confidence intervals around the estimated blue king crab population components often include zero as the lower range of the estimate (Stevens et al, 1992). Third, a 1 percent removal rate may result in differential harvest of size components of the blue king crab population if the crab do not recruit to trawl gear in proportion to their abundance. The number of mature and immature female crab and the number of juvenile, prerecruit and legal male crab change from year to year. If trawl vessels do not take incidental catches of all size components of the population equally, a 1 percent harvest rate can impact the population size components differently.

The data available for this analysis consisted of historic (1980-1992) observer data, which had not been expanded to

unobserved vessels. The observer data was expanded to the unobserved hauls within the general Pribilof Islands area by three methods: (1) expansion based on observer coverage (percent observer coverage for the fleet for the year); (2) expansion based on the ratio of total observed groundfish catch to total reported groundfish catch; and (3) expansion based on the ratio of total observed incidental catch of king crab to total reported king crab. All three methods of data expansion were examined for appropriateness in this analysis in order to arrive at a rough estimate of total king crab bycatch in the Pribilof Islands area. Accurate reports of domestic bycatch of king crab were not readily available outside of Zone 1 and the most appropriate method of expansion was determined to be by the ratio of observed to reported weight of groundfish catch.

Since concentrations of blue king crab in particular are available in the vicinity of the Pribilof Islands, since bycatch can vary with time, and since numbers of the smaller crab are available in the vicinity of the Pribilof Islands, expanded bycatch numbers are of unknown validity, but are expected to be conservatively low. The smaller crab, especially, can experience damage when passing through or being retained in the nets, and yet many of these will necessarily be unobserved.

In proposing the analysis for this alternative, the desired limit was requested to be based on 1 percent of the estimated population size from the previous year. The selection of a 1 percent limit is not based on any specific population parameters and may not be scientifically justified. The blanket adoption of such a level may be questionable, and should be considered with caution. Figure 2.14 portrays the population information presented in Figure 2.4 scaled down to 1 percent of the estimated population. In addition, the observed bycatch and adjusted bycatch (by the ratio of observed total groundfish catch to total reported groundfish catch) have been provided (Figure 2.14). The proportion of the population comprised of any particular size or sex group can vary from year to year. Thus, 1 percent of the actual population being taken as bycatch is not composed of equal proportions of each size category. In 1980, the female component of the population represented the vast majority of the population in that year (92 percent). The population did not contain the harvestable component (prerecruit and legal male crab), which might be expected for the overall population size. Legal male crab comprised a small segment of the population until 1990 when their numbers began a slow increase. This lack of response in the legal male component has occurred in spite of a discontinuation of directed fishing since 1987. A focus on the total population abundance can ignore population components that can be under greater stress than the population as a whole.

The data indicates that the trawl fisheries capture, on the average, crab that weigh between 2 - 4.5 pounds. Figure 2.15, indicates the average size of all the incidental catch of king crab in the Pribilof Islands area, and the average size of blue king crab as reported annually by the NMFS observer program. For comparison, the directed pot fisheries, which target and retain the larger legal males, capture crab which are 7 - 8 pounds in size (Spalinger and Jackson, 1993). As might be expected, smaller crab on average are taken by trawl nets than in the directed pot fishery, which is exclusively targeting large males. The annual NMFS' reports indicate that on the average the blue king crab taken as bycatch are in the prerecruit or larger size classes. Without actual size distributions, it is difficult to verify that the trawl fisheries take a disproportionate number of crab at larger sizes. The smallest crab would be more likely to slip through trawl mesh, so that crab in the prerecruit size class and larger (e.g., > 110 mm) might be most likely to compose trawl bycatch. The impacts of trawl gear on the smaller crab that are not retained by nets are unknown.

A rough comparison between crab size categories taken in the annual NMFS' trawl survey and as measured by observers on trawl vessels indicates that the crab caught in groundfish trawls are the same size or larger than those encountered by the trawl survey. Figure 2.16 provides the percentage of small crab (small females < 90 mm and juvenile males < 110 mm), which were encountered in trawl and survey tows. The difference in crab sizes taken by trawls can be dependent on tow location as, for instance, larger crab might be located at a greater distance from the Pribilof Islands and more susceptible to trawl gear. However, the hauls with the greatest difference in the percentage of small crab (e.g., 1987, 1988, 1989, and 1991) showed a high degree of overlap between the areas fished by bottom trawlers and the areas populated by crab based on the annual surveys (See Appendices A and B). The overall indication is that trawlers do not take crab of different sizes equally, but tend to take more crab of a certain size (prerecruit) and above, probably due to trawl mesh size.

Given an equal proportion of crab in all size categories, and given equal trawl bycatch of each size category, trawlers would not be expected to have great impacts on any one size category. The population is highly variable in size components and indications are that trawl vessels tend to retain crab in the larger size categories. A harvest of 1 percent of the population by trawl vessels could have unanticipated impacts on a size class. For instance in a population with few large (i.e., mature) individuals (few large females - which spawn biennially - and few prerecruit and legal males), the capture of 1 percent of the more numerous smaller individuals might lead to a disproportionately high bycatch of larger individuals.

Expected Impacts:

As can be seen in Figure 2.14, the 1 percent of the estimated population from the previous year (the figures have been lagged appropriately so that the abundance from the prior year is compared with the bycatch in the year) would have limited the estimated bycatch of king crab in only a few of the last 13 years. This is, again, given the proper expansion of estimated observable bycatch numbers, and abundance of the entire population (regardless of size composition). The fact that a bycatch level equal to 1 percent of the population was not attained in the early 1980's is not surprising given the high population levels. The lack of attainment of 1 percent of the estimated abundance is also not extraordinary in the years 1985 - 1989 when the population was at extremely low levels. There were not many crab available for bycatch at these low levels. The increase in bycatch since 1989 (with the exception of 1990) appears to have been higher than previously encountered. The proportion of king crab taken in 1991 and 1992 was greater than the subsequent population increases in the early 1990's. Adoption of a 1 percent level for a limit would have closed the fishery in 1989 and in 1992, and given higher bycatch levels experienced by the domestic fisheries, this pattern could be expected to continue in the future. It is also evident in Figure 2.17 that the impact of the domestic trawl fisheries in recent years has been greater on the crab within the Pribilof Islands area than in any of the previous years. Nearly one third of all of the king crab taken in the Bering Sea in 1991 and 1992 were taken within the Pribilof Islands area.

Closure due to a limit, which is equal to 1 percent of the population, would have economic impacts on the trawl fleets similar to Alternative 8 (section 2.4.3.5) above, but reduced because of the ability to capture some groundfish within the closure boundaries prior to the attainment of the limit. If the limit is not attained, impacts would be the same as status quo. It is expected that management costs would be higher under this alternative than under Alternative 8 because of increased costs to the management agencies to account for crab bycatch within the defined area. Because limit accounting involves monitoring of the bycatch and prediction of bycatch as the limit is approached, it is often the case that the total bycatch exceeds the limit before the closure is implemented. It would be expected that the impacts on crab stocks could often exceed 1 percent of the estimated abundance, thus reducing the anticipated savings. Additional impacts imposed by a limit based on abundance is dependant on the sex and size composition of the incidental catch. Disproportionate harvest of mature crabs reduces reproductive potential while disproportionate removal rates of pre-recruit and legal crabs decrease available targeted catch and can exacerbate overfishing at low stock sizes.

If a limit is considered that is based on the abundance of the population, it would be important to anticipate effects on individual segments of the population rather than on a population total. The Pribilof Islands area is critical to juveniles so that this segment of the population should be protected as much as possible, but the population itself is maintained by the mature segment of the population. The male segment of the mature population has been depressed in recent years, and only half of the female segment of the population is reproductively viable in any given year. A set percentage removal of the population must be justified by clearly identified biological objectives.

2.4.5 Analysis of Alternative 10: Closure of area defined by blue king crab habitat when 20,000 king crab have been taken as incidental catch.

The effects of a constant limit of 20,000 crab are similar to those presented under Alternative 9 above. A 20,000 crab limit would have closed the domestic fisheries in the area in 1989, 1991, and 1992. Figure 2.18 indicates that the 1989 fishery would have stopped in October, the 1991 fishery would have been halted in May, and the 1992 fishery would have been stopped in August given a 20,000 crab limit. The amount of groundfish catch taken within the area defined for closure following these dates was minimal in 1989, accounted for approximately 12 percent of the Pribilof Islands area catch in 1991 and approximately 6 percent of the Pribilof Islands area catch in 1992. Assuming that the groundfish taken in the closure zone could not be made up elsewhere, the maximum effects of the closure based on historic data are shown in Figure 2.19. This figure compares groundfish catch for the year with groundfish catch minus the catch that came from the closed area. Given that the catch foregone in the closure area could be made up elsewhere in the general Pribilof Islands area or in the rest of the Bering Sea, the actual impacts of such a closure are expected to be minimal.

The adoption of a constant limit of 20,000 crab would have the most negative impact on the blue king crab population at smaller population sizes because 20,000 crab would represent a higher proportion of the total population. The 20,000 crab limit was higher than 1 percent of the population in 1986, and approximately the same as 1 percent of the population in 1987-1989. As the abundance of blue king crab increases from depressed levels, the higher the bycatch encounter rate would be, and the earlier the trawl fisheries would be closed. A limit at this level would help protect, for instance, low levels of legal male crab since the individual components of the population are not expected to become as low as 20,000 crab. Unfortunately, the

better the health and size of the crab stocks, the heavier the penalty on the trawl fisheries. The economic costs under this alternative are expected to be similar to those seen under Alternative 9 above when blue king crab abundance is low, and more similar to Alternative 8 (permanent closure) above when the crab abundance is high.

2.4.6 Analysis of Alternative 11: Permanent closure of a subarea near the Pribilofs with closure of area defined by blue king crab habitat when a limit is reached.

In response to a request by the AP, an additional alternative examines the effects of maintaining an area of permanent closure to trawling in the immediate vicinity of the Pribilof Islands. The larger closure area defined by blue king crab habitat would be closed as well upon attainment of a PSC.

The subarea defined for permanent closure encompasses the 60 m depth contours surrounding the Pribilof Islands as requested by the Advisory Panel and the area between the Pribilof Islands. Armstrong et al (1985) indicated that depths to 60 m in the vicinity of the Pribilof Islands provide critical habitat for juvenile king crab. The subarea boundaries were drawn to ensure the inclusion of this critical juvenile habitat (Figure 2.20) as well as areas important to female crab. Review of the annual NMFS survey maps in Appendix A, especially the years of low abundance from 1985-89, reconfirm that some of the critical area has been preserved. The defined subarea largely follows the coordinates of the larger area proposed for closure to ease management of the closure. The coordinates for the area are as follows:

Latitude	Longitude
56.5	169.735
56.93	170.36
57.23	171.0
57.5	171.0
57.5	169.04
56.57	169.04
56.5	169.42

It should be noted that the area defined for closure under Alternative 8 was chosen as a minimum area to protect blue king crab stocks. The distribution of blue king crab often exceeded the boundary that had been defined, however, the core population appeared to center within the boundary. Care was taken in drawing the main closure zone boundary to protect crab habitat while at the same time minimizing the effect on bottom trawl operations. The subarea as defined above further reduces

protection to blue king crab stocks, and fishing along the boundary of the smaller subarea may allow large impacts on the blue king crab population.

A comparison of groundfish catch, king crab bycatch, and trawl effort between the general Pribilof Islands area, the area defined for closure, and the subarea defined for permanent closure are provided in Figures 2.21 - 2.23 for the years 1980 - 1992. Table 2.5 provides a detailed comparison by target fishery for the 1991 and 1992 domestic fisheries. In general, the Pribilof Islands area has provided between 5 percent and 20 percent of the total Bering Sea groundfish catch in the foreign and joint venture fisheries, and between 10 percent and 20 percent in the domestic fisheries. Up to 10 percent of the total Bering Sea groundfish catch came from the area defined for closure in the foreign fishery (1981), but the closure area has only provided roughly 2.5 percent of the total Bering Sea groundfish catch to the domestic fishery in 1989, and less than 2 percent in 1991 or 1992. Furthermore, the subarea defined for permanent closure provided less than 1 percent of the total groundfish catch in either 1991 or 1992. A similar pattern for fishing effort can be seen in Figure 2.23.

In contrast to groundfish catch and effort, a high proportion of the crab taken in the general Pribilof Islands area are taken within the area defined for closure, and in some years almost all of the crab were also taken within the subarea defined for permanent closure. King crab bycatch in the general Pribilof Islands area represented the highest proportion of Bering Sea incidental catch of king crab in the 1991 and 1992 domestic groundfish fisheries (30 percent and 33 percent, respectively). The majority of these crab were taken in the area defined for closure, and this area accounted for 21 percent and 26 percent of all of the incidental catch of crab in the Bering Sea in 1991 and 1992, respectively. The subarea defined for permanent closure accounted for approximately one half of the crab taken in the larger area defined for closure. Depending on fishing effort, the subarea defined for permanent closure will not protect crab stocks to the degree provided under the larger area.

Expected Impacts:

Given a limit on king crab bycatch (1 percent of blue king crab abundance or 20,000 king crab), which triggers a closure of the defined zone, maintenance of a subarea permanently closed to trawling would help protect some of the blue king crab stocks. It should be noted that the amount of groundfish taken in the portion of the area defined for closure which was outside of the subarea defined for permanent closure was small in relation to the number of crab that were taken outside of the permanently closed subarea. The proportion increase in groundfish made

available outside of the permanently closed subarea is very small compared to the proportion of crab that are caught outside of the permanently closed subarea.

The savings to blue king crab are increased over Alternatives 9 and 10, but are not as great as the savings under Alternative 8. The small impacts on groundfish catch under Alternative 8 are reduced further under Alternative 11 but are not as great as the reduction in impacts under Alternatives 9 and 10. Alternative 11 incorporates all of the management costs under Alternative 8 and adds the costs of monitoring the closure of the subarea, and also includes the bycatch accounting costs under Alternatives 9 and 10, thus it would incur the highest management costs.

2.5 Other considerations:

2.5.1 Red king crab

Few red king crab were detected in the Pribilof Islands area by the annual NMFS' trawl survey until 1988. Since 1988 red king crab abundance has increased in the area immediately surrounding St. Paul Island, especially at the western end of the island (Figures A.21 - A.25). A small directed red king crab fishery was recommended for the 1993 season, and occurred in an area to the north of the area defined for closure in this amendment.

2.5.2 *C. bairdi* Tanner crab

C. bairdi Tanner crab are distributed across the Bering Sea shelf and are numerous in the Pribilof Islands area, especially between the two islands and to the west in the deeper waters between the 200 m and 100 m contours. Survey catches for 1975, 1980, 1985, and 1990 are presented in Figures A.26 - A.29. *C. bairdi* Tanner crab apparently experienced a decrease in abundance during the mid-1980's.

2.5.3 Korean Hair crab

According to the 1992 and 1993 NMFS' surveys, there are two major populations of Korean hair crab stocks in the southern Bering Sea. The first is located north of the Alaska Peninsula in Bristol Bay, and the second larger population is concentrated in an area contiguous to the Pribilof Islands. Catches of Korean hair crab have been sporadic and incidental to the other crab fisheries in the area. A directed fishery by 12 vessels produced

a catch of 1.2 million pounds during October, 1992. The 1993 fishery will occur incidental to the *C. bairdi* Tanner crab fisheries in the area, with an estimated guideline harvest level of 2.5 million pounds, the largest harvest since 1980. The proposed trawl closures will effectively protect these major stocks associated with the Pribilof Islands.

2.5.4 Pacific Halibut

Pacific Halibut are distributed somewhat ubiquitously throughout the southern Bering Sea. Since the closure of an area leads to fleet displacement, there were concerns that such a displacement would move vessels into areas with a higher bycatch of halibut. Data from observed vessels was examined to determine the mean number of halibut and the mean weight (kg) of halibut taken per tow. Because not all tows are taken on the bottom, and because tows classified as pelagic can still occur on the bottom, only hauls that encountered halibut are presented in Figures 2.24 and 2.25. Both the mean number of halibut per tow and the mean weight of halibut per tow can vary from year to year, and there is no indication that bycatch was consistently higher or lower in the area defined for closure, in the general Pribilof Islands area, or in the Bering Sea. This pattern was similar when all hauls (including those with zero halibut) were examined.

The number of hauls that contained halibut and the number of hauls with no halibut were also compared. The percentage of hauls which contained halibut tended to be higher within the area defined for closure than in either the Pribilof Islands area or the Bering Sea (Figure 2.26). Based on these results, displacement of the fleet outside of the area defined for closure would not be expected to increase the bycatch of halibut in neighboring areas.

The bycatch rates of halibut (expressed as number of halibut per metric ton of groundfish catch) in the entire Bering Sea, within the general Pribilof Islands area, and within the area defined for closure were also compared. As Figure 2.27 indicates, bycatch rates are variable from year to year, however, the bycatch rates within the area defined for closure tended to be somewhat higher than in either of the other two areas. Halibut bycatch rates would not be expected to be higher outside of the closure area, and may in fact be reduced if fleet activity moves away from the Pribilof Islands.

Closure of the defined area would not be expected to increase halibut bycatch in other areas, and would move vessels out of an area with generally higher halibut bycatch rates.

2.5.5 Seabirds

Red-faced cormorant, northern fulmar, black-legged and red-legged kittiwakes, least auklet, common and thick-billed murres, parakeet auklet, crested auklet, and horned puffin are among the most common nesting and feeding seabirds in the Pribilof Islands. Seabird density in the BSAI fluctuates seasonally and assessments for Amendments 18/23 (1991a) did not postulate a trend for the area. The assessment noted that about 88 percent of the world population of red-legged kittiwakes and 92 percent of the Alaskan thick-billed murre population breed on the Pribilof Islands. According to the assessment, these species' populations have exhibited poor reproductive success in recent years, resulting in population declines. The diets of murres, black-legged kittiwakes, and other species include pollock and other fish species taken in directed fisheries and as bycatch.

The effects of the Bering Sea groundfish trawl fishery on habitats and food resources used by seabirds is not well documented. Byrd and Piatt of the U.S. Fish and Wildlife Service have provided geographical distribution ranges of various seabird species on and surrounding the Pribilof Islands (Appendix C). The data provided by Byrd and Piatt indicates that the proposed trawl closure may reduce disturbance to nesting and foraging seabirds and their prey resources, and would likely benefit species that forage within that zone. The proposed closure zone would encompass many of the areas of heavy foraging indicated by the maps provided, but would not include important foraging areas to the south of St. George Island beyond the shelf break.

Specifically, this proposal would provide little coverage of the forage areas utilized by red-legged kittiwakes and Northern fulmars. Only some protection would be provided for black-legged kittiwake forage areas. However, the proposed area should provide significant protection to forage areas for red-faced cormorants, murres spp., common murres, thick-billed murres, least auklets, parakeet auklets, crested auklets, and horned puffins.

2.5.6 Marine mammals

Impacts on Marine Mammals

Marine mammals not listed under the Endangered Species Act that may be present in the Bering Sea/Aleutian Islands include cetaceans, [mike whale (Balaenoptera acutorostrata), killer whale (Orcinus orca), Dall's porpoise (Phocoenoides dalli), harbor porpoise (Phocoena phocoena), Pacific white-sided dolphin

(Lagenorhynchus obliquidens), and the beaked whales (e.g., Berardius bairdii and Mesoplodon spp.)] as well as pinnipeds [northern fur seals (Callorhinus ursinus), and Pacific harbor seals (Phoca vitulina)] and the sea otter (Enhydra lutris).

Of the marine mammals inhabiting the BSAI, the assessment for Amendments 18/23 (1991a) discussed three species in some depth that were important in the Pribilof Islands: Steller sea lions (*Eumetopias jubatus*), northern fur seals (*Callorhinus ursinus*) and Pacific harbor seals (*Phoca vitulina*). The Steller sea lion is listed as threatened under the Endangered Species Act (ESA). About two-thirds of the world population of northern fur seals is associated with the Pribilof Islands and, although the population is currently stable, it is listed as depleted under the MMPA. Pacific harbor seals in Bristol Bay and westward along the North side of the Alaska Peninsula have remained stable and have shown no declines in trend since the mid 1960s. Pollock were important in the diets of these three pinnipeds, and the Pribilof Islands were particularly important habitat for the northern fur seal. A 10-nautical mile (19 kilometer) radius "no trawling" zone is in effect around the Walrus Island Steller sea lion rookery near St. Paul Island in the Pribilofs. Given the available information and the existing regulations for the areas around the Pribilof Islands, the fishery there was judged to meet the "no jeopardy" standard of the ESA. The MMPA only applies to incidental takes of marine mammals. However, it is possible that additional information on the ecosystem requirements of marine mammals may indicate that the existing regulations need to be modified in order to optimize marine mammal populations (Sue Mello, NMFS, personal communication, May, 1992).

Under the status quo, management strategies and enforcement practices would not change. Therefore management and enforcement costs would not be expected. Under closure of an area to protect blue king crab habitat, any effects on sea lions and fur seals due to trawl gear would be reduced.

Impacts on Endangered, Threatened, or Candidate Species

Listed and candidate species that may be present in the BSAI are discussed in detail in the EA/RIR/IRFA conducted on the 1993 Total Allowable Catch Specifications for the BSAI and the pollock nonroe season delay.

Species that are listed, or proposed to be listed, under the Endangered Species Act that may occur in the Bering Sea/Aleutian Islands include: the endangered fin whale (Balaenoptera physalus), sei whale (Balaenoptera borealis), humpback whale (Megaptera novaeangliae), sperm whale (Physeter catodon) and short-tailed albatross (Diomedea albatrus); the threatened

Steller sea lions (Eumetopias jubatus), and Snake River fall chinook salmon (Oncorhynchus tshawytscha); and the proposed spectacled eider (Somateria fischeri). Listed species of whales are not expected to be affected by the proposed alternatives. Steller sea lions are expected to benefit from Alternative 2 through 14 and particulary from the preferred alternative (Alternative 8). Under all of the alternatives, listed species of seabirds would not be adversely affected in any manner that has not been considered in previous Section 7 consultations with the USFWS (February 1, 1993). Listed species of Pacific salmon would not be adversely affected in any manner that has not already considered in an informal Section 7 consultation conducted on the 1994 BSAI and GOA Groundfish FMPs and the proposed delay of the pollock nonroe season (April 21, 1993). No further consultation pursuant to section 7 of the ESA is required.

Listed species of salmon, including the Sacramento River winter-run chinook salmon and Snake River sockeye salmon, fall chinook and spring/summer chinook salmon may be present in the BSAI.

Endangered, threatened, proposed, and candidate species of seabirds that may be found within the regions of the BSAI where the groundfish fisheries operate, and potential impacts of the groundfish fisheries on these species are discussed in the Environmental Assessment prepared for the BSAI groundfish 1994 TAC specifications. USFWS, in the informal consultation on the 1994 specifications (February 1, 1994), concluded that groundfish operations are likely to result in an unquantified level of mortality to short-tailed albatrosses, a listed species, but will not jeopardize the continued existence of the population. The take level was not expected to exceed that authorized in the USFWS consultation conducted on the implementation of the Marine Mammal Exemption Program (1988). Alternative 8 is not expected to affect any proposed, candidate, or listed seabirds in a manner not already authorized in previous consultations.

Coastal Zone Management Act

Each of the alternatives would be conducted in a manner consistent, to the maximum extent practicable, with the Alaska Coastal Management Program within the meaning of section 30(c)(1) of the Coastal Zone Management Act of 1972 and its implementing regulations.

Conclusions or Finding of No Significant Impact

None of the alternatives are likely to significantly affect the quality of the human environment, and the preparation of an environmental impact statement for selection of Alternative 8 as the proposed action is not required by section 102(2)(C) of the National Environmental Policy Act or its implementing regulations.

2.5.7 Effects of trawling

Because of the dynamic nature of the ocean environment, it is difficult to determine the links between bottom trawling and environmental changes (Jones, 1992). In his review of the environmental impacts of bottom trawling, Jones states:

> Research has established that the degree of environmental perturbation from bottom trawling activities is related to the weight of the gear on the seabed, the towing speed, the nature of the bottom sediments, and the strength of the tides and currents. The greater the frequency of gear impact on an area, the greater the likelihood of permanent change.

The long-term impact bottom trawling may have on the benthic communities in the area is difficult to determine, especially since many of the locations for which possible effects have been noted are also subject to various other influences such as man-made pollution.

The impacts of both bottom and pelagic trawl gear on marine mammals, seabirds, and crab are difficult to determine. Although sea birds and marine mammals forage from the discard chutes of trawl vessels, it is difficult to determine what effect this behavior has on these surface dependent species and whether or not this behavior causes incidental takings when the trawl gear is being retrieved. The prohibition at 50 CFR 675.7(n) limits the amount of crab that can be taken and determines whether the type of trawl gear is authorized. This prohibition allows NMFS to determine whether trawl gear is being fished on the bottom when directed fishing for pollock with pelagic trawl gear is authorized. In addition, the rock sole and flatfish fisheries contribute the highest bycatch rates to bottom dwelling organisms, including the depleted blue king crab. Therefore, to insure compliance while providing the maximum protection to the habitat, the Council decided at its April 1994 meeting to include all trawl gear in this prohibition.

2.5.8 Effects on Management and Enforcement Costs

All alternatives except for status quo are likely to require an increase in management and enforcement costs because of increased at-sea surveillance to enforce the ban on trawling. If all trawling were forbidden in the area, at-sea boardings would not be required so that cost increases would be reduced. If just bottom trawling were prohibited, it would be necessary to board at-sea to determine if vessels were in compliance. The nature of the closure area being a straight-line polygon decreases difficulties in boundary enforcement. Management costs would be increased under Alternatives 9 - 11 because accounting for bycatch toward a PSC and subsequent closure of an area would require additional monitoring and analytical costs.

2.6 Summary of Analyses

In summary, different areas for trawl closure in the vicinity of the Pribilof Islands have been addressed in this amendment. Two of the areas proposed for closure are based on existing management areas: IPHC Area 4C and IPHC Area 4C west of 169° West (Alternatives 2, 3, 6, and 7). An additional area was proposed that extended outward from the Pribilof Islands 25 miles (Alternatives 4 and 5). The Bering Sea Bycatch Model was used to examine the effects of Alternatives 2 - 7. Only marginal impacts were found to exist between the alternatives and Alternative 1 or status quo.

Historic blue king crab encounters in NMFS annual trawl surveys, bycatch on observed vessels and directed catch of blue king crab have been examined to determine a boundary for trawl closure which would protect blue king crab in the Pribilof Islands area (Alternative 8). The boundary selected does not encompass the entire range of blue king crab in the area, but does surround the habitat with highest blue king crab concentrations. Included in the boundary is habitat vital to juvenile blue king crab, populations of red king crab, and some of the area important to foraging sea birds. The boundary was selected to allow trawl access to the edge of the 100 m contour and the groundfish resources to the east and north of the Pribilof Islands. The boundary was also drawn with straight edges and as few corners as possible in order to facilitate ease of closure enforcement. Analysis has shown little or no impact on pollock or Pacific cod fisheries and a small impact on flatfish fisheries.

A smaller subarea was also defined for permanent closure if the area based on crab habitat (Alternative 8) is closed after a limit had been obtained (Alternative 11). The effects of a limit based on 1 percent of the estimated blue king crab abundance (Alternative 9) and of a limit set at 20,000 king crab

(Alternative 10) were also examined in the amendment. A limit based on 1 percent of the estimated blue king crab abundance can have unexpected effects given differential harvest of varying size components of the blue king crab population. Enforcement costs increase when monitoring for bycatch under either a 1 percent population limit or a 20,000 crab limit.

The overall impact on groundfish fisheries by Alternative 8 is expected to be small in relation to Alternative 1, status quo. The impact on king crab stocks, Korean hair crab stocks, and sea bird foraging under Alternative 8 is expected to be beneficial and contain no negative impacts when compared with Alternative 1. The benefits to crabs, seabirds, and marine mammals under Alternative 8 are reduced in Alternative 9 because of continued access to the area by trawlers until the limit is attained. The benefits of Alternative 8 are reduced by lesser amounts under Alternatives 10 and 11 because of generally lower limit constraints and continued protection of a portion of the area defined for closure under Alternative 8. Alternative 11 would allow an increased bycatch of king crab over Alternative 8 for marginal increases in groundfish catch. Alternatives 9, 10, and 11 all allow greater access to groundfish, but the increased harvest opportunities are minimal in comparison to the increased bycatch of crab which occurs when vessels operate in the area defined for closure in Alternative 8.

FINDING OF NO SIGNIFICANT IMPACT

For the reasons discussed above, implementation of either Alternative would not significantly affect the quality of the human environment. Therefore, the preparation of an environmental impact statement on the preferred alternative is not required by section 102(2)(C) of NEPA or its implementing regulations.

Gary Matlock

12-30-94
DATE

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Appendix A. NMFS annual trawl survey of the eastern Bering Sea. Blue king crab, 1975-1992; Red king crab, 1988-1992; *C. bairdi* Tanner crab, 1975, 1980, 1985, and 1990.

Figure A.1. Locations of annual NMFS trawl surveys, 1975-1992.

Figure A.2. Blue king crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.3. Blue king crab catch in 1976 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.4. Blue king crab catch in 1977 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.5. Blue king crab catch in 1978 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.6. Blue king crab catch in 1979 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.7. Blue king crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.8. Blue king crab catch in 1981 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.9. Blue king crab catch in 1982 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.10. Blue king crab catch in 1983 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.11. Blue king crab catch in 1984 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.12. Blue king crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of

crab. Size of key legend circle = 200 crab.

Figure A.13. Blue king crab catch in 1986 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.14. Blue king crab catch in 1987 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.15. Blue king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.16. Blue king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.17. Blue king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.18. Blue king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.19. Blue king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.20. Blue king crab catch in 1993 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.21. Red king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.22. Red king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.23. Red king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.24. Red king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.25. Red king crab catch in 1992 NMFS trawl survey of

the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.26. *C. bairdi* Tanner crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.27. *C. bairdi* Tanner crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.28. *C. bairdi* Tanner crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.29. *C. bairdi* Tanner crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Appendix B. Observed hauls for which species identification of crab bycatch was made. Foreign, 1982-1987; joint venture, 1985-1989; Domestic 1989 and 1991.

Figure B.1. Blue king crab bycatch in 1982 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.2. Blue king crab bycatch in 1983 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.3. Blue king crab bycatch in 1984 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.4. Blue king crab bycatch in 1985 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.5. Blue king crab bycatch in 1986 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.6. Blue king crab bycatch in 1987 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.7. Blue king crab bycatch in 1985 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.8. Blue king crab bycatch in 1986 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.9. Blue king crab bycatch in 1987 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.10. Blue king crab bycatch in 1988 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.11. Blue king crab bycatch in 1989 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

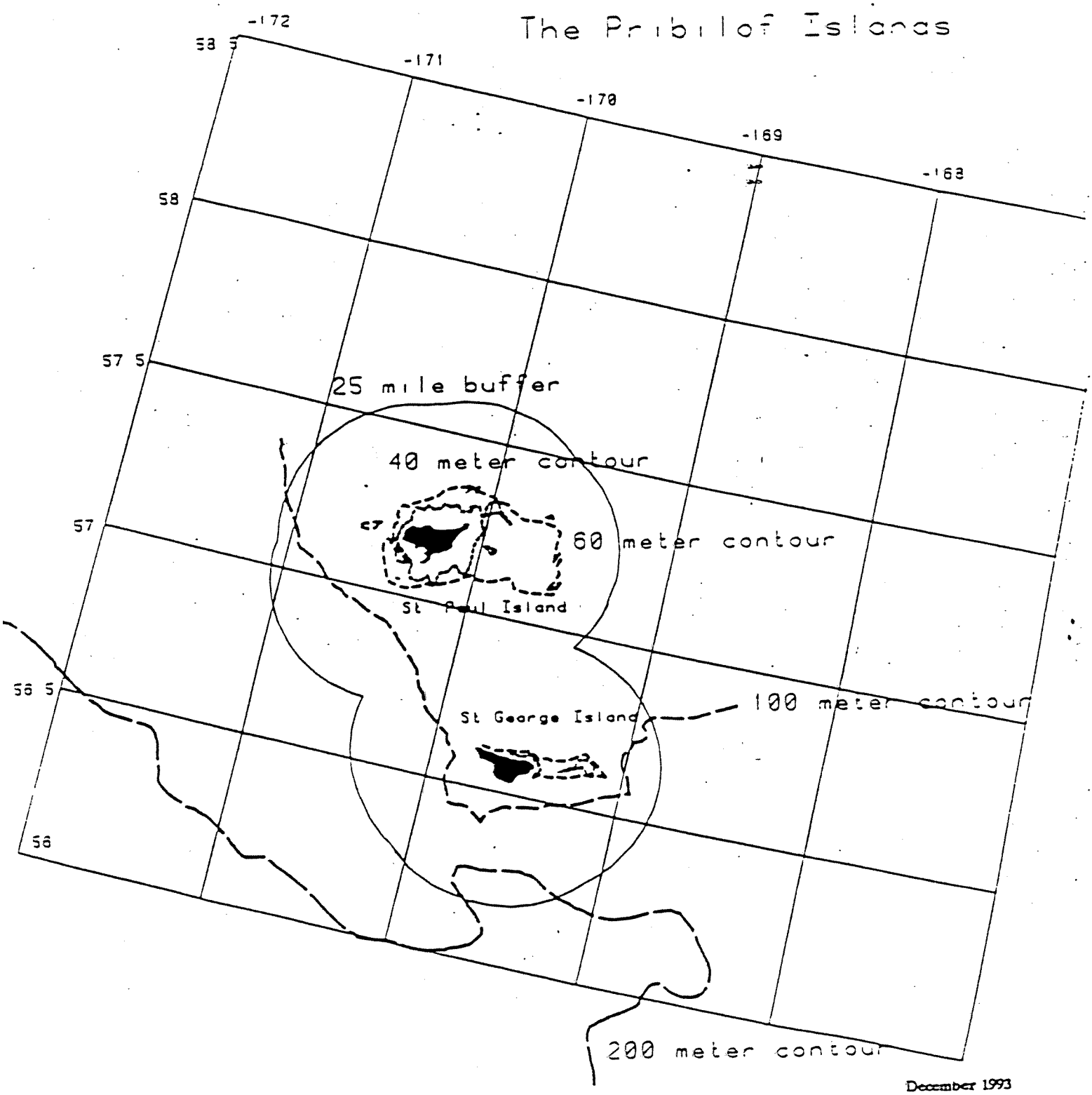
Figure B.12. Blue king crab bycatch in 1989 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.13. Blue king crab bycatch in 1991 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.14. Number of blue king crab identified by observers from each year and target fishery.

Appendix C. Location of seabird foraging areas near the Pribilof Islands. Provided by the U.S. Fish and Wildlife Service.

Figure 2.1. The Pribilof Islands in the Bering Sea with associated depth contours and previously proposed 25 nm buffer.



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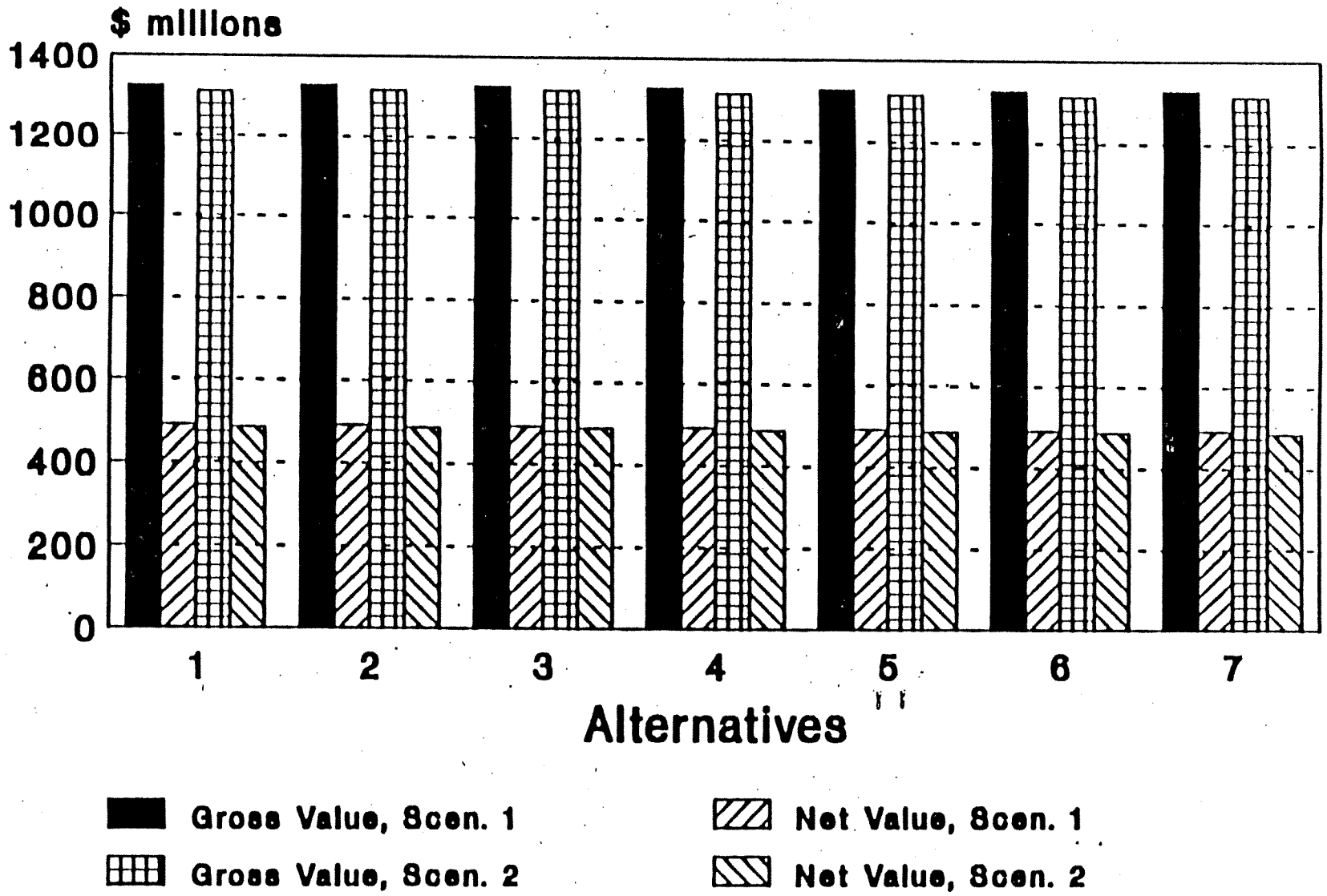

Figure 2.2. Comparison of Groundfish Adjusted Gross and Net Values Among Alternatives and Scenarios. Alternatives and Scenarios Defined in Text and Tables 2.1 and 2.2.

Figure 2.3. Historic blue king crab abundance estimates from NMFS annual trawl surveys and annual directed catch, 1974-1992.

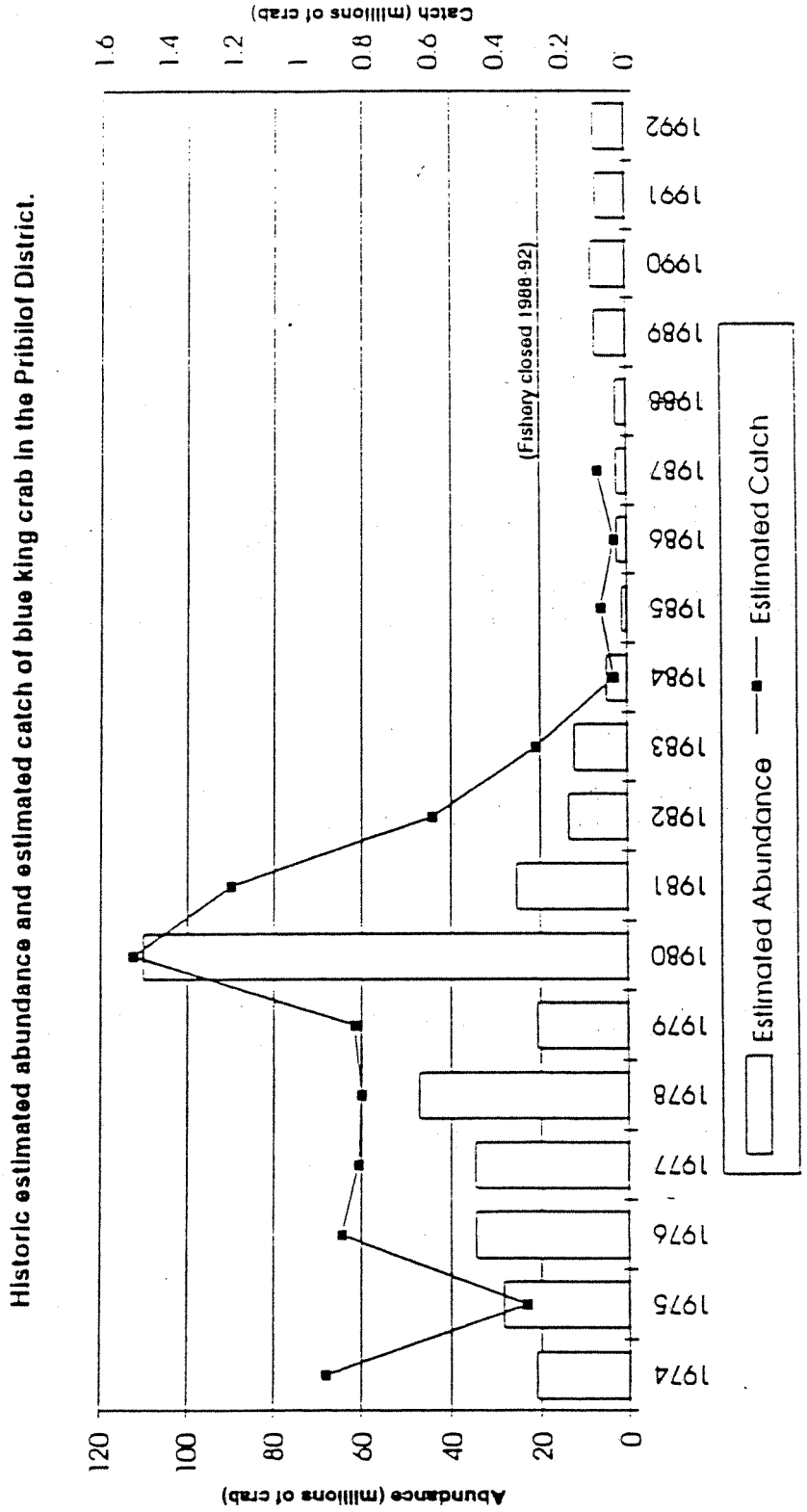

Figure 2.4. Estimated abundance of Pribilof Islands blue king crab abundance by size category, 1980 - 1992.

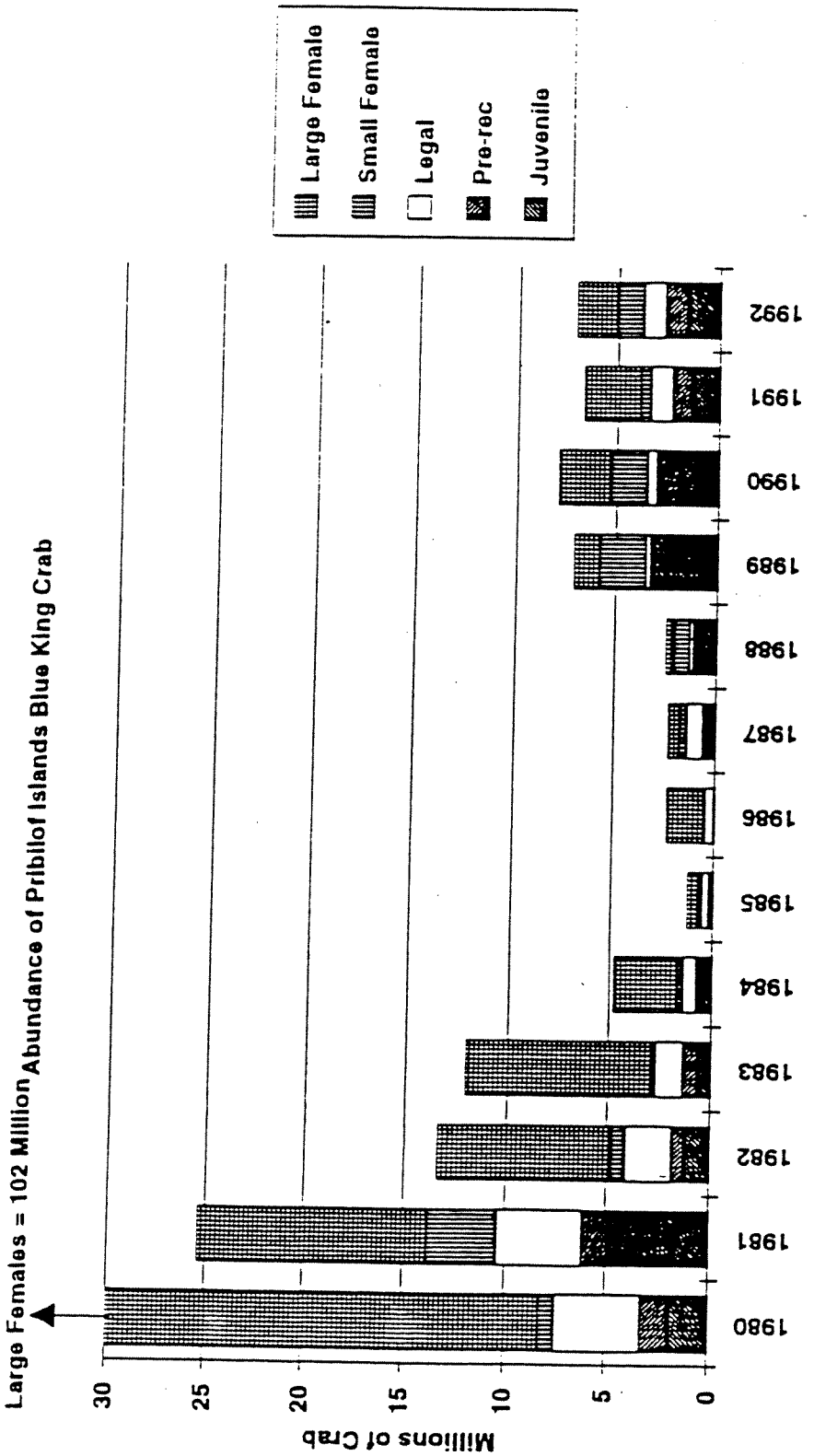

Figure 2.5. Location and catch in numbers of blue king crab in the Pribilof Islands area, 1982/83 season. Blocks represent 1/2 latitude by 1 longitude statistical reporting areas.

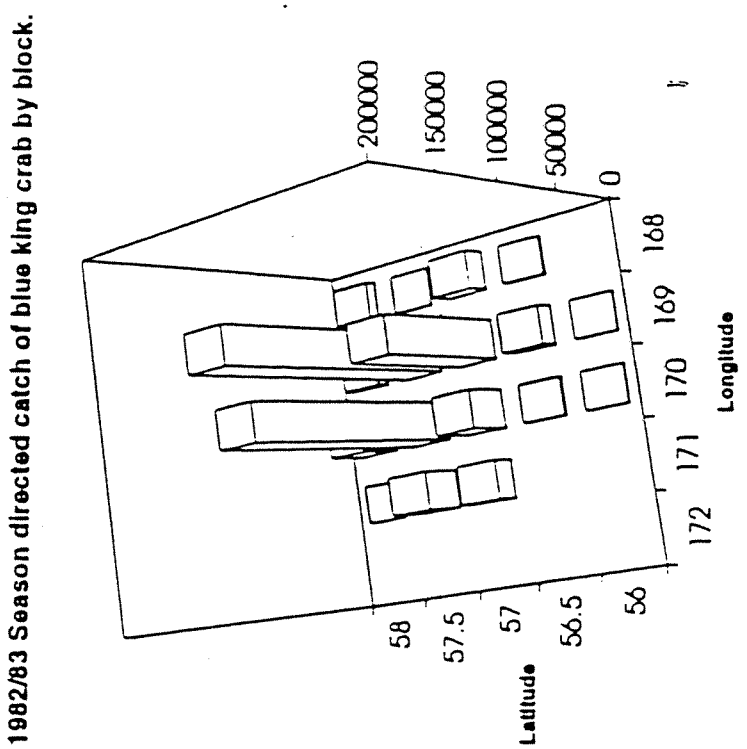

Figure 2.6. Location and catch in numbers of blue king crab in the Pribilof Islands area, 1983/84 season. Blocks represent 1/2 latitude by 1 longitude statistical reporting areas.

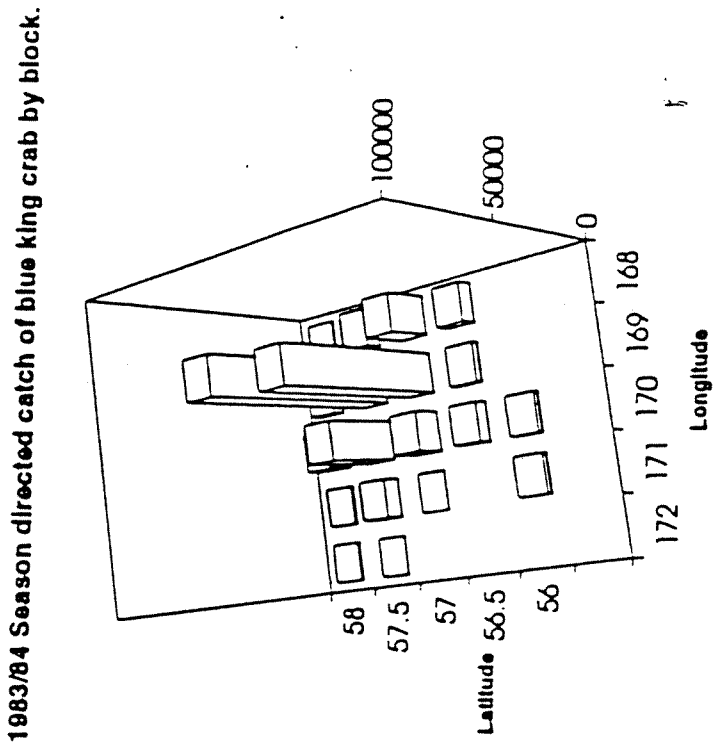

Figure 2.7. Proposed closure area surrounding the Pribilof Islands for blue king crab population and habitat conservation.

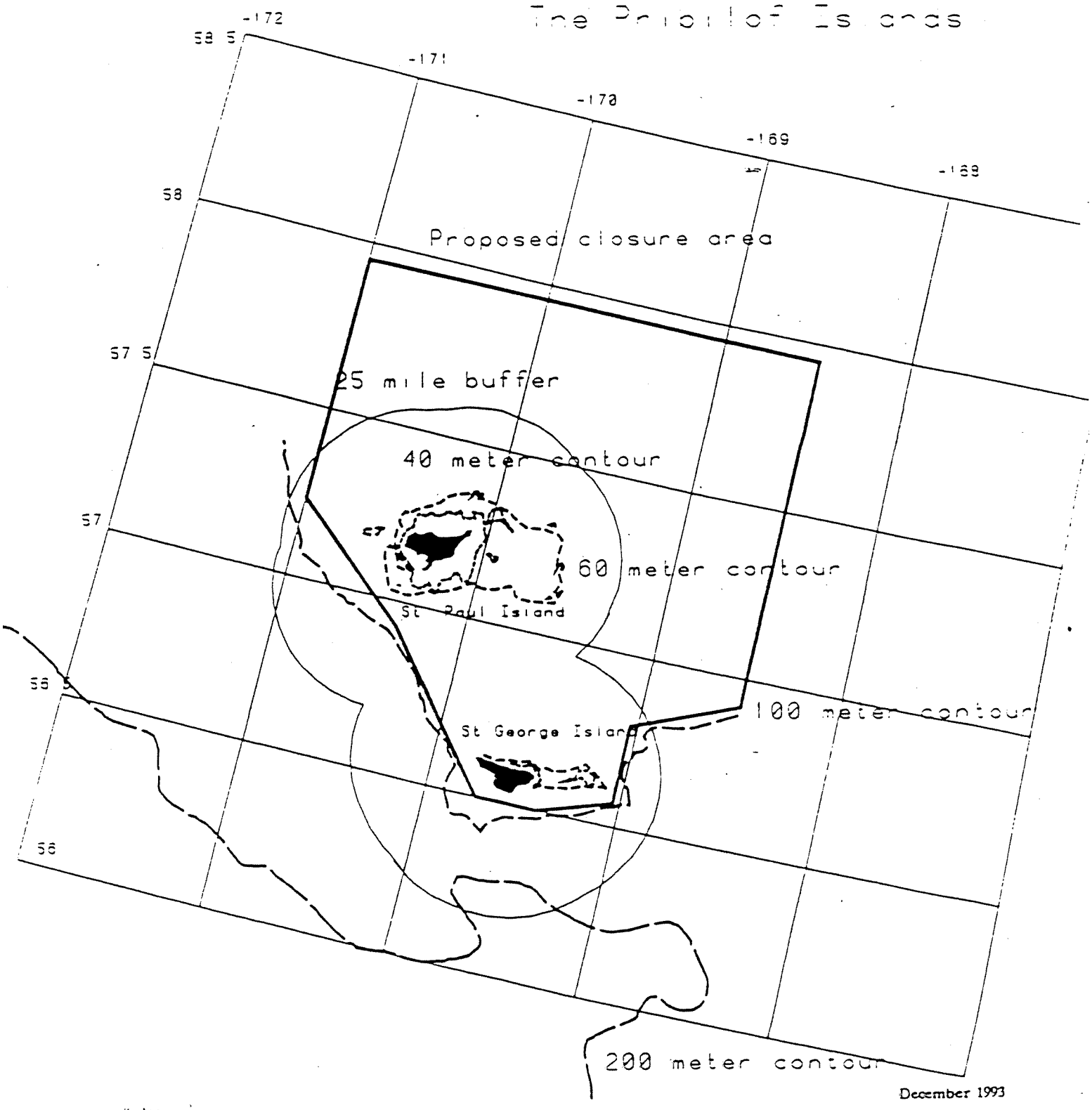

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Figure 2.8. Location of individual observed hauls in the domestic flatfish and other flatfish fisheries, 1990-1992. Heavy line indicates proposed closure area.

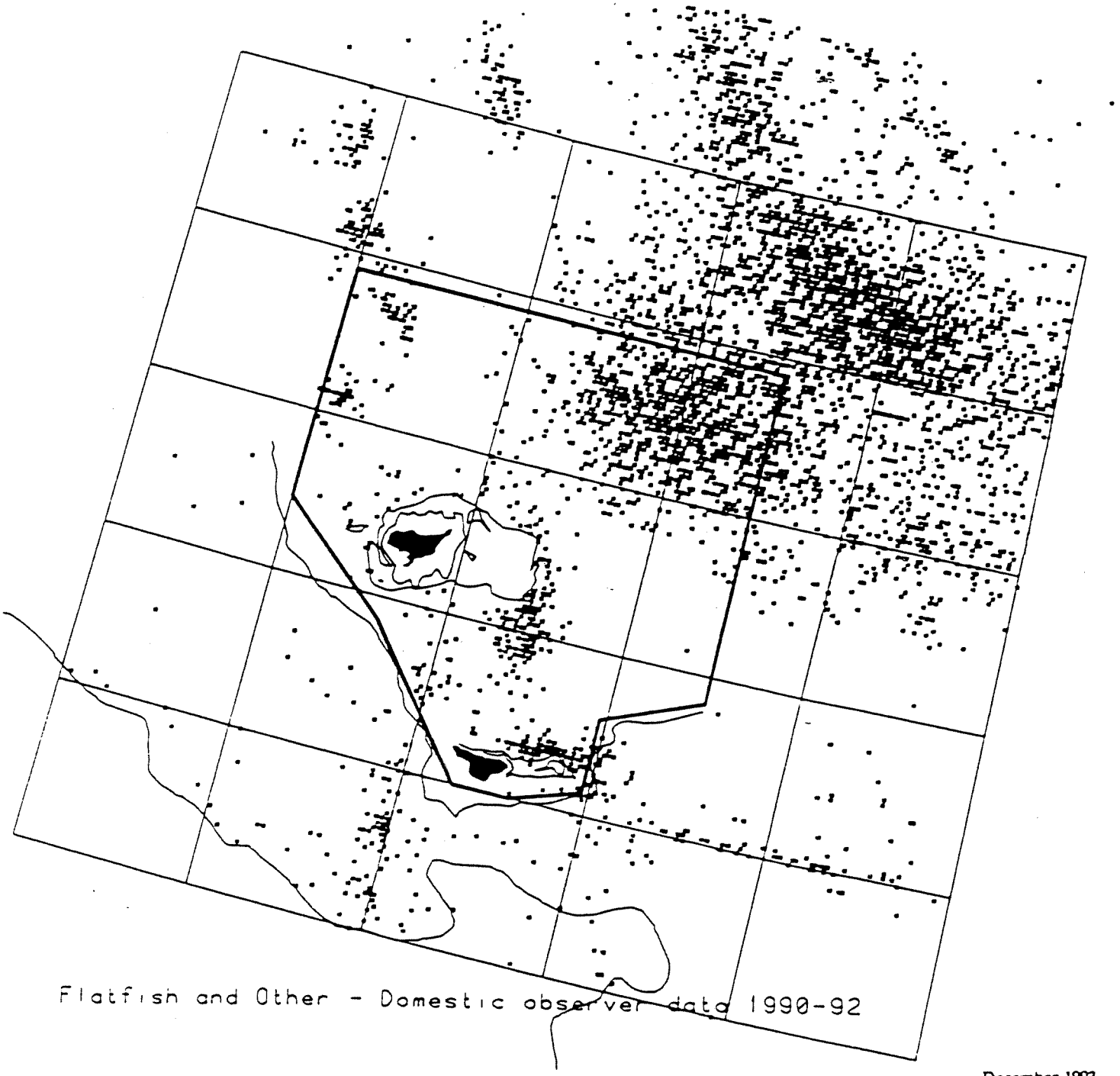


Figure 2.9. Location of individual observed hauls in the domestic fisheries which were not flatfish nor other flatfish fisheries, 1990-1992. Heavy line indicates proposed closure area.

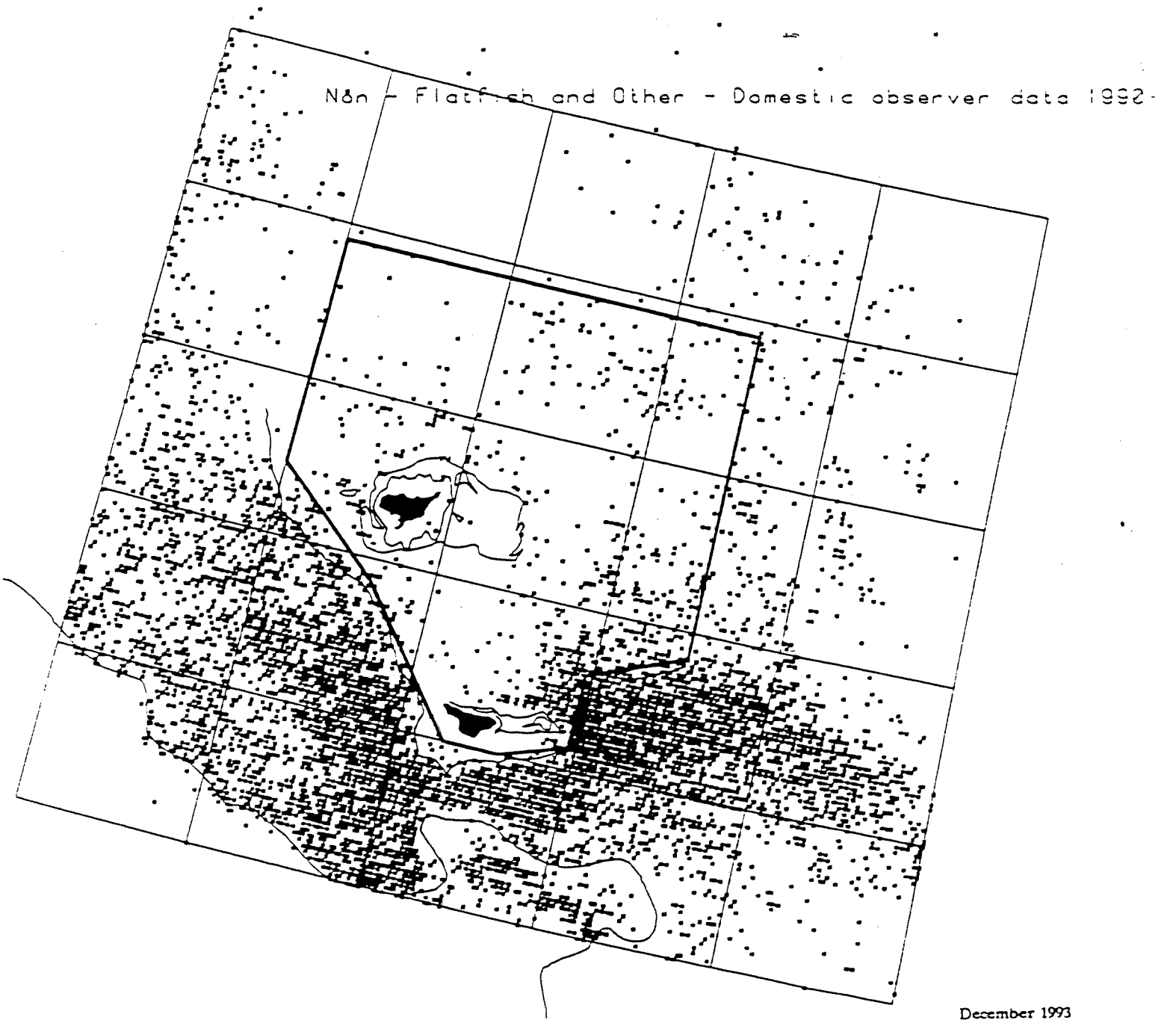


Figure 2.10. Observed groundfish catch in metric tons from the entire Bering Sea, from the general area around the Pribilof Islands, and from the proposed closure zone, 1991.

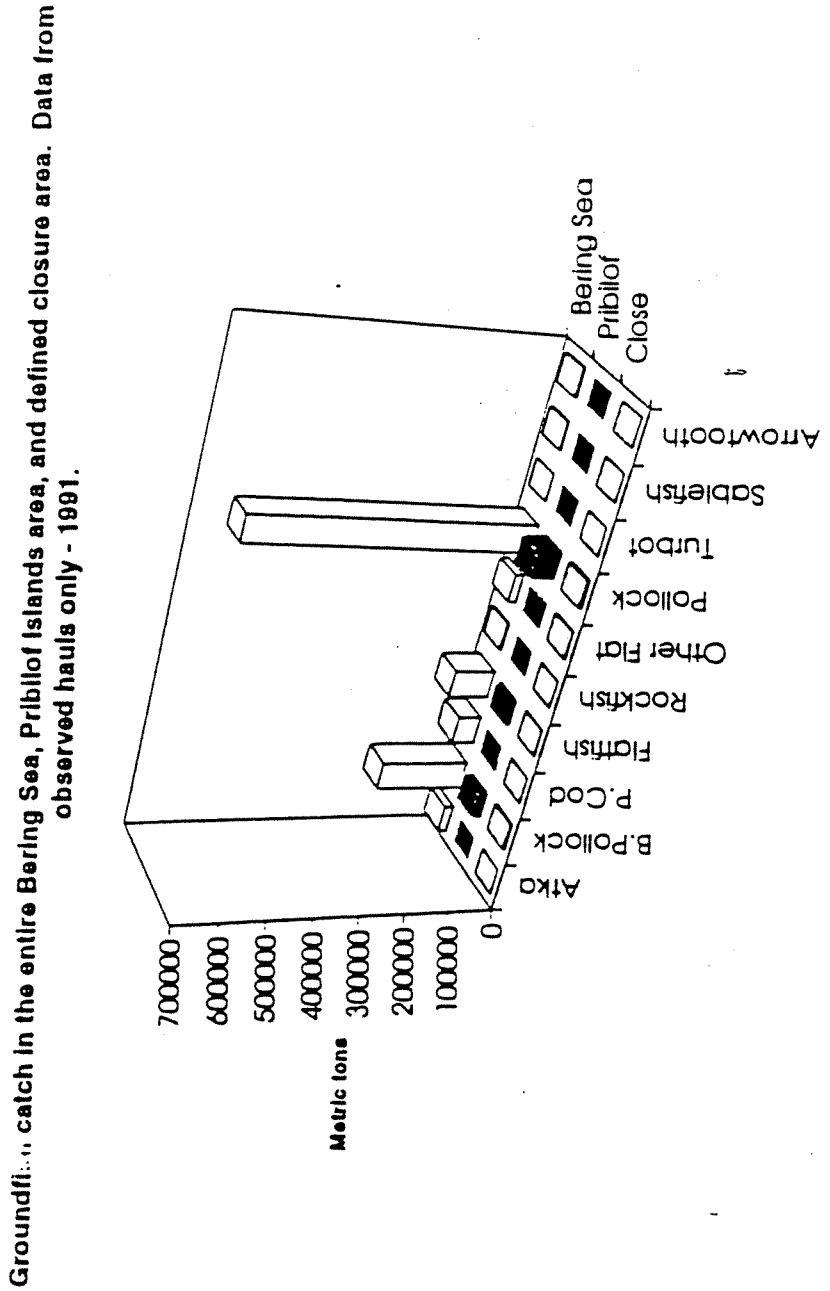


Figure 2.11. Observed groundfish catch in metric tons from the entire Bering Sea, from the general area around the Pribilof Islands, and from the proposed closure zone, 1992.

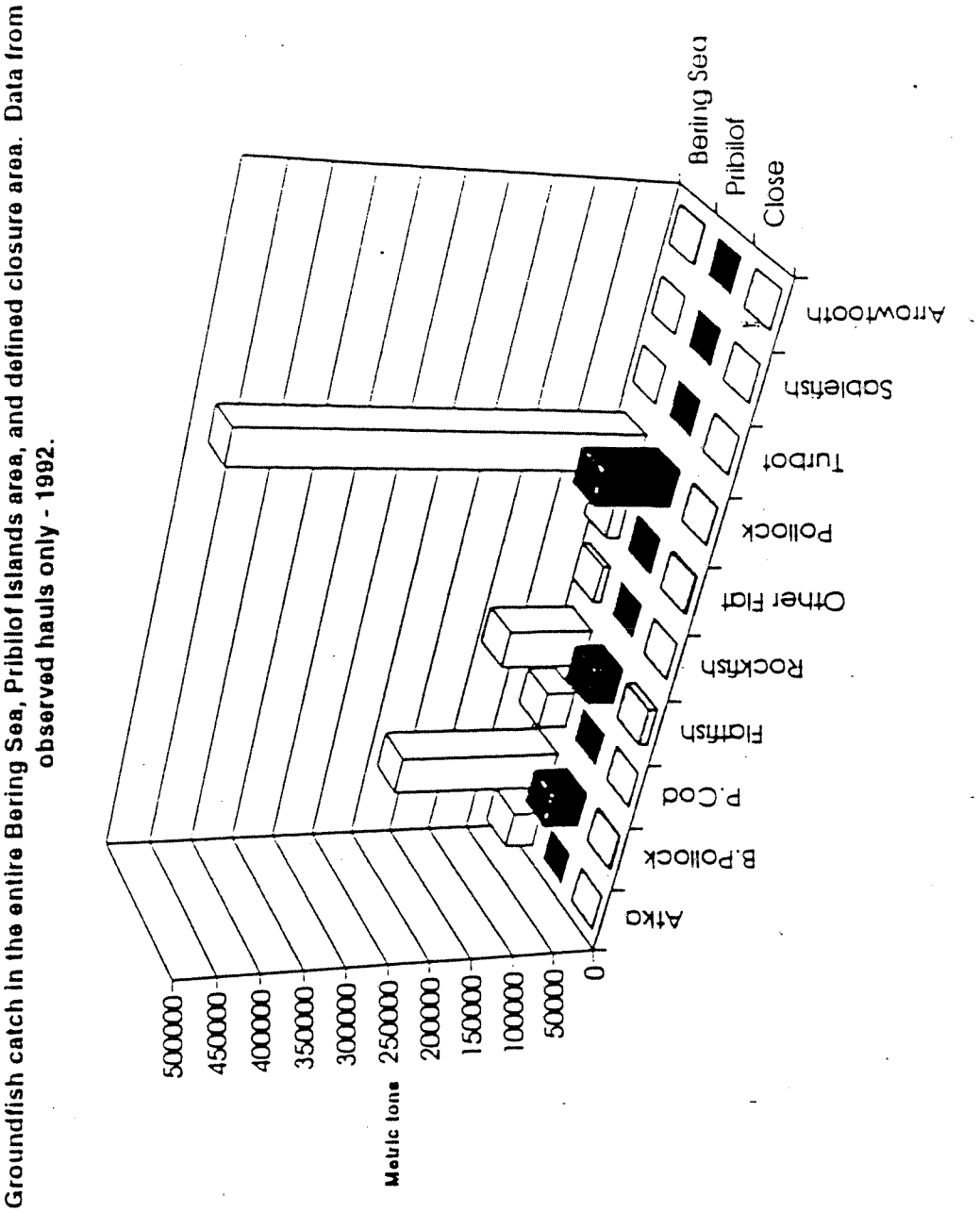


Figure 2.12. Observed king crab (all species) bycatch in metric tons from the entire Bering Sea, from the general area around the Pribilof Islands, and from the proposed closure zone, 1991.

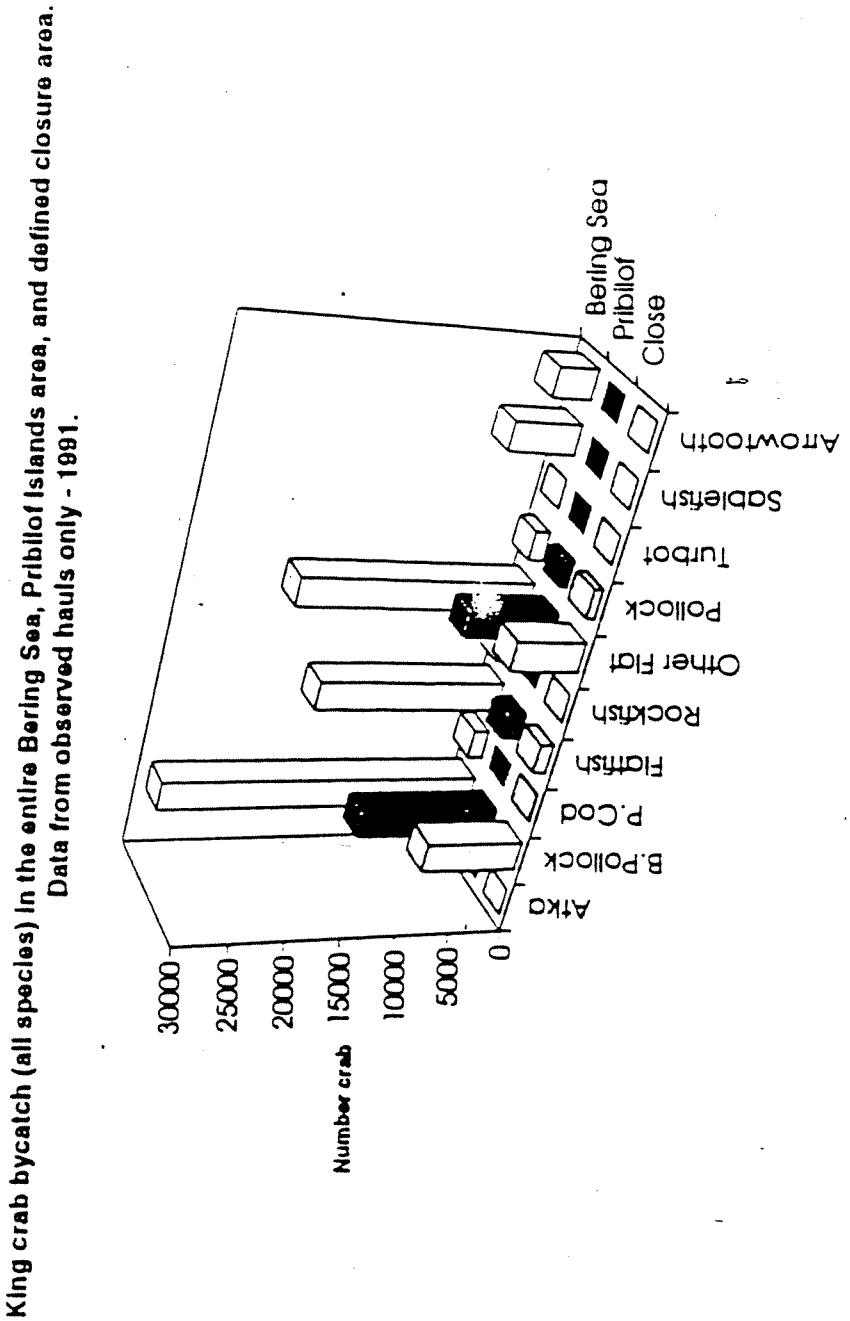


Figure 2.14. One percent of estimated Pribilof Islands blue king crab abundance by size category, 1980-1992. Observed bycatch and bycatch adjusted by ratio of observed to reported groundfish represented by lines.

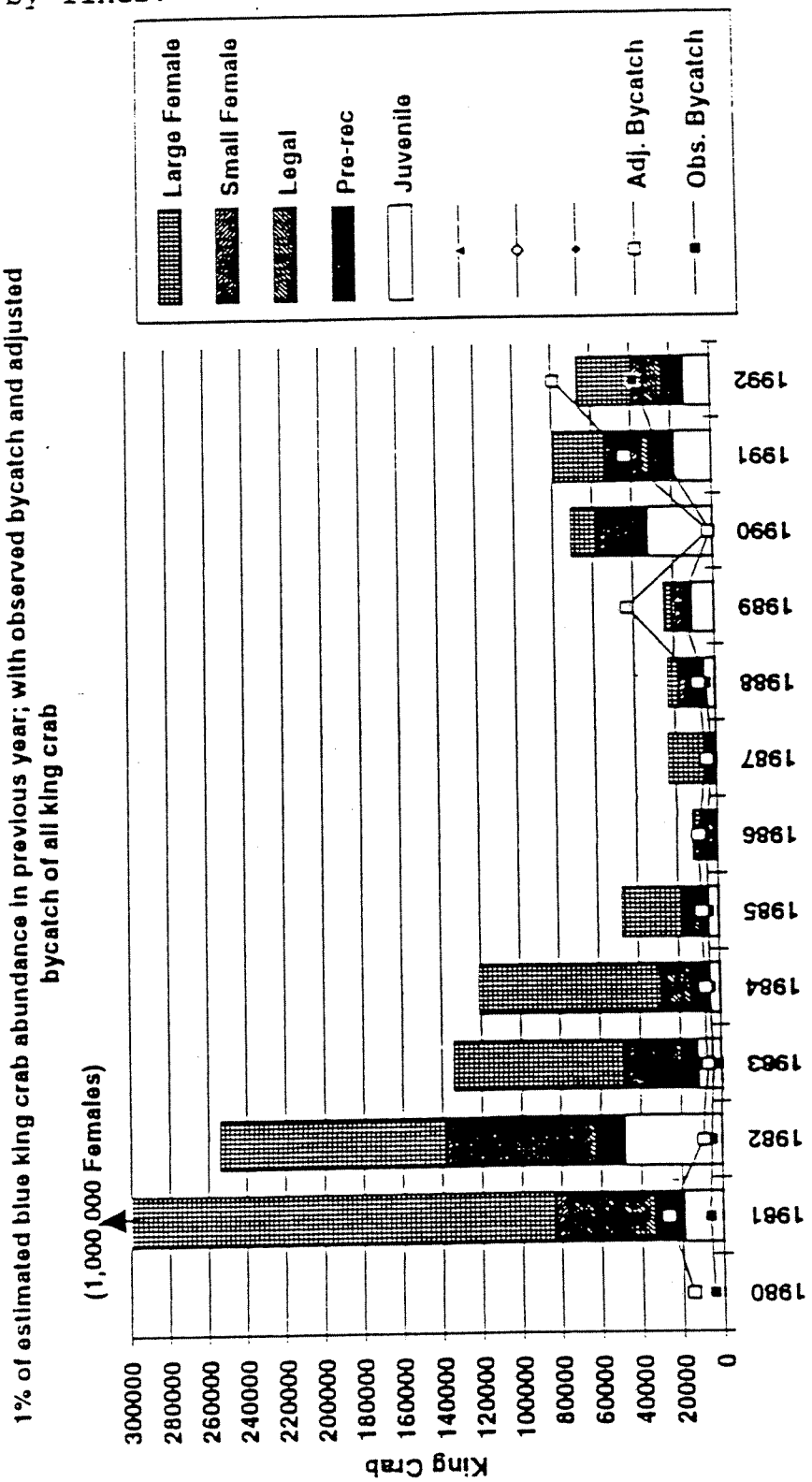


Figure 2.13. Observed king crab (all species) bycatch in metric tons from the entire Bering Sea, from the general area around the Pribilof Islands, and from the proposed closure zone, 1992.

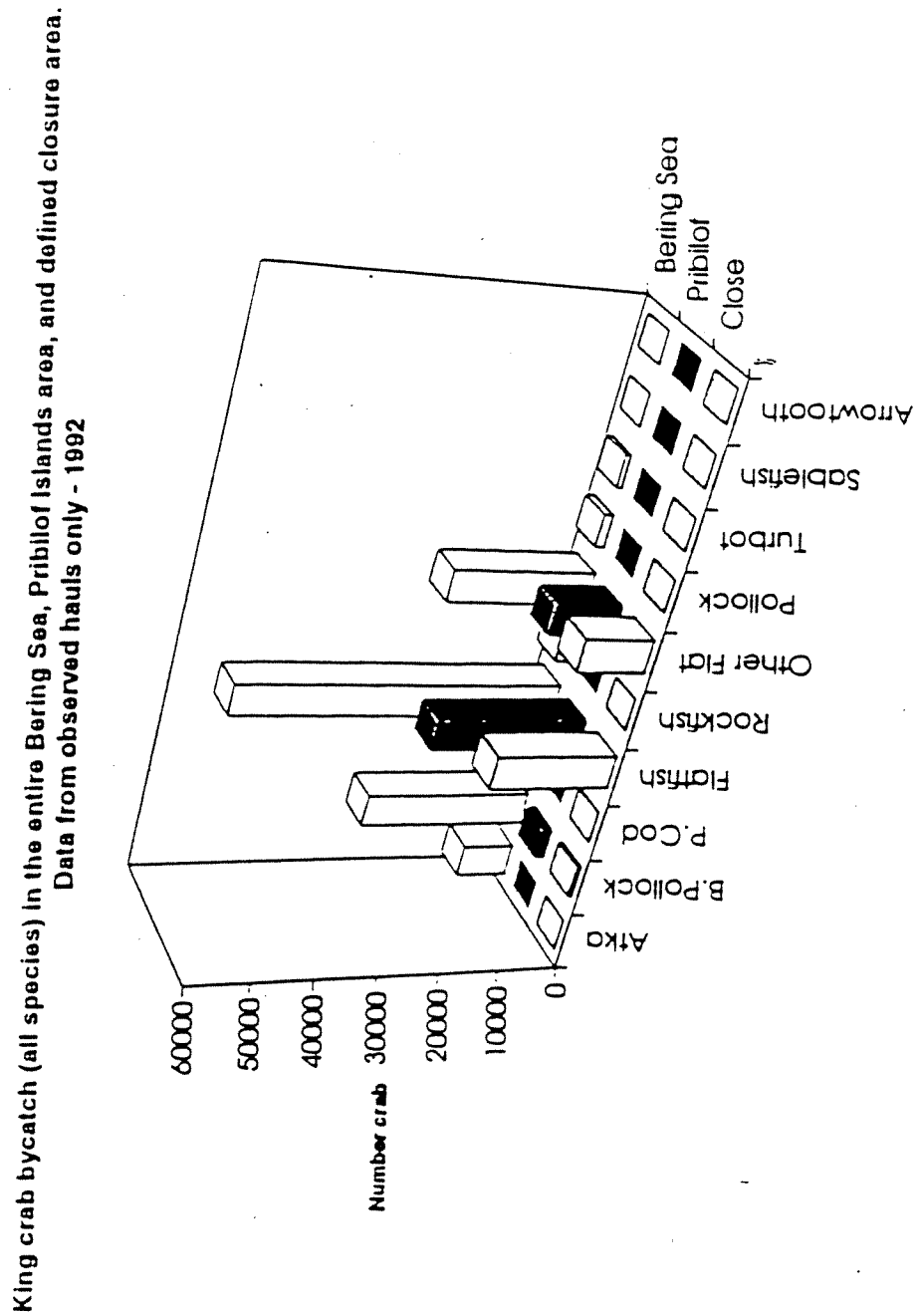


Figure 2.16. Percentage of blue king crab which were categorized as small female (< 90mm) or juvenile male (< 110mm) in observed trawls and annual NMFS survey.

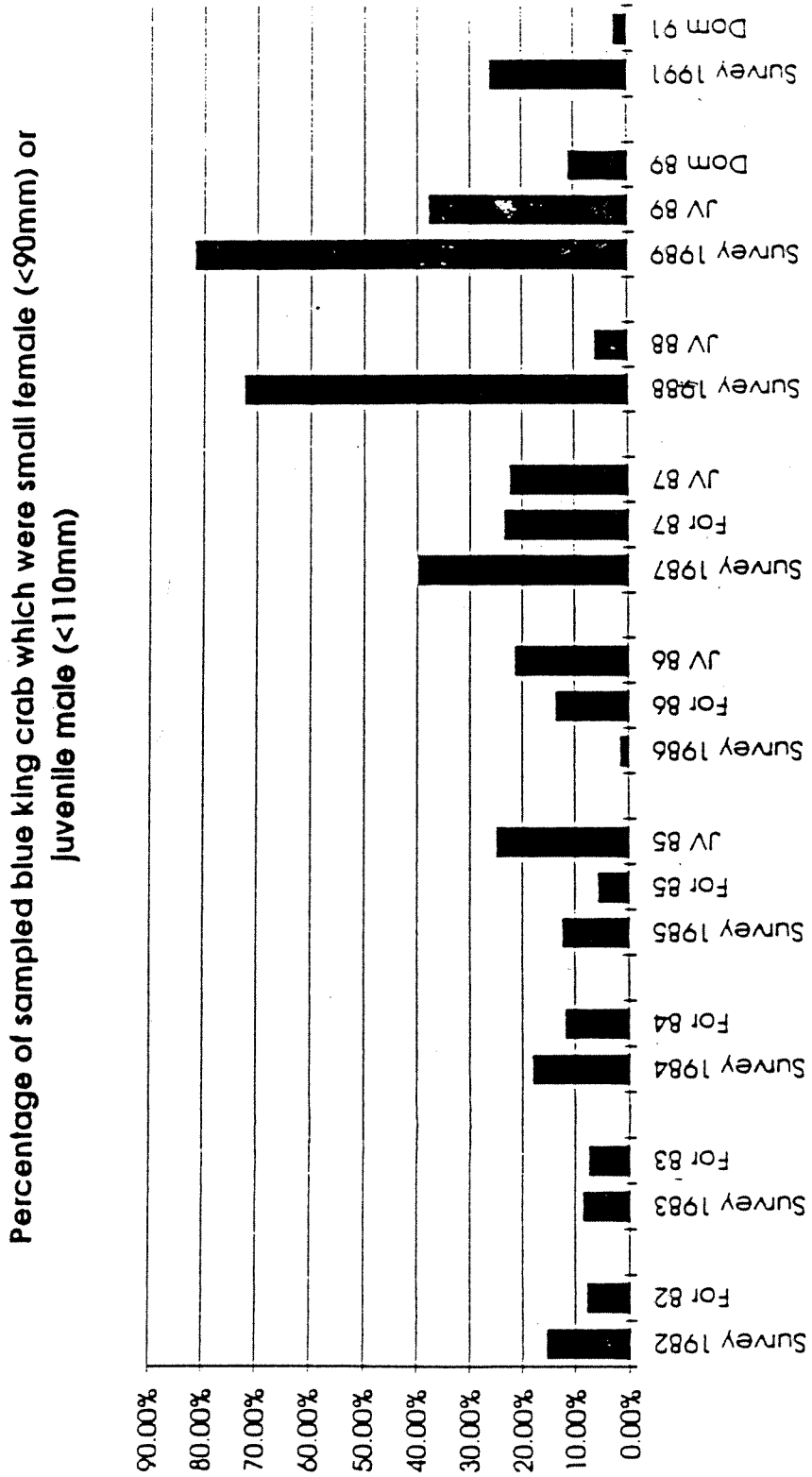


Figure 2.15. Average weight per crab (in pounds) as reported by NMFS observer program, as observed in Pribilof Islands area, and as occurs in directed pot fishery.

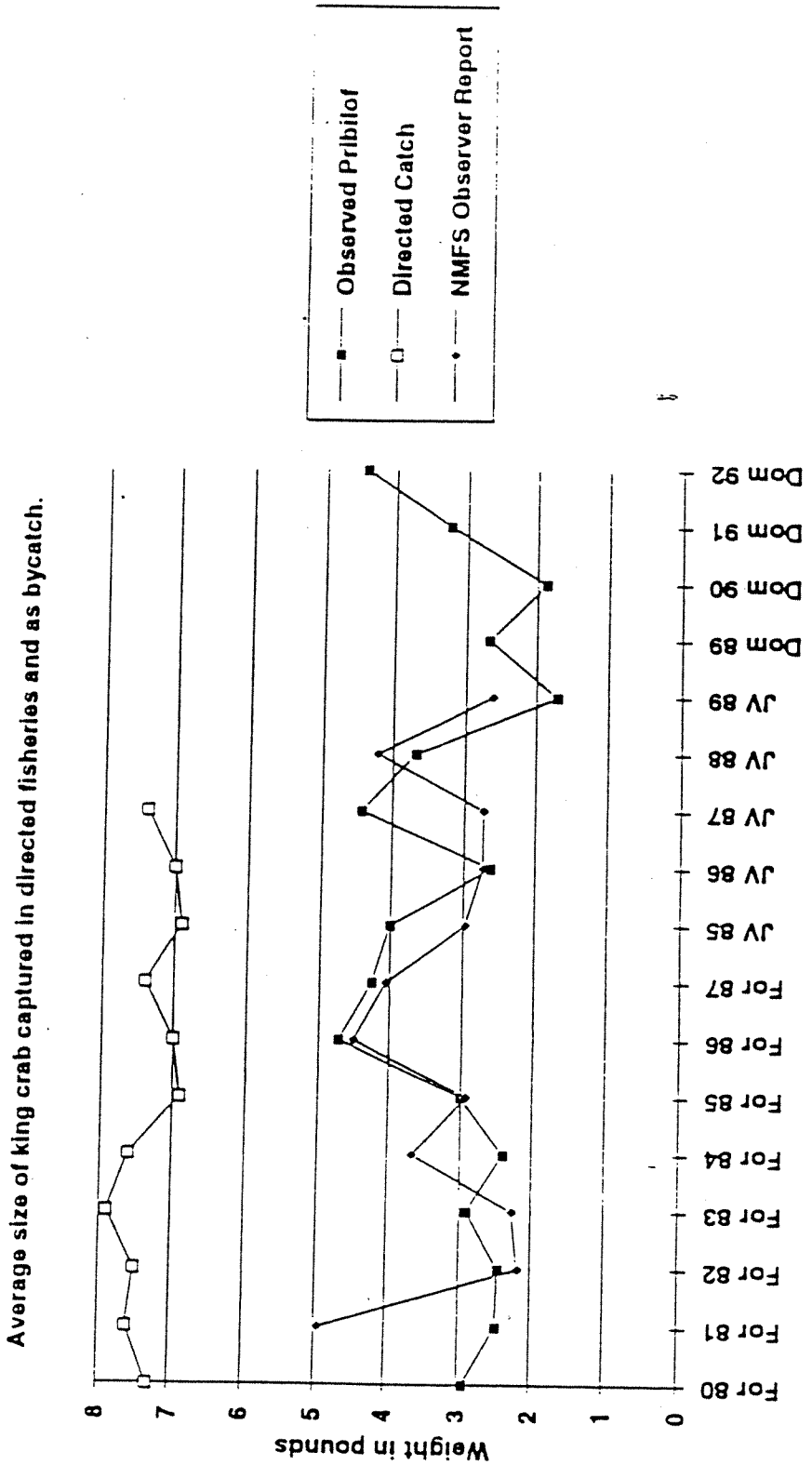


Figure 2.18. Estimated king crab bycatch (expanded to unobserved vessels) by month and year.

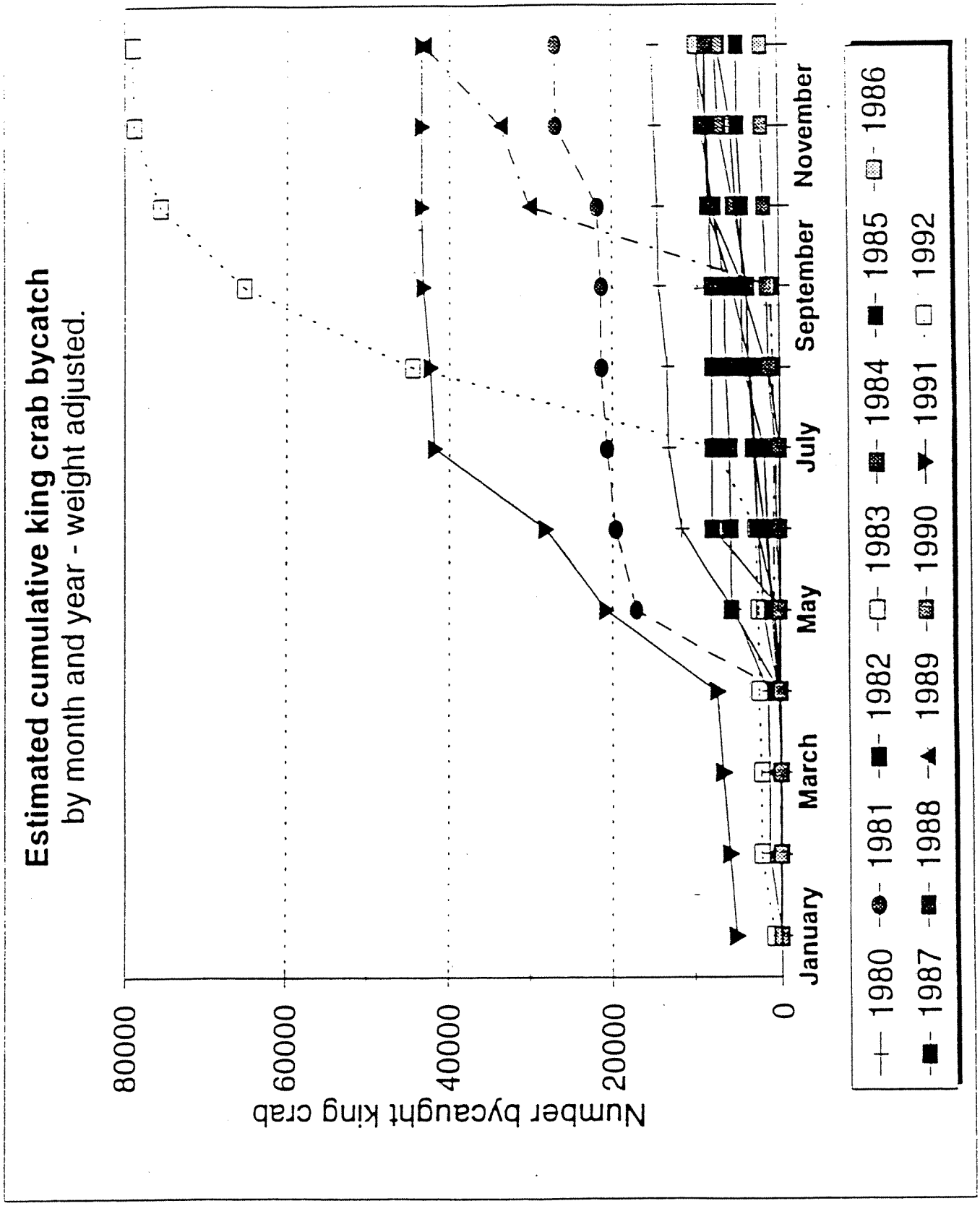


Figure 2.17. Total observed king crab (all species, unexpanded) from foreign, JV and domestic fisheries by area of bycatch.

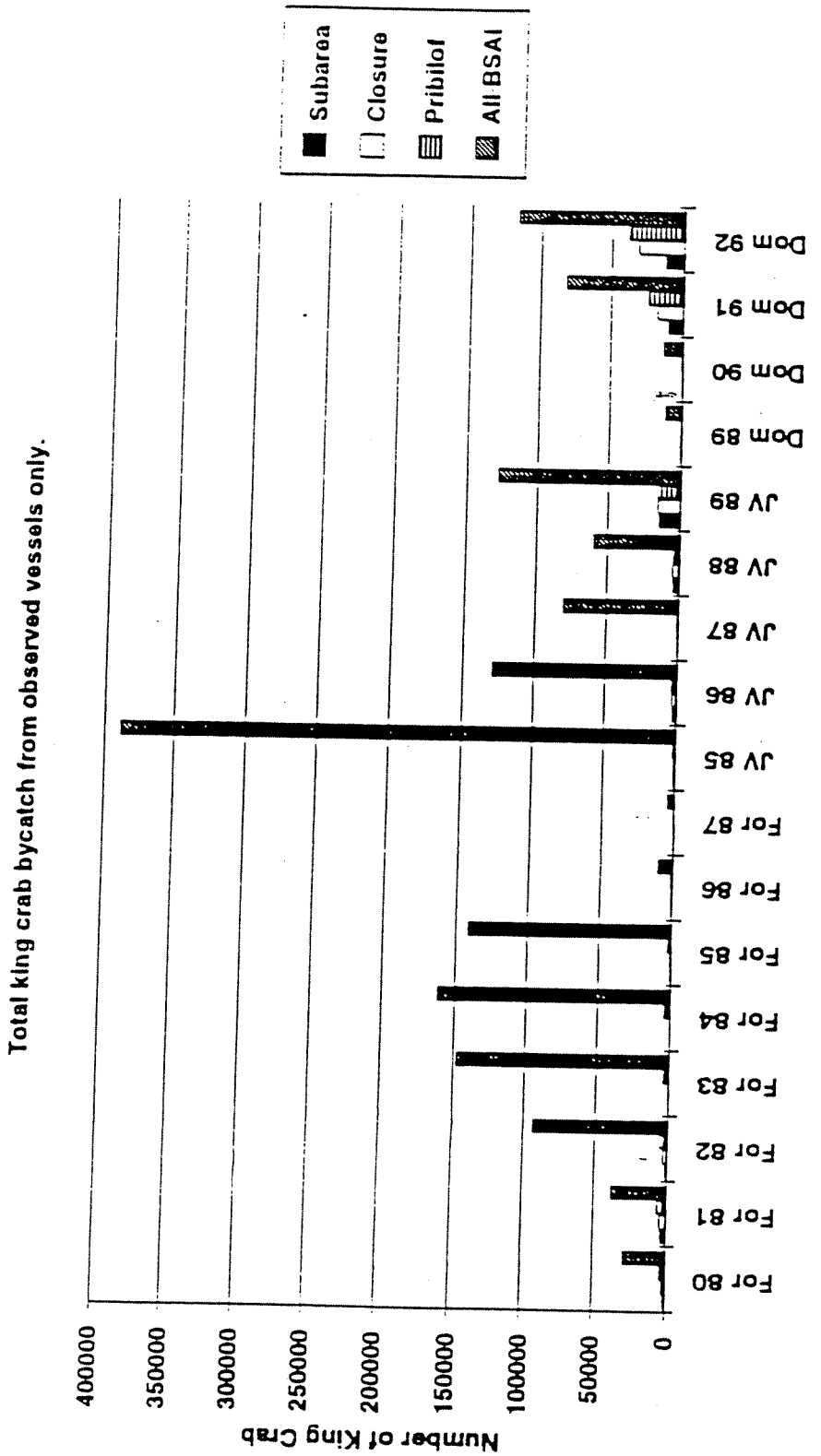


Figure 2.20. Subarea defined for permanent closure in the Pribilof Islands area, as in Alternative 11.

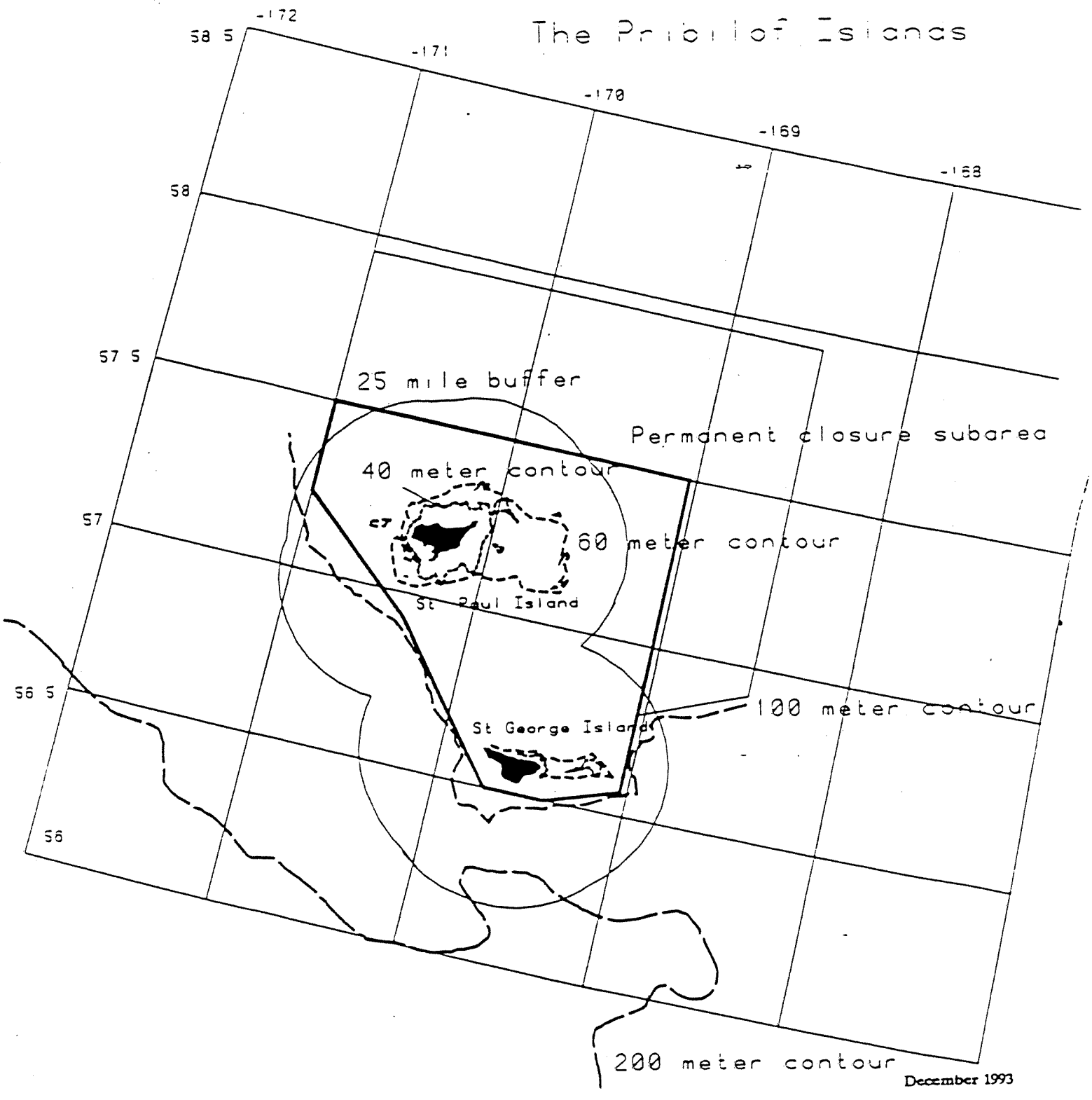


Figure 2.19. Estimated total groundfish catch in the Pribilof Island area from the 1989, 1991 and 1992 domestic groundfish fisheries. Total catch and estimated catch given closure of defined area are provided for each year.

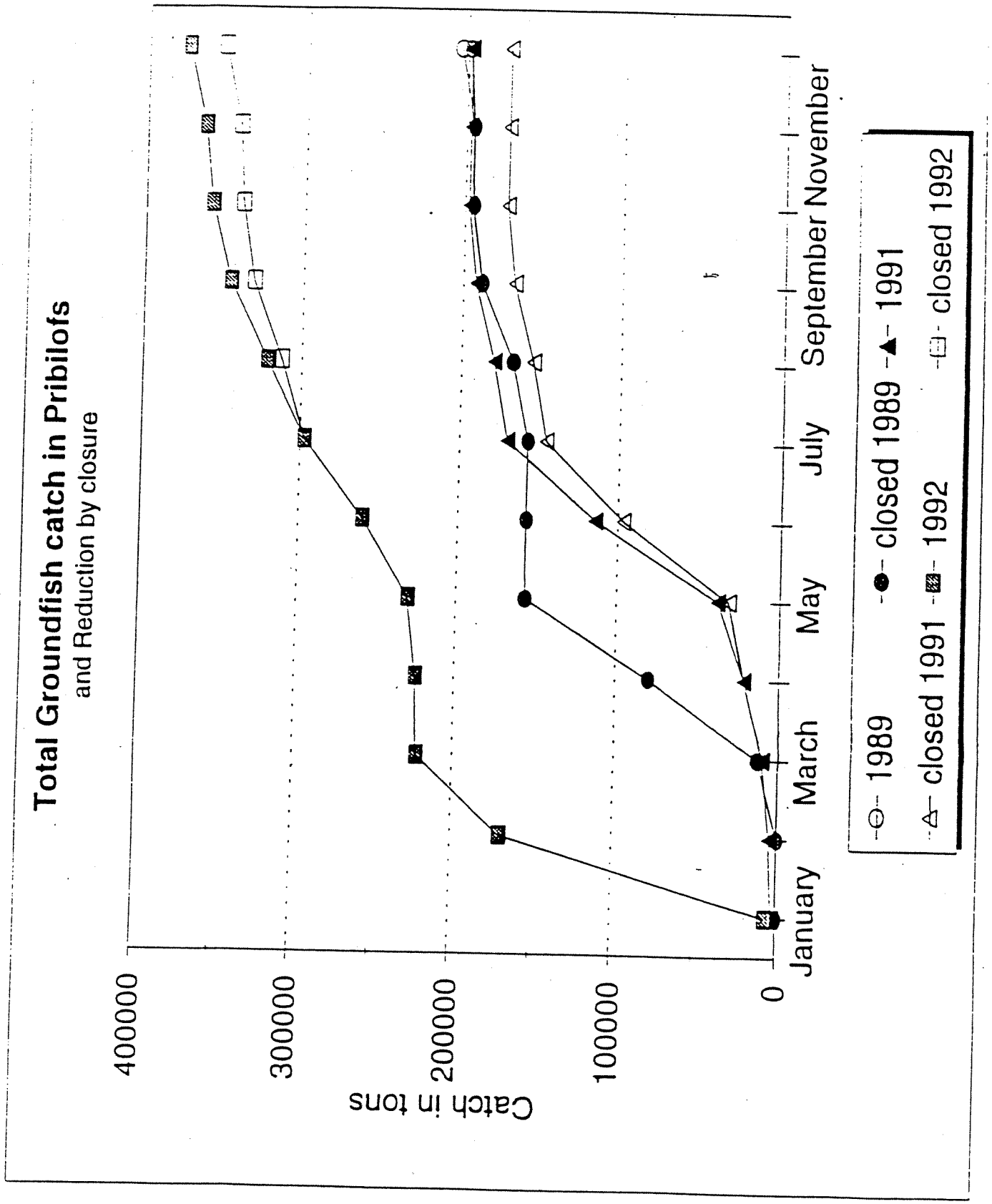


Figure 2.22. Historic king crab bycatch (number of crab) by area expressed as a percentage of the total observed king crab bycatch for the entire Bering Sea.

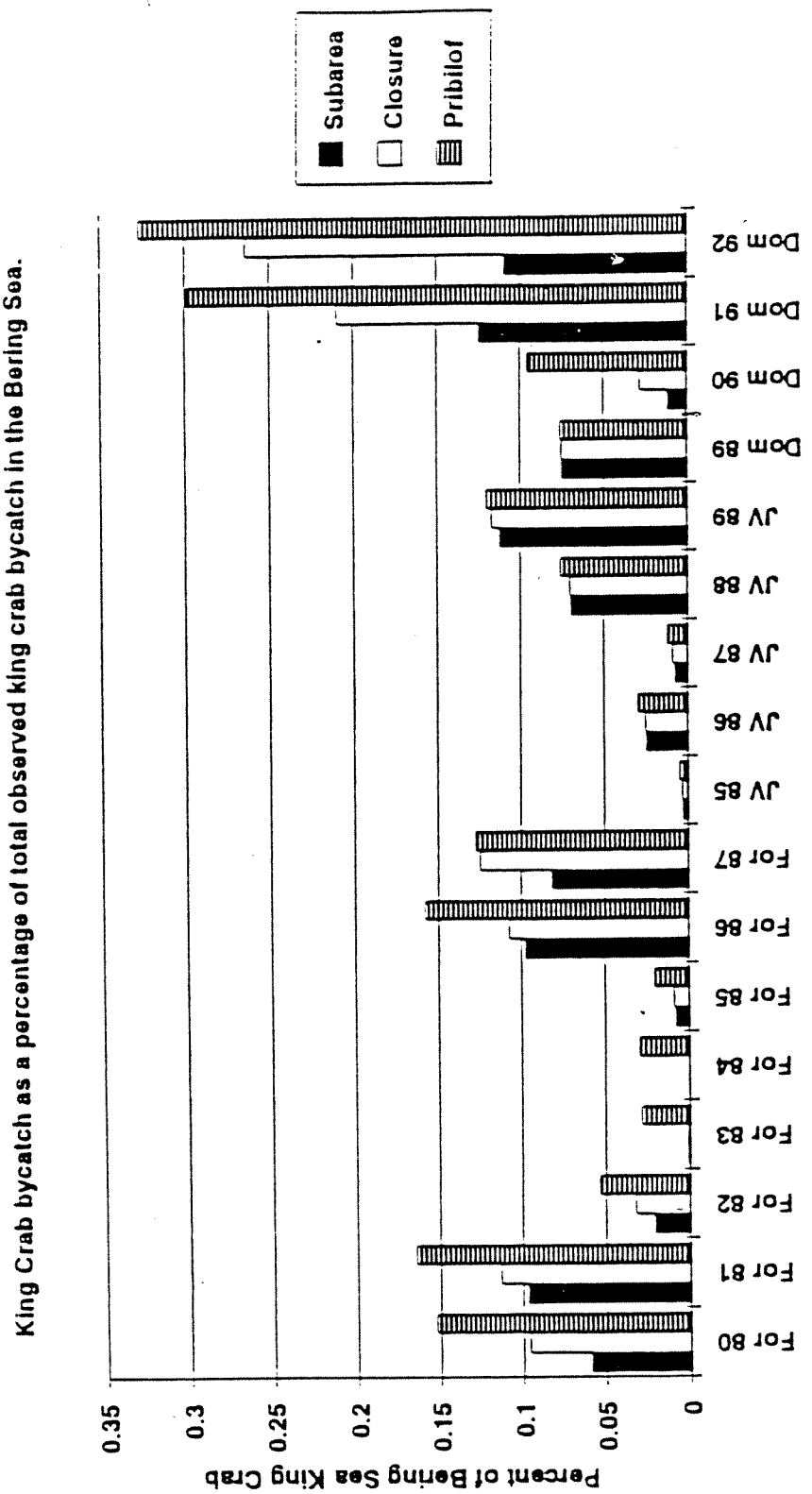


Figure 2.21. Historic groundfish catch (weight in tons) by area expressed as a percentage of the total observed groundfish catch for the entire Bering Sea.

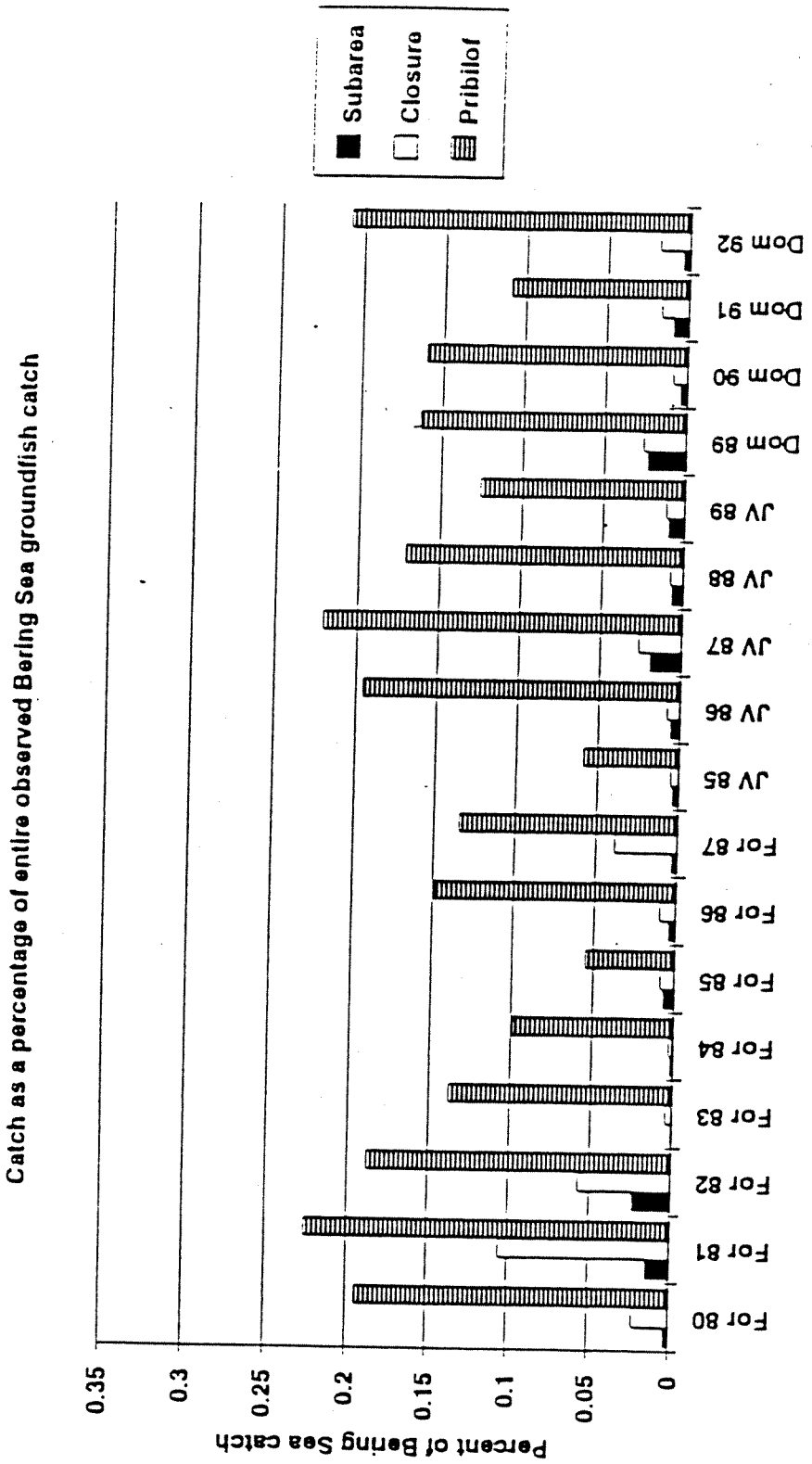


Figure 2.24. Mean number of halibut per tow by area for hauls containing halibut only.

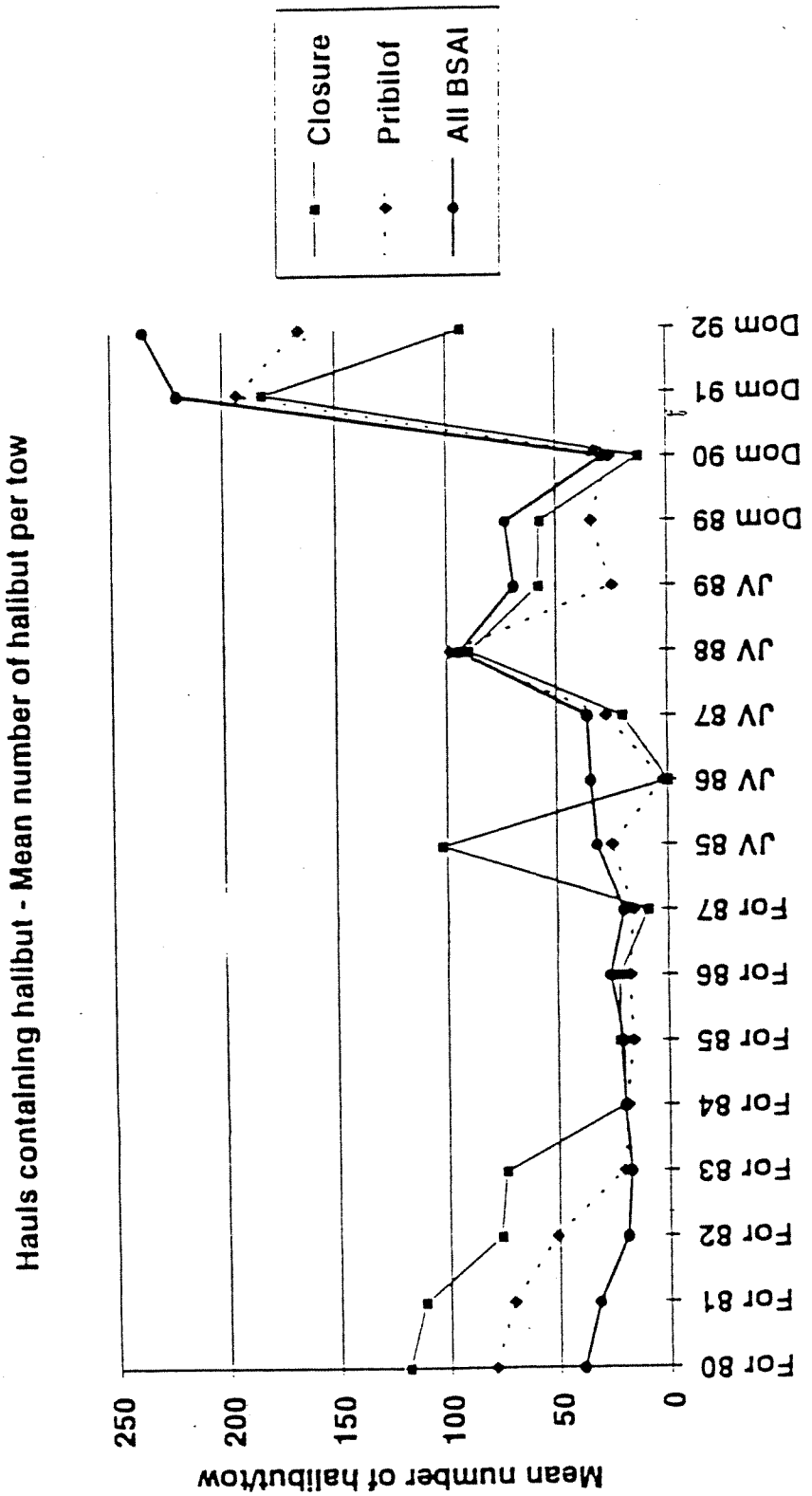


Figure 2.23. Historic effort (number of tows) by area expressed as a percentage of the total observed number of tows for the entire Bering Sea.

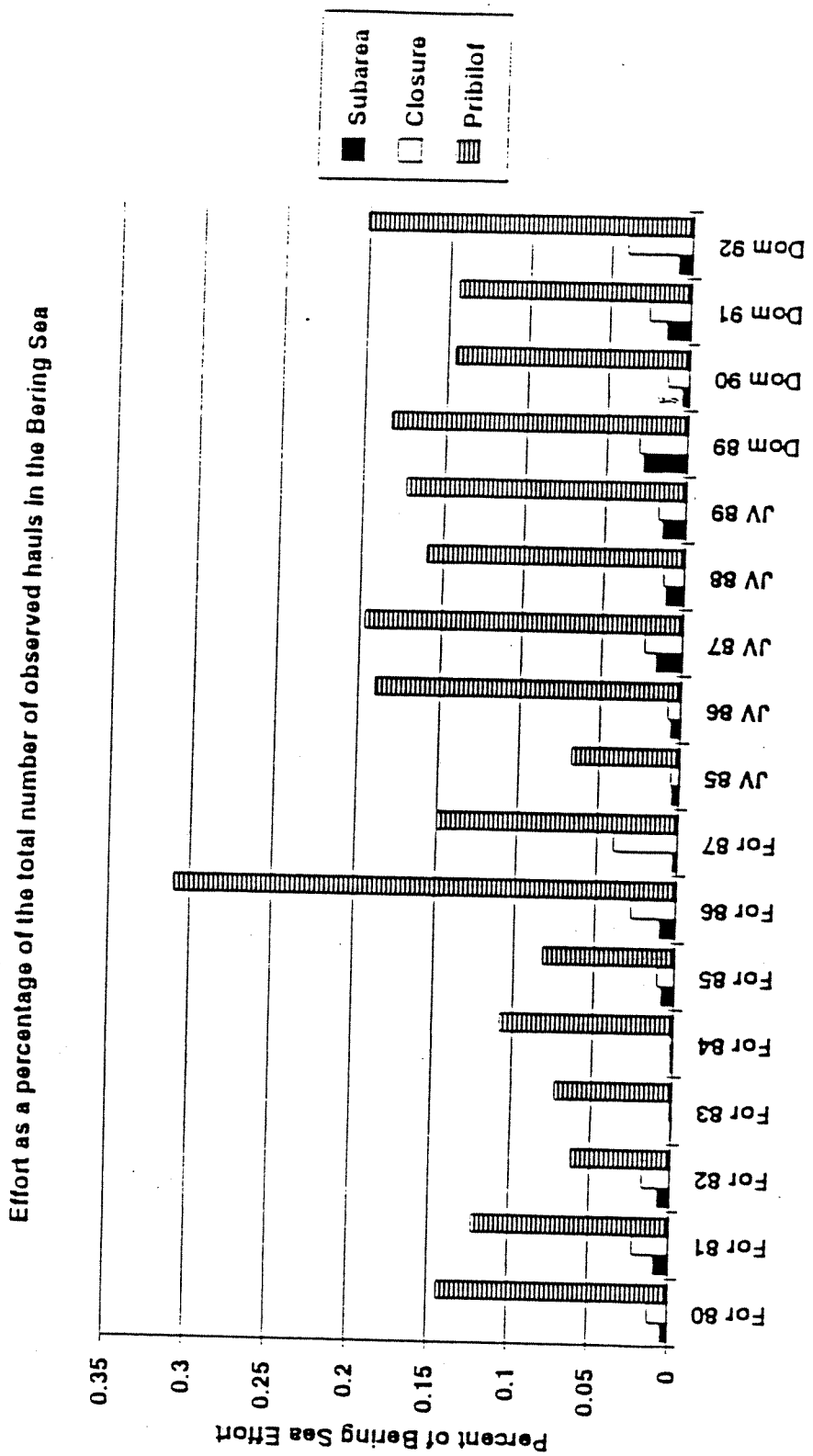


Figure 2.26. Percentage of all tows containing halibut and all tows without halibut by area.

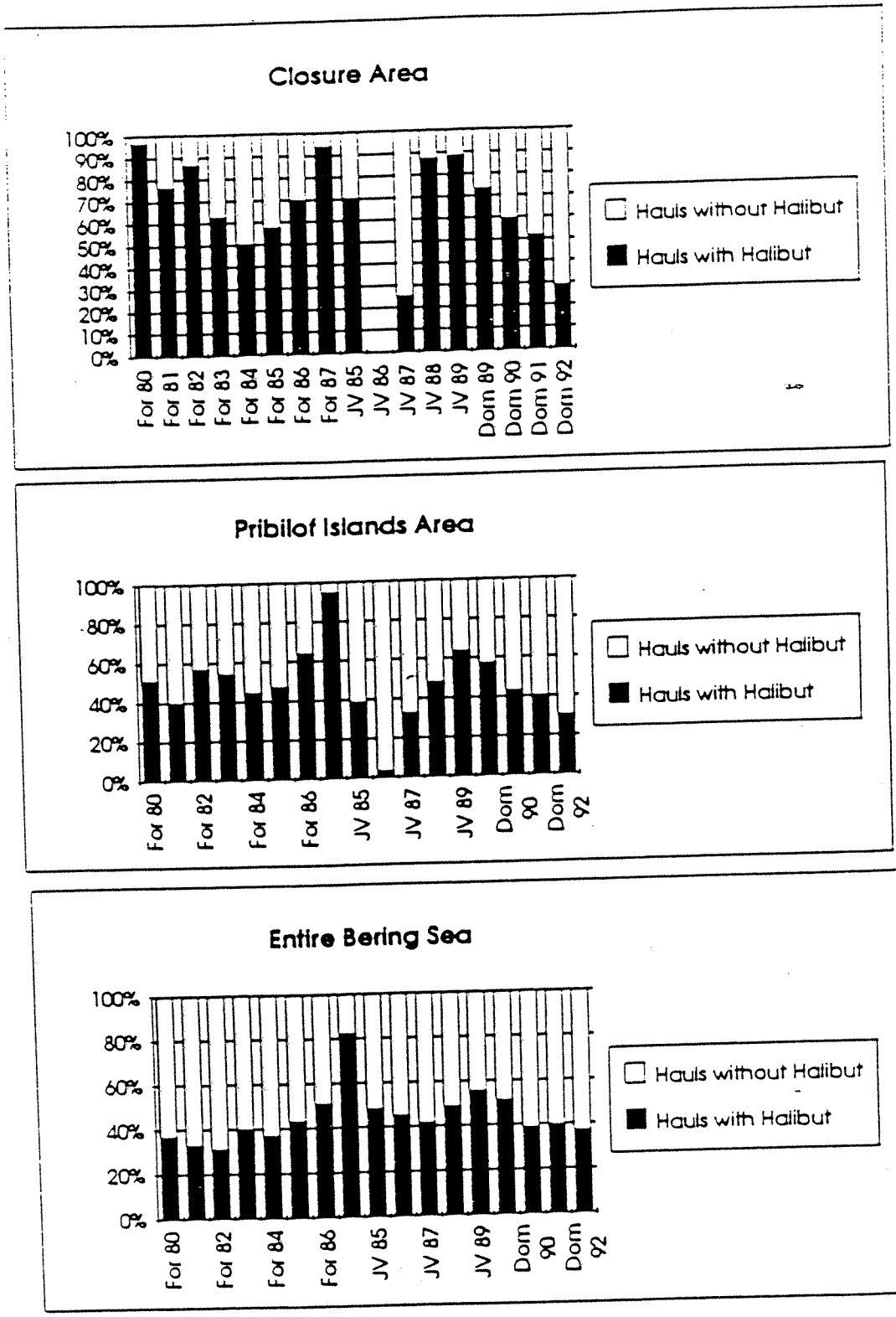
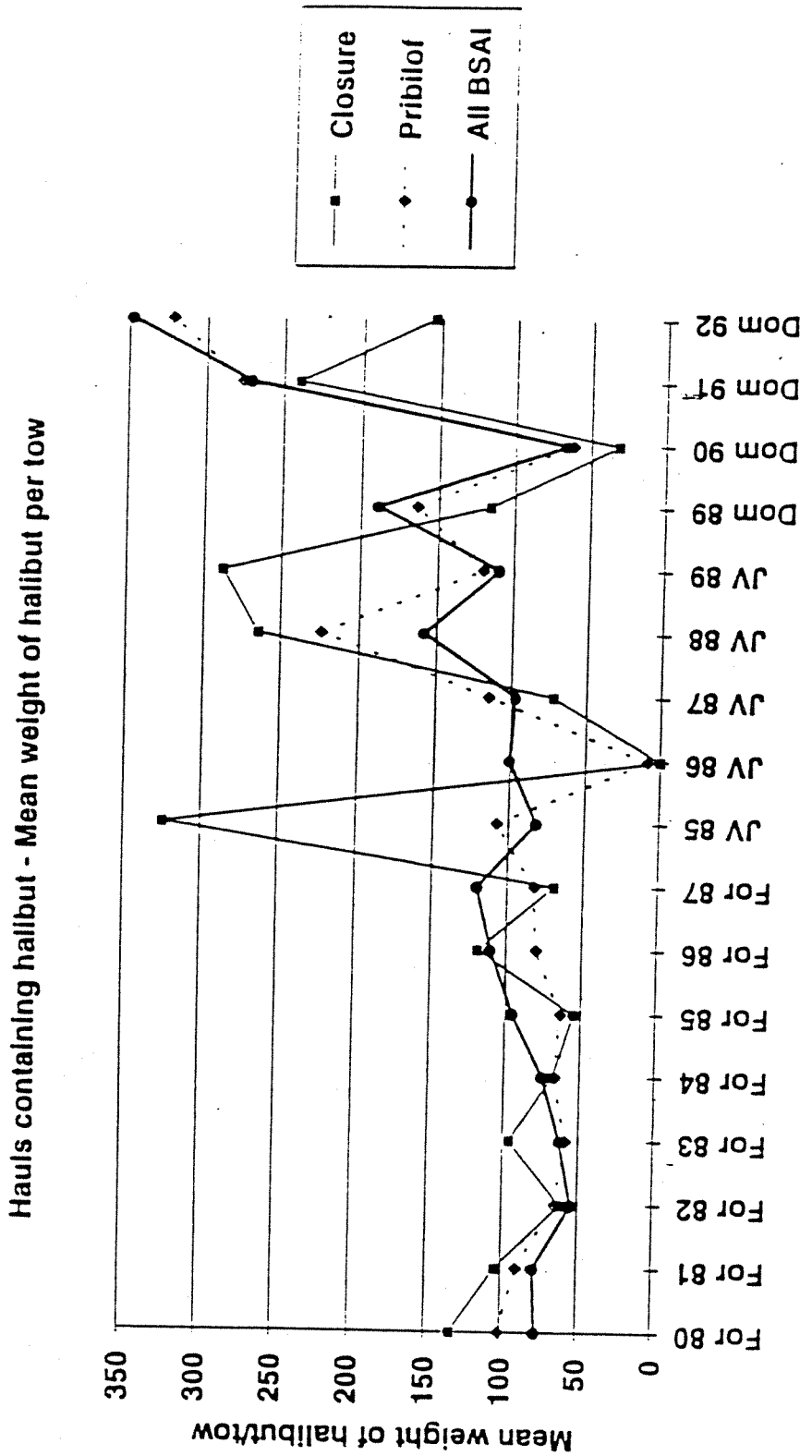


Figure 2.25. Mean weight of halibut per tow by area for hauls containing halibut only.

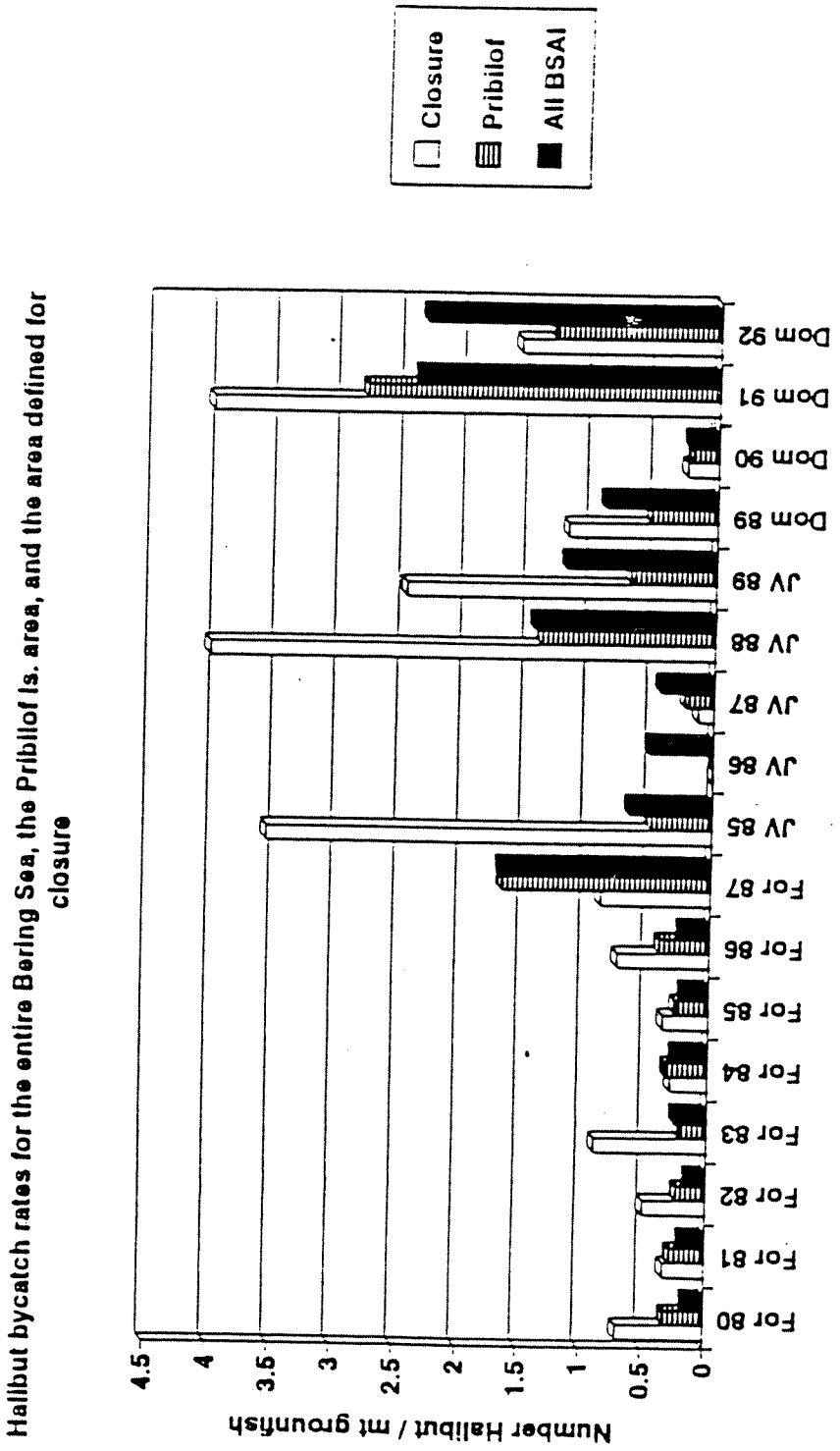


Alternatives 1 through 7 under Scenario 1 for closing areas around the Pribilof Islands.

	Alternative						
	1	2	3	4	5	6	7
Groundfish Catch (1000 mt)							
Fixed Gear Cod & Sablefish	65	65	65	65	65	65	65
Pollock Surimi	1,333	1,335	1,333	1,334	1,334	1,333	1,333
Cod & Atka Mackerel Fillets	166	166	166	166	166	166	166
All Other Headed & Gutted	193	192	192	192	192	192	192
TOTAL	1,758	1,759	1,757	1,758	1,757	1,757	1,757
Groundfish Gross Revenue ($1,000,000)							
TOTAL	1,354	1,357	1,357	1,356	1,355	1,354	1,355
Groundfish Net Revenue (Gross Revenue - Variable Cost, $1,000,000)							
TOTAL	505	506	506	506	506	505	506
Bycatch Amounts							
Halibut (mt)	3,552	3,599	3,558	3,584	3,582	3,597	3,597
Herring (mt)	1,523	1,573	1,558	1,544	1,545	1,539	1,544
Red King Crab (no)	74,272	78,229	78,886	76,614	76,902	76,331	76,252
Tanner Crab (1,000 no)	1,982	1,957	1,913	1,985	1,941	1,981	1,936
Chinook (no)	21,764	21,996	22,447	21,767	21,661	21,814	21,897
Bycatch Present Gross Value (All fisheries, $1,000,000)							
TOTAL	28	28	28	28	28	28	28
Bycatch Present Net Value (All fisheries, $1,000,000)							
TOTAL	14	14	14	14	14	14	14
Groundfish Adjusted Gross Value (Groundfish Gross Revenue Total - Bycatch Present Gross Value Total, $1,000,000)							
TOTAL	1,326	1,329	1,329	1,328	1,328	1,326	1,327
Groundfish Adjusted Net Value (Groundfish Net Revenue Total - Bycatch Present Net Value Total, $1,000,000)							
TOTAL	491	492	492	492	492	491	492

[1] Alternative 1 - Status quo. Alternative 2 - Close IPHC Area 4C to bottom trawling. Alternative 3 - Close IPHC Area 4C to all trawling. Alternative 4 - Close 25 nm around islands to bottom trawling. Alternative 5 - Close 25 nm around islands to all trawling. Alternative 6 - Close IPHC Area 4C west of 169°W to bottom trawling. Alternative 7 - Close IPHC Area 4C west of 169°W to all trawling. Scenario 1 - Effective vessel incentive program.

Figure 2.27. Halibut bycatch rates as number of halibut per metric ton of groundfish catch by area for foreign, JV and domestic hauls.



TABLES

Table 2.3 Percentage of total Bering Sea groundfish catch and total Bering Sea king crab bycatch taken within the general Pribilof Island area and within defined closure area for each target fishery.

Percentage of Bering Sea groundfish and Bering Sea king crab taken in the general Pribilof Island Area and in the defined closure area.

	Groundfish					King Crab			
	1992		1991			1992		1991	
	Pribilof Area	Closure	Pribilof Area	Closure	[redacted]	Pribilof Area	Closure	Pribilof Area	Closure
Atka	0.03%	0.02%	0.00%	0.00%	[redacted]	0.00%	0.00%	0.00%	0.00%
B.Pollock	23.14%	0.88%	13.33%	2.73%	[redacted]	7.34%	2.41%	44.25%	30.04%
P.Cod	7.77%	0.14%	8.12%	0.37%	[redacted]	45.45%	45.45%	13.70%	10.00%
Flatfish	34.98%	10.05%	17.53%	1.63%	[redacted]	47.01%	36.25%	11.28%	6.86%
Rockfish	1.19%	0.00%	2.60%	0.00%	[redacted]	0.00%	0.00%	0.00%	0.00%
Other Flat	23.90%	16.89%	29.92%	14.35%	[redacted]	47.67%	46.62%	38.92%	29.36%
Pollock	19.57%	0.23%	9.40%	1.12%	[redacted]	0.14%	0.00%	74.35%	63.64%
Turbot	0.00%	0.00%	45.75%	0.00%	[redacted]	0.00%	0.00%	100.00%	0.00%
Sablefish	0.00%	0.00%	0.00%	0.00%	[redacted]	0.00%	0.00%	0.00%	0.00%
Arrowtooth	18.06%	0.00%	13.26%	0.00%	[redacted]	0.00%	0.00%	2.05%	0.00%
Total	20.80%	1.81%	10.95%	1.64%	[redacted]	32.67%	26.42%	29.85%	20.96%

Table 3.4 Catch and value for directed groundfish and bycatch species in the BSAI fisheries under Alternatives 1 through 7 under Scenario 2 for closing areas around the Pribilof Islands.

	Alternative						
	1	2	3	4	5	6	7
Groundfish Catch (1000 mt)							
Fixed Gear Cod & Sablefish	65	65	65	65	65	65	65
Pollock Surimi	1,335	1,336	1,336	1,338	1,336	1,336	1,334
Cod & Atka Mackerel Fillets	166	166	166	166	166	166	166
All Other Headed & Gutted	173	176	176	172	172	172	172
TOTAL	1,740	1,743	1,743	1,741	1,739	1,739	1,737
Groundfish Gross Revenue ($1,000,000)							
TOTAL	1,343	1,347	1,349	1,346	1,345	1,343	1,343
Groundfish Net Revenue (Gross Revenue – Variable Cost, $1,000,000)							
TOTAL	501	503	504	502	502	501	501
Bycatch Amounts							
Halibut (mt)	3,884	3,909	3,911	3,900	3,897	3,904	3,902
Herring (mt)	1,628	1,663	1,660	1,649	1,643	1,639	1,636
Red King Crab (no)	92,123	89,000	89,648	86,839	87,130	86,472	86,368
Tanner Crab (1,000 no)	1,792	1,856	1,816	1,813	1,770	1,808	1,763
Chinook (no)	21,527	21,781	22,240	21,555	21,438	21,597	21,669
Bycatch Present Gross Value (All fisheries, $1,000,000)							
TOTAL	30	30	30	30	30	30	30
Bycatch Present Net Value (All fisheries, $1,000,000)							
TOTAL	15	15	15	15	15	14	15
Groundfish Adjusted Gross Value (Groundfish Gross Revenue Total – Bycatch Present Gross Value Total, $1,000,000)							
TOTAL	1,313	1,317	1,319	1,316	1,315	1,313	1,313
Groundfish Adjusted Net Value (Groundfish Net Revenue Total – Bycatch Present Net Value Total, $1,000,000)							
TOTAL	486	487	488	487	487	487	486

[1] Alternative 1 – Status quo. Alternative 2 – Close IPHC Area 4C to bottom trawling. Alternative 3 – Close IPHC Area 4C to all trawling. Alternative 4 – Close 25 nm around islands to bottom trawling. Alternative 5 – Close 25 nm around islands to all trawling. Alternative 6 – Close IPHC Area 4C west of 169°W to bottom trawling. Alternative 7 – Close IPHC Area 4C west of 169°W to all trawling. Scenario 2 – No effective vessel incentive program.

Table 2.5. Percentage of Bering Sea groundfish and king crab taken in the general Pribilof Island Area, in the defined closure zone, and in the defined sub-area for permanent closure.

	Groundfish							King Crab					
	1992			1991				1992			1991		
	Prib. Area	Closure	Sub-area	Prib. Area	Closure	Sub-area		Prib. Area	Closure	Sub-area	Prib. Area	Closure	Sub-area
Atka	0.03%	0.02%	0.02%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
B.Pollock	23.14%	0.88%	0.24%	13.33%	2.73%	1.57%		7.34%	2.41%	1.22%	44.25%	30.04%	13.35%
P.Cod	7.77%	0.14%	0.14%	8.12%	0.37%	0.37%		45.45%	45.45%	45.45%	13.70%	10.00%	10.00%
Flatfish	34.98%	10.05%	0.35%	17.53%	1.63%	0.17%		47.01%	36.25%	5.65%	11.28%	6.86%	0.00%
Rockfish	1.19%	0.00%	0.00%	2.60%	0.00%	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Other Fla	23.90%	16.89%	13.91%	29.92%	14.35%	11.28%		47.67%	46.62%	40.34%	38.92%	29.36%	28.63%
Pollock	19.57%	0.23%	0.16%	9.40%	1.12%	0.69%		0.14%	0.00%	0.00%	74.35%	63.64%	10.94%
Turbot	0.00%	0.00%	0.00%	45.75%	0.00%	0.00%		0.00%	0.00%	0.00%	100.00%	0.00%	0.00%
Sablefish	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Arrowtoo	18.06%	0.00%	0.00%	13.26%	0.00%	0.00%		0.00%	0.00%	0.00%	2.05%	0.00%	0.00%
Total	20.80%	1.81%	0.45%	10.95%	1.64%	0.97%		32.67%	26.42%	11.00%	29.83%	20.95%	12.53%

Table 2.4 Mean groundfish catch and mean king crab bycatch taken in the entire Bering Sea, within the general pribilof Island area, and within the area proposed for closure for each target fishery.

Mean tons of Bering Sea groundfish and mean number of Bering Sea king crab taken in the general Pribilof Island Area and in the defined closure area.

	Groundfish (Mean tons/tow)						King Crab (Mean number/tow)					
	1992			1991			1992			1991		
	Entire BS	Pribilof Area	Closure	Entire BS	Pribilof Area	Closure	Entire BS	Pribilof Area	Closure	Entire BS	Pribilof Area	Closure
Atka	30.54	3.07	0.00	32.99	0.00	0.00	7.46	0.00	0.00	0.82	0.00	0.00
B.Pollock	37.23	40.60	23.28	31.91	23.53	19.23	5.25	1.82	9.03	4.74	11.59	31.45
P.Cod	14.85	13.95	0.00	14.37	14.55	11.41	0.13	0.73	0.00	0.39	0.67	8.44
Flatfish	17.15	18.50	15.42	17.62	20.04	20.79	8.98	13.02	29.09	3.42	2.50	17.01
Rockfish	16.51	10.51	0.00	12.69	8.42	0.00	4.28	0.00	0.00	4.33	0.00	0.00
Other Flat	12.51	14.67	14.20	15.21	16.33	14.88	18.12	42.39	56.78	17.49	24.44	35.01
Pollock	67.32	74.87	62.75	60.44	40.61	40.27	0.20	0.00	0.00	0.13	0.67	4.75
Turbot	25.14	0.00	0.00	9.51	8.40	0.00	84.30	0.00	0.00	15.27	17.25	0.00
Sablefish	0.00	0.00	0.00	6.12	0.00	0.00	0.00	0.00	0.00	0.08	0.00	0.00
Arrowtoo	9.03	6.77	0.00	11.46	9.64	0.00	0.13	0.00	0.00	7.11	0.92	0.00
All Targets	36.65	37.73	16.69	36.12	27.43	23.24	4.92	7.96	32.66	2.92	6.03	23.94

Figure A.17. Blue king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.18. Blue king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

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Figure A.20. Blue king crab catch in 1993 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.21. Red king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.22. Red king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.23. Red king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.24. Red king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.25. Red king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.26. *C. bairdi* Tanner crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.27. *C. bairdi* Tanner crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.28. *C. bairdi* Tanner crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.29. *C. bairdi* Tanner crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Appendix A. NMFS annual trawl survey of the eastern Bering Sea. Blue king crab, 1975-1992; Red king crab, 1988-1992; *C. bairdi* Tanner crab, 1975, 1980, 1985, and 1990.

Figure A.1. Locations of annual NMFS trawl surveys, 1975-1992.

Figure A.2. Blue king crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.3. Blue king crab catch in 1976 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.4. Blue king crab catch in 1977 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.5. Blue king crab catch in 1978 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.6. Blue king crab catch in 1979 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.7. Blue king crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.8. Blue king crab catch in 1981 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.9. Blue king crab catch in 1982 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.10. Blue king crab catch in 1983 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.11. Blue king crab catch in 1984 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.12. Blue king crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.13. Blue king crab catch in 1986 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.14. Blue king crab catch in 1987 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.15. Blue king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.16. Blue king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.2. Blue king crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

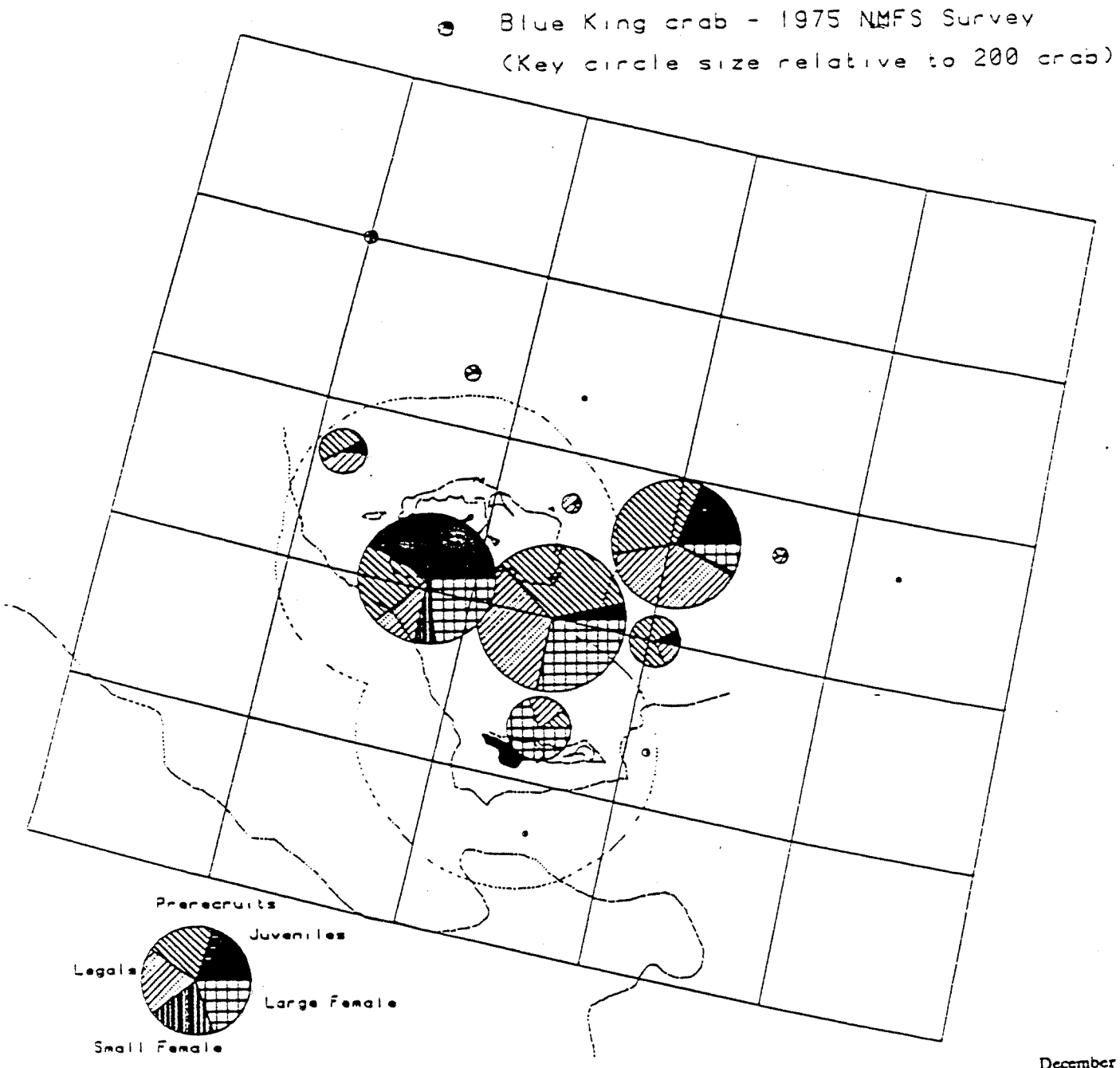


Figure A.1. Locations of annual NMFS trawl surveys, 1975-1992.

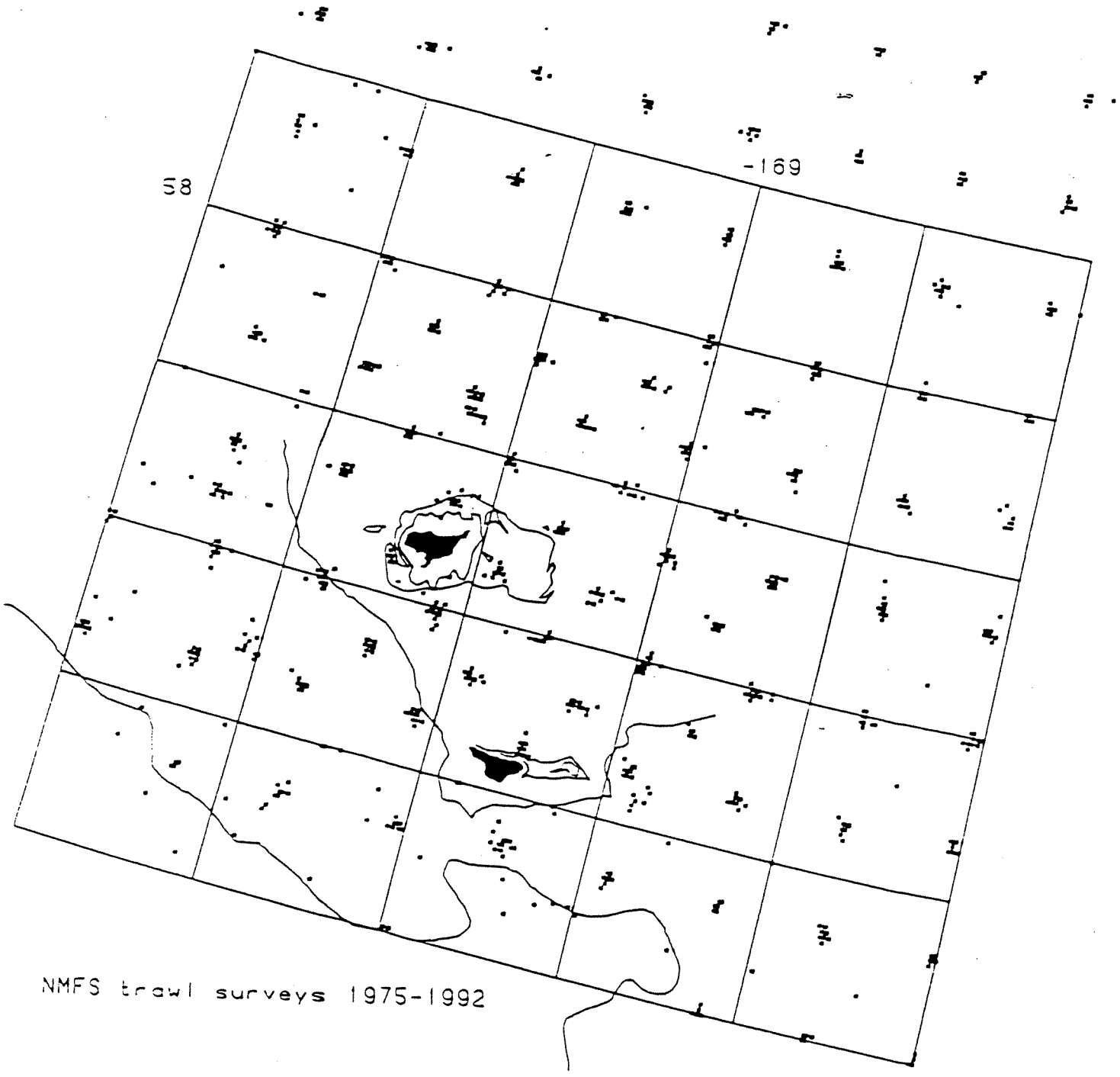


Figure A.4. Blue king crab catch in 1977 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

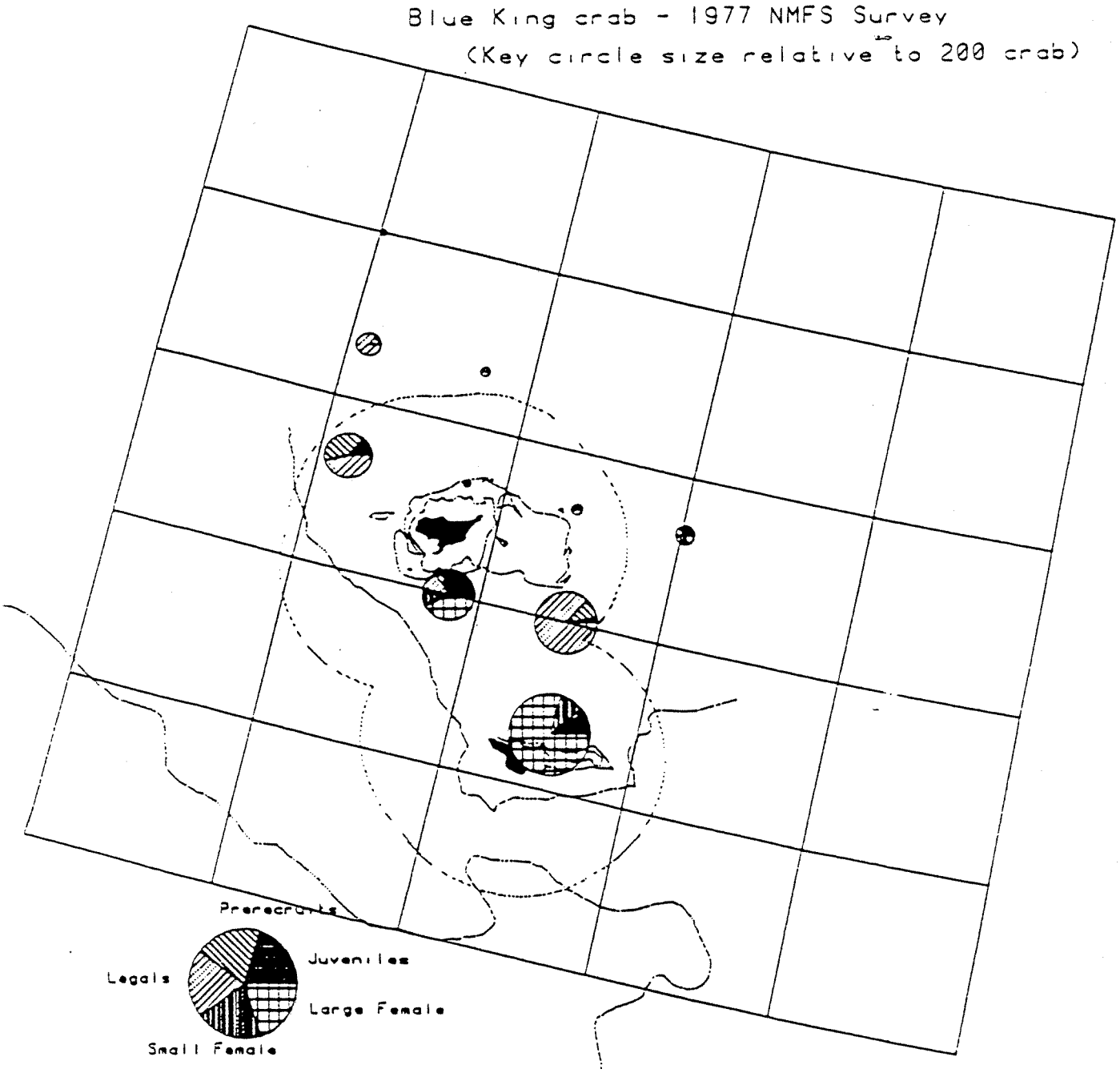


Figure A.3. Blue king crab catch in 1976 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

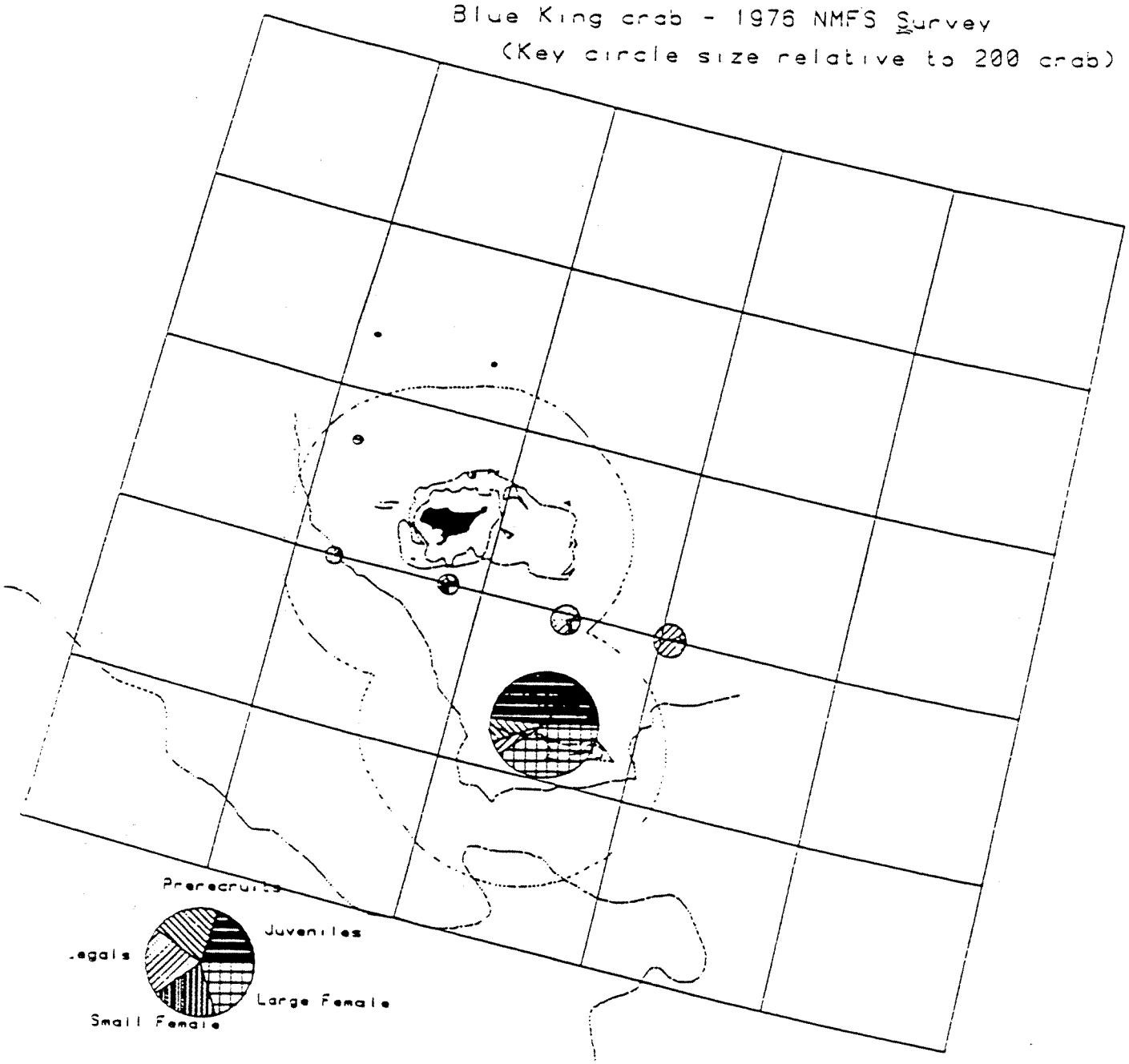


Figure A.6. Blue king crab catch in 1979 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

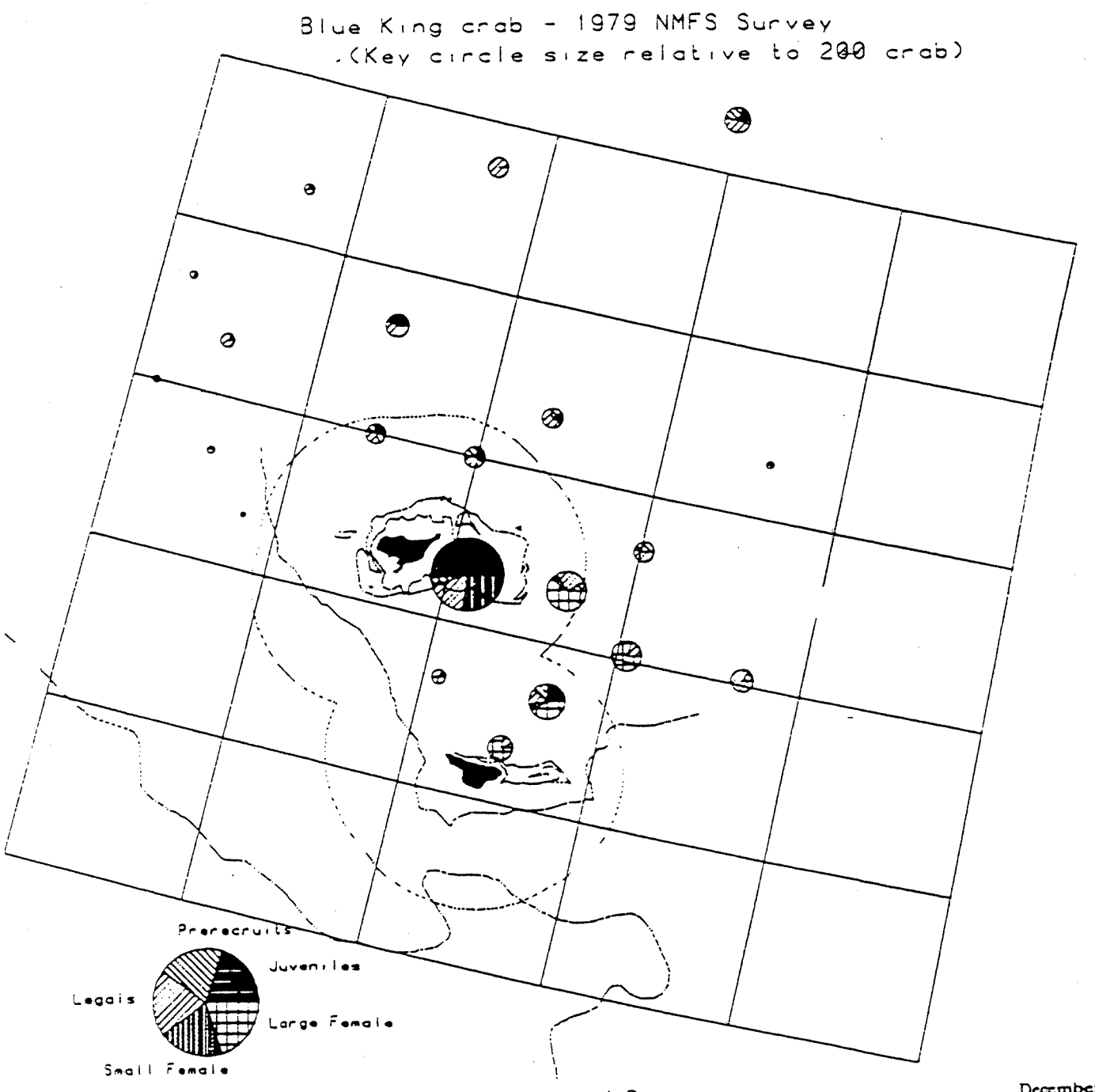


Figure A.5. Blue king crab catch in 1978 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

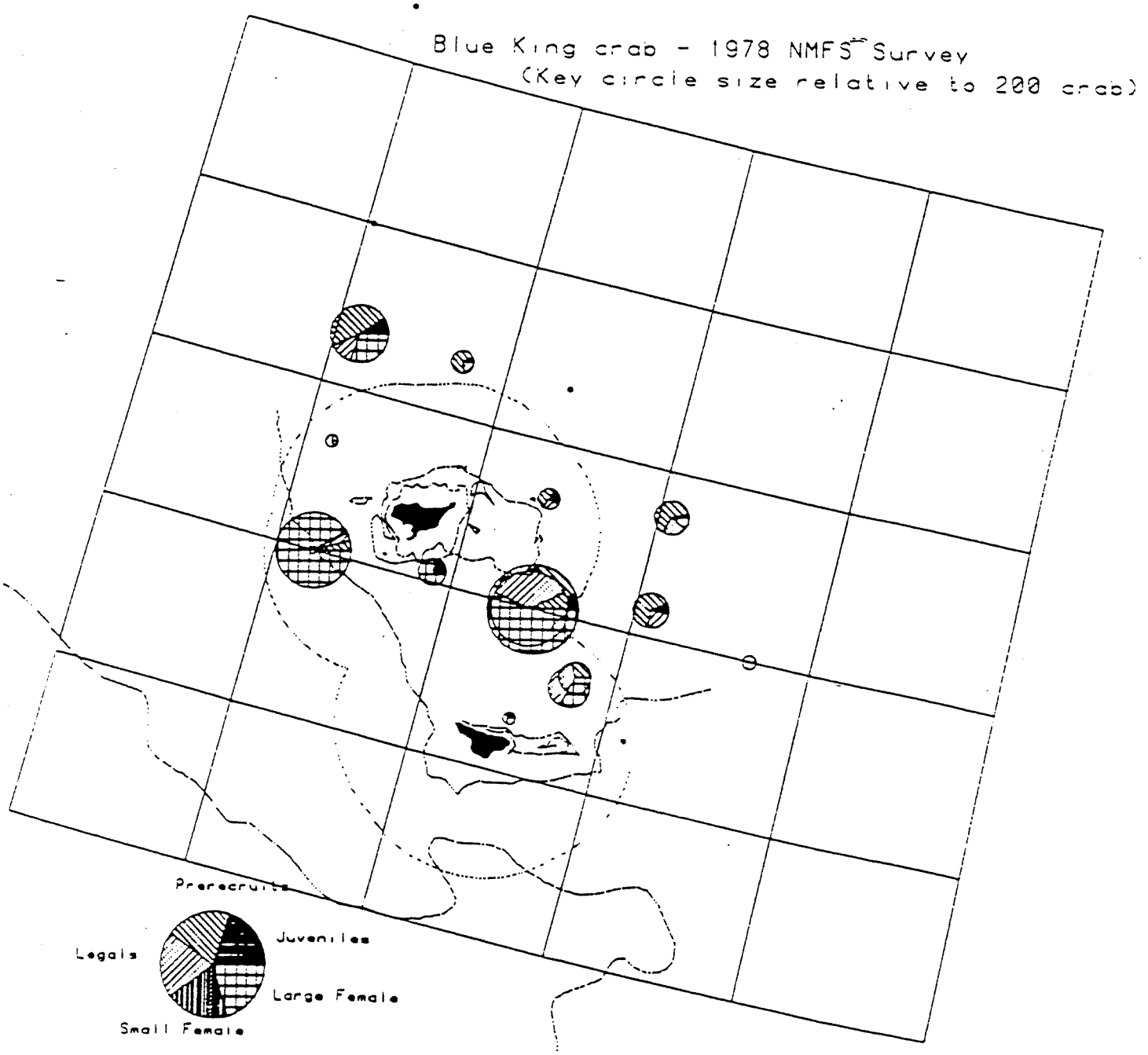


Figure A.8. Blue king crab catch in 1981 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

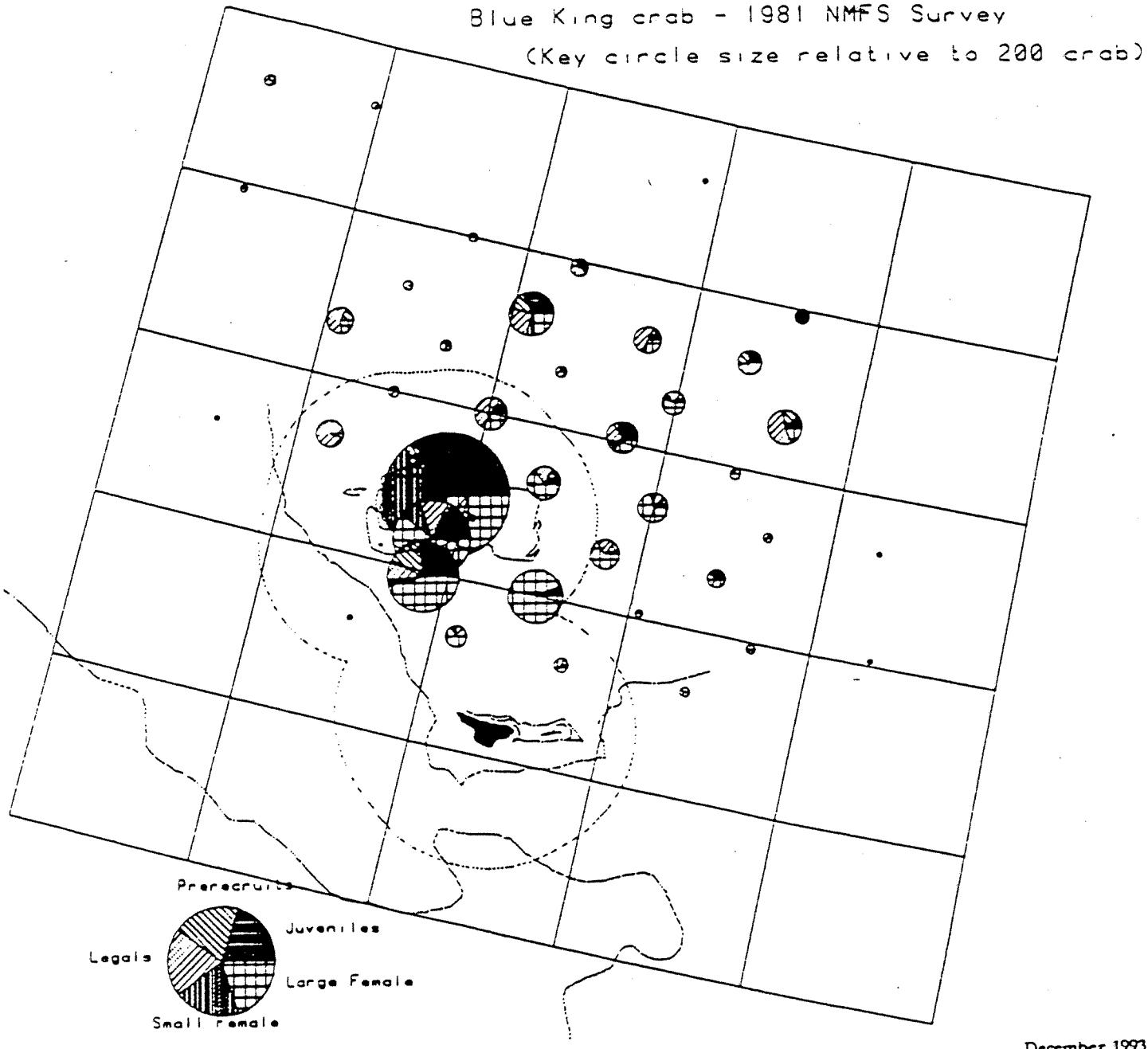


Figure A.7. Blue king crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

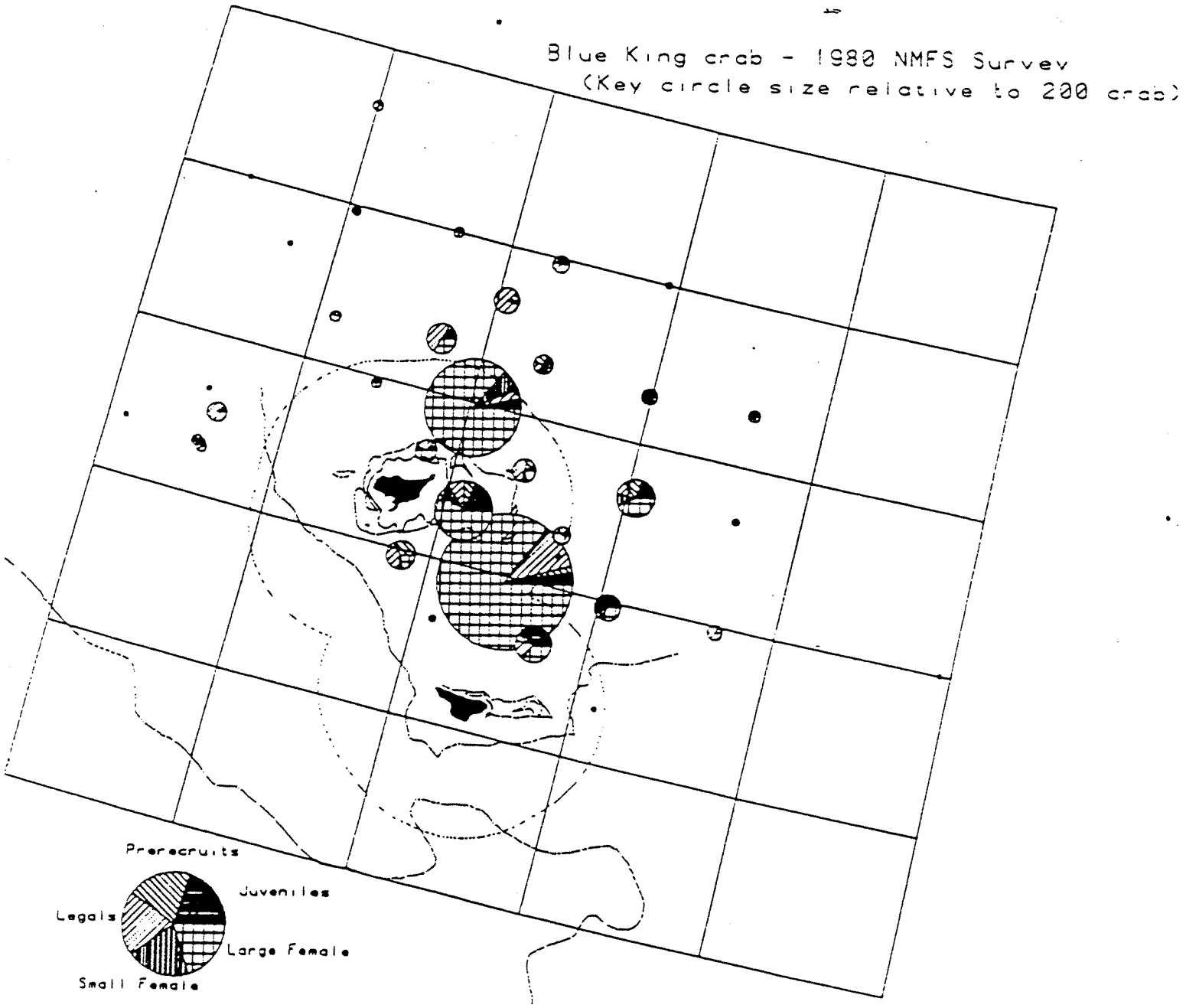


Figure A.9. Blue king crab catch in 1982 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

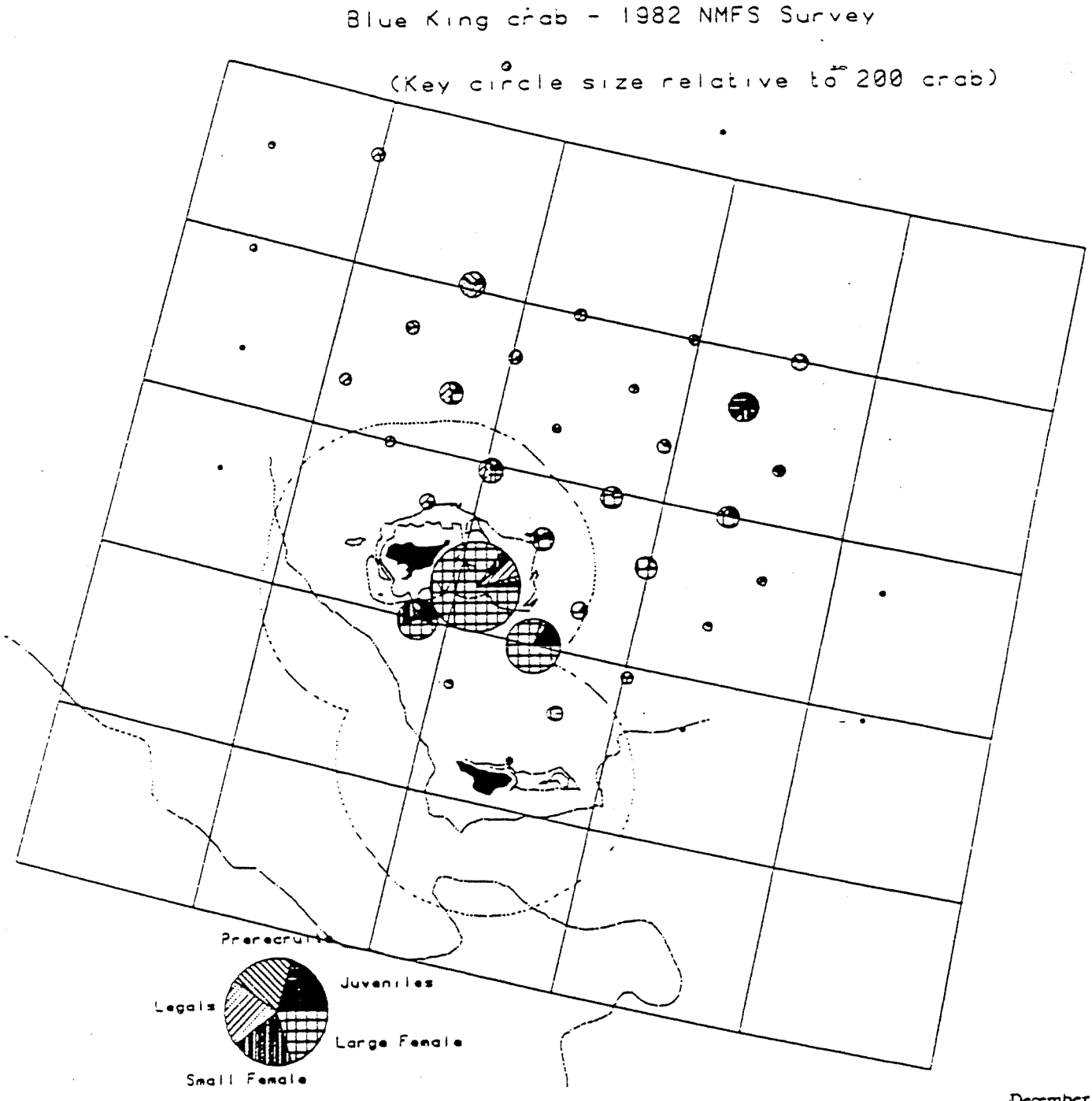


Figure A.10. Blue king crab catch in 1983 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

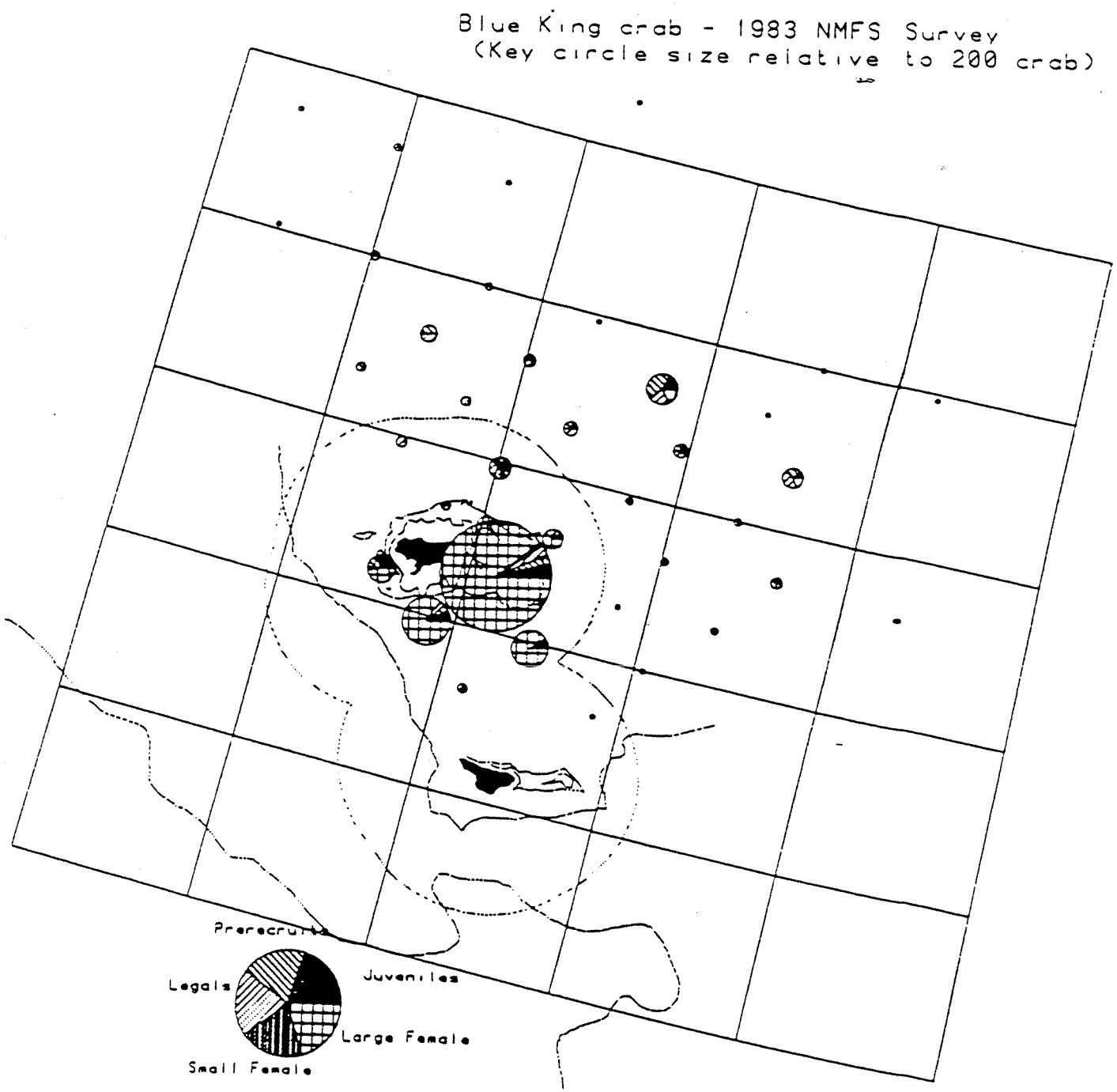


Figure A.11. Blue king crab catch in 1984 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

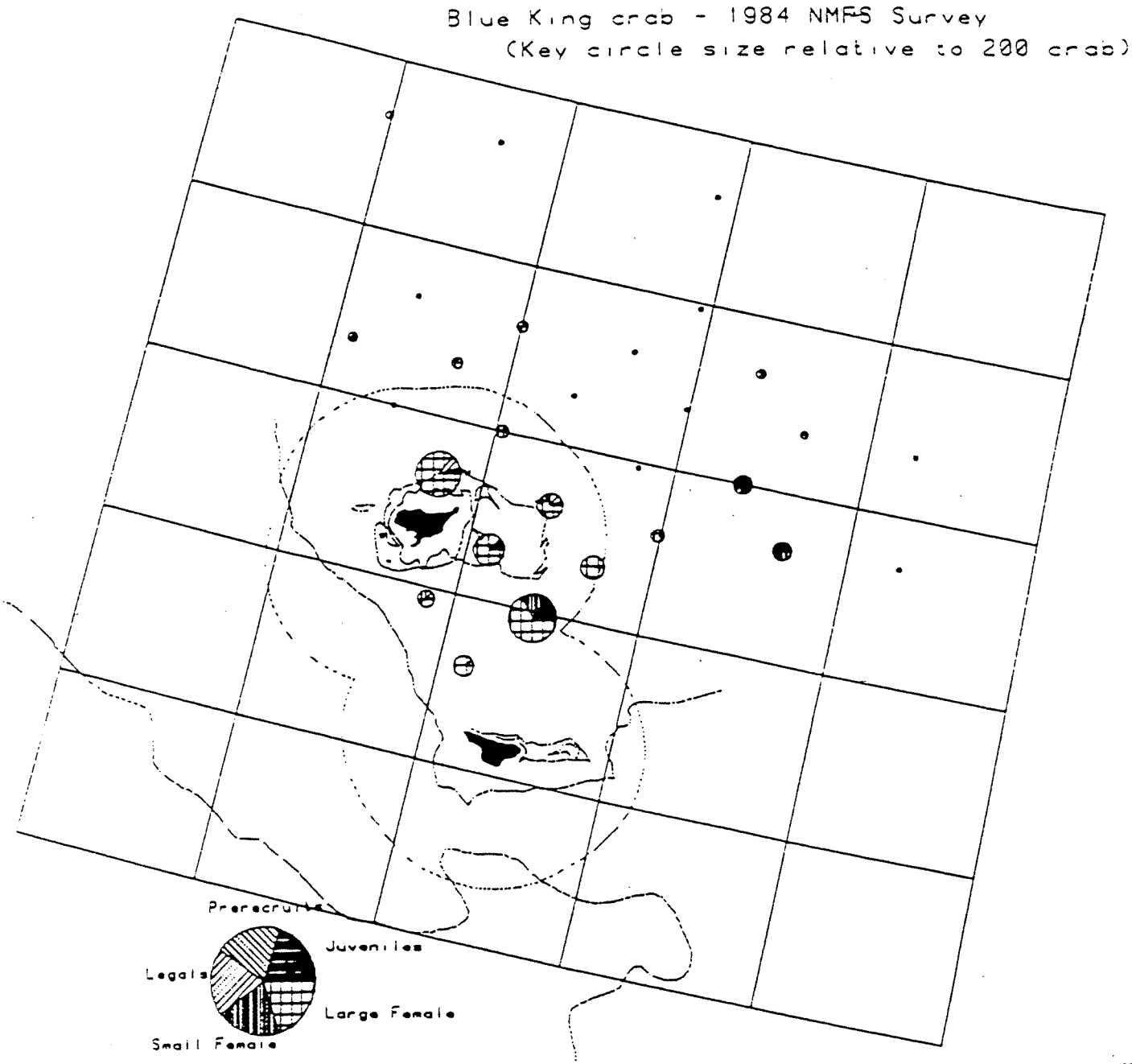


Figure A.12. Blue king crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

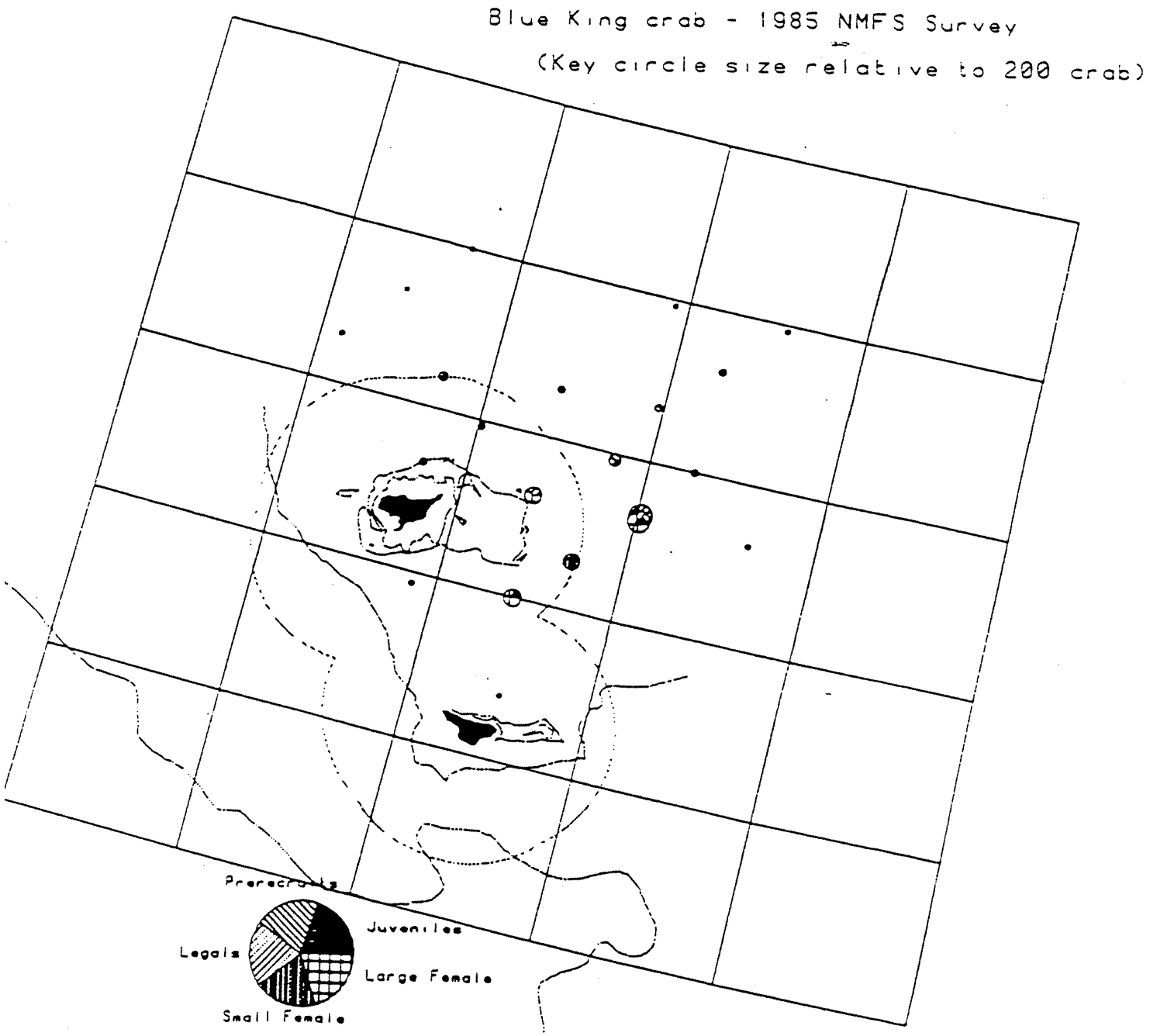


Figure A.13. Blue king crab catch in 1986 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

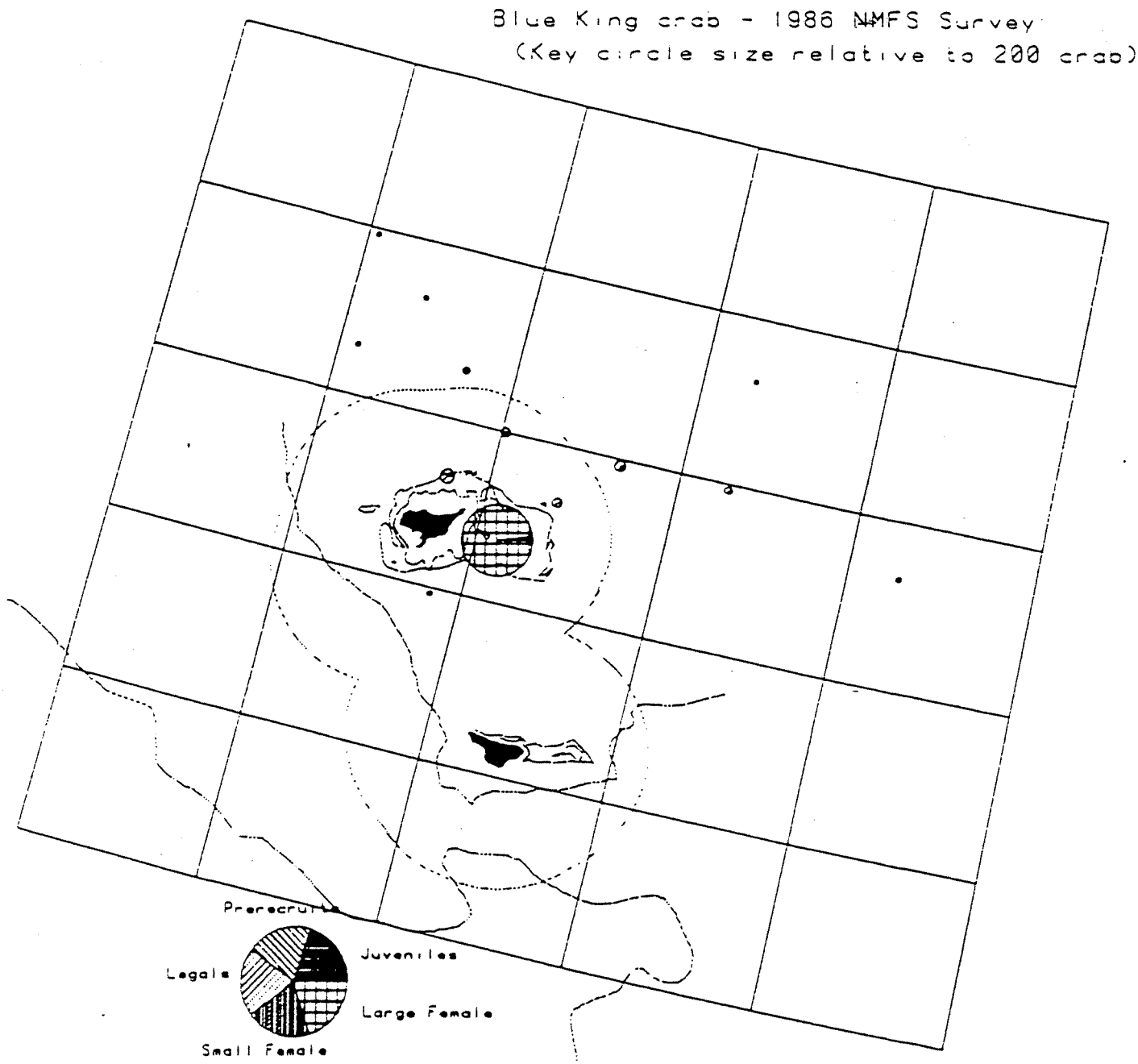


Figure A.14. Blue king crab catch in 1987 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

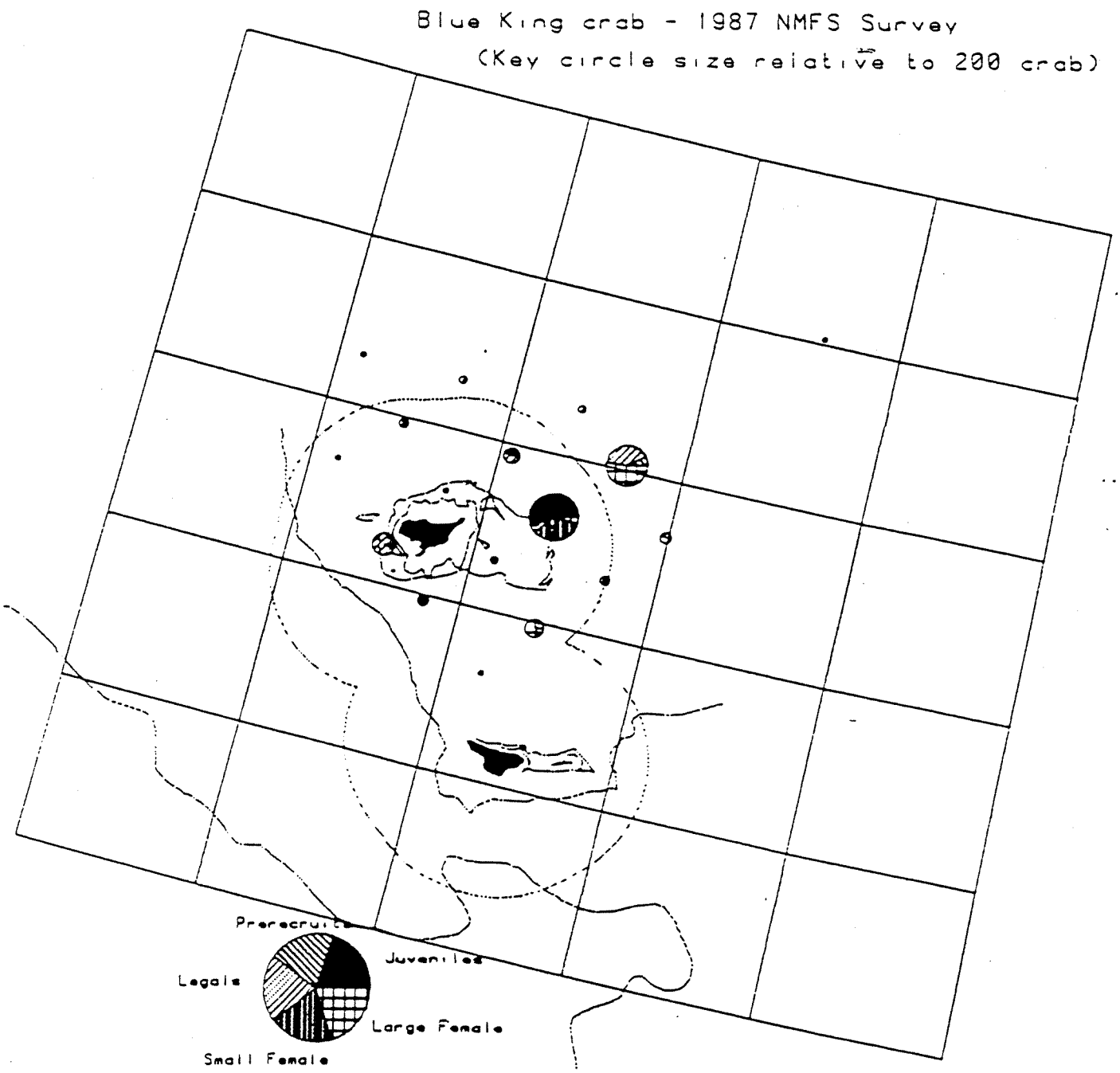


Figure A.15. Blue king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

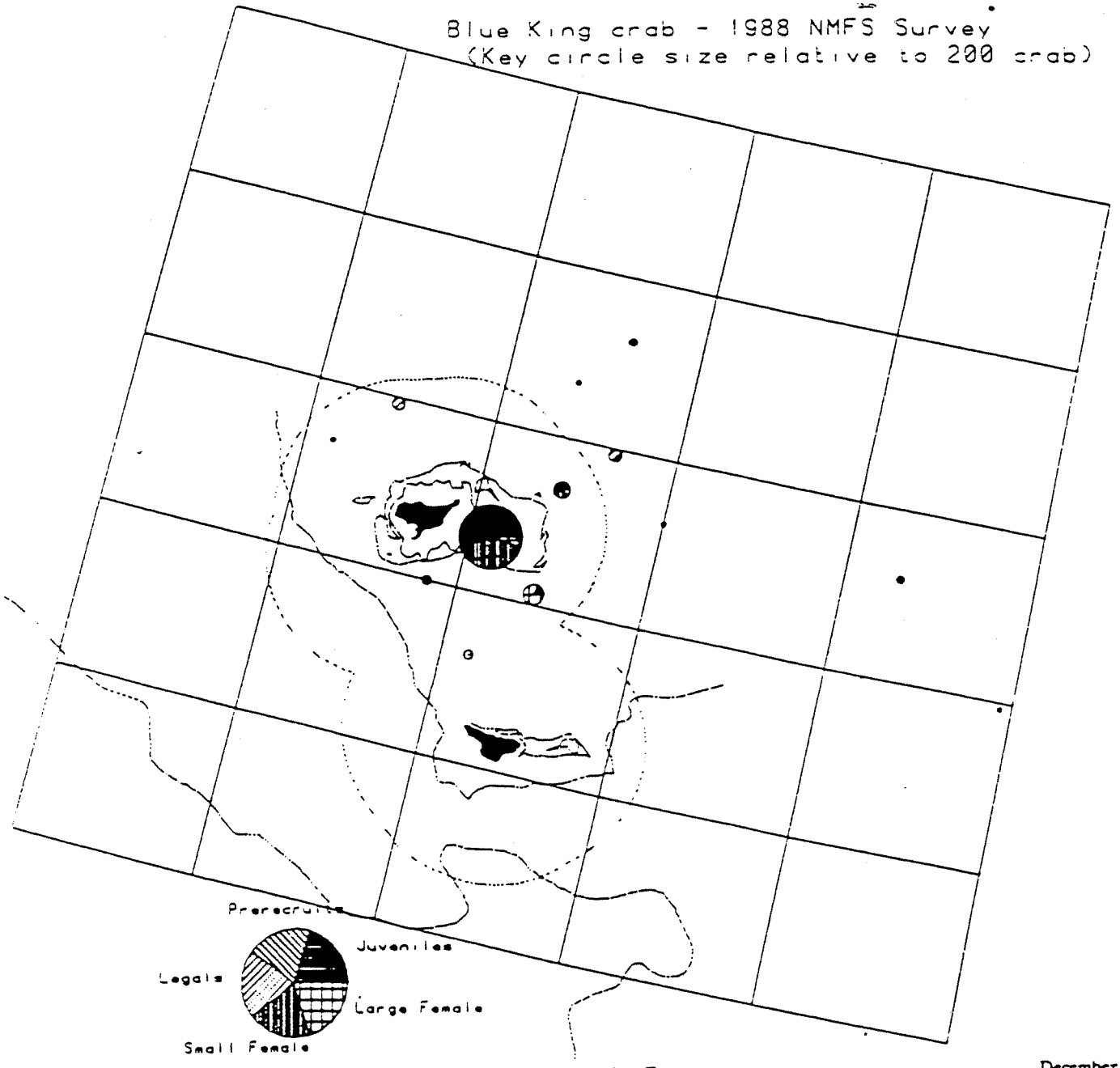


Figure A.16. Blue king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

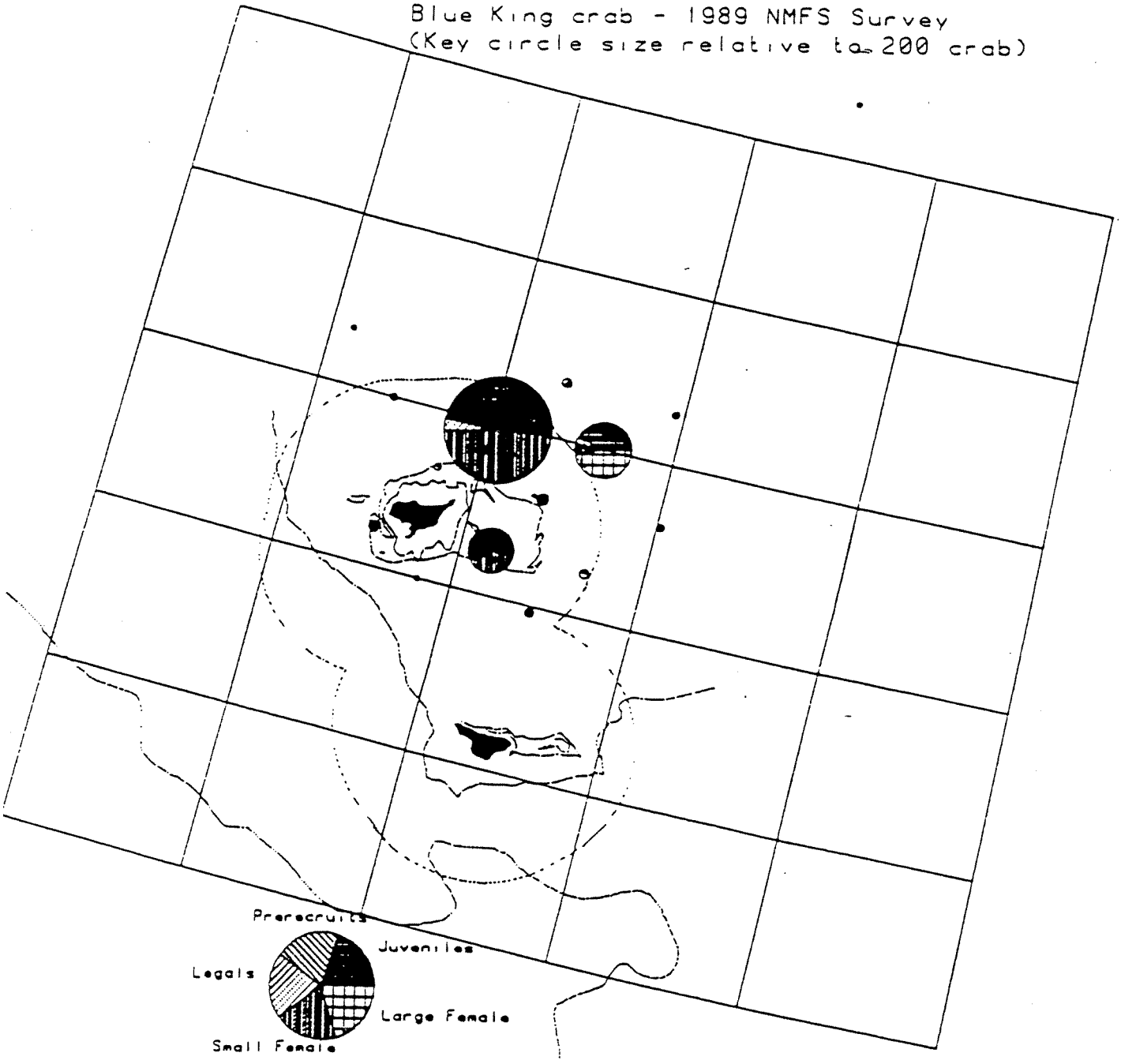


Figure A.17. Blue king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

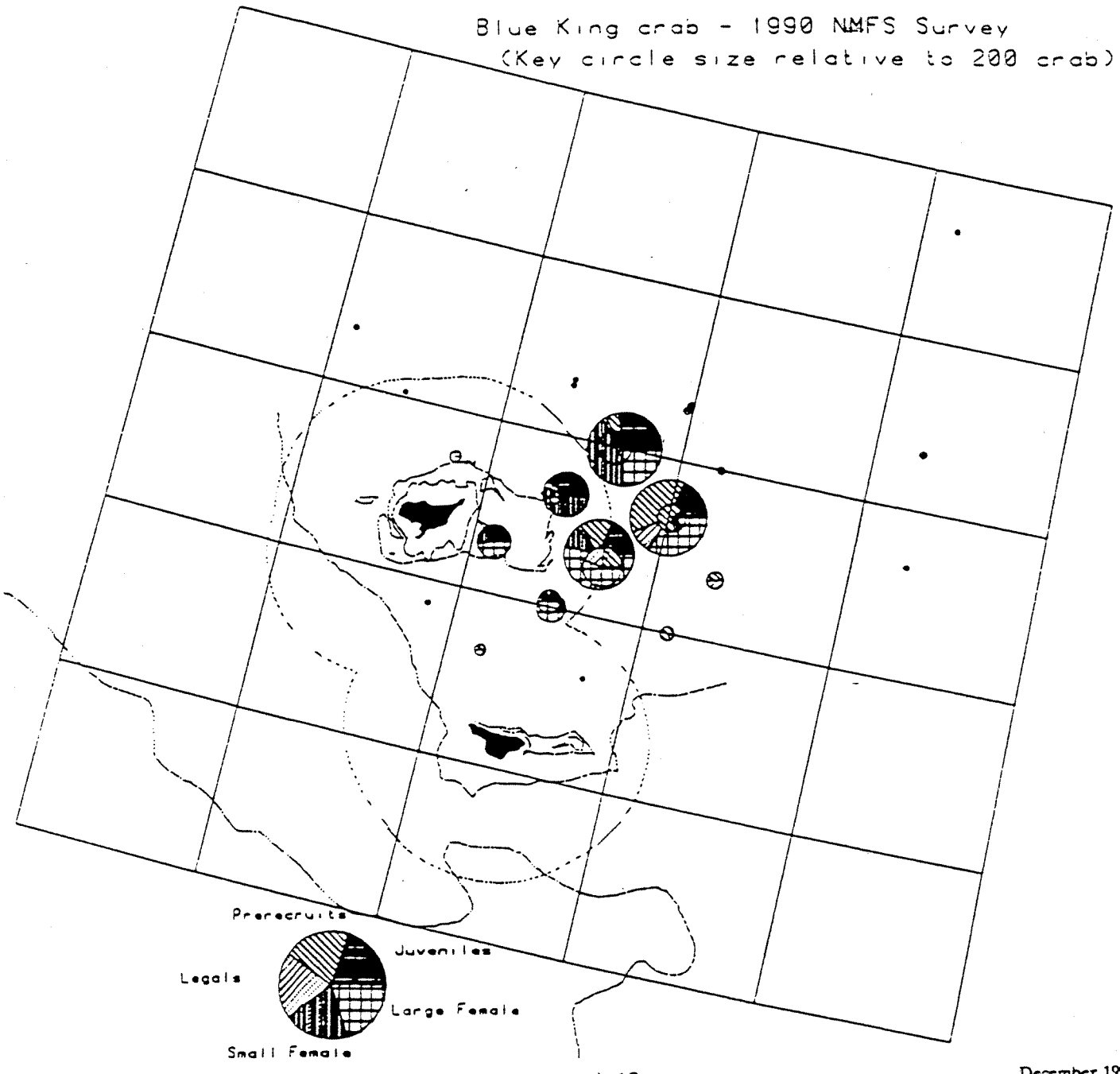


Figure A.18. Blue king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

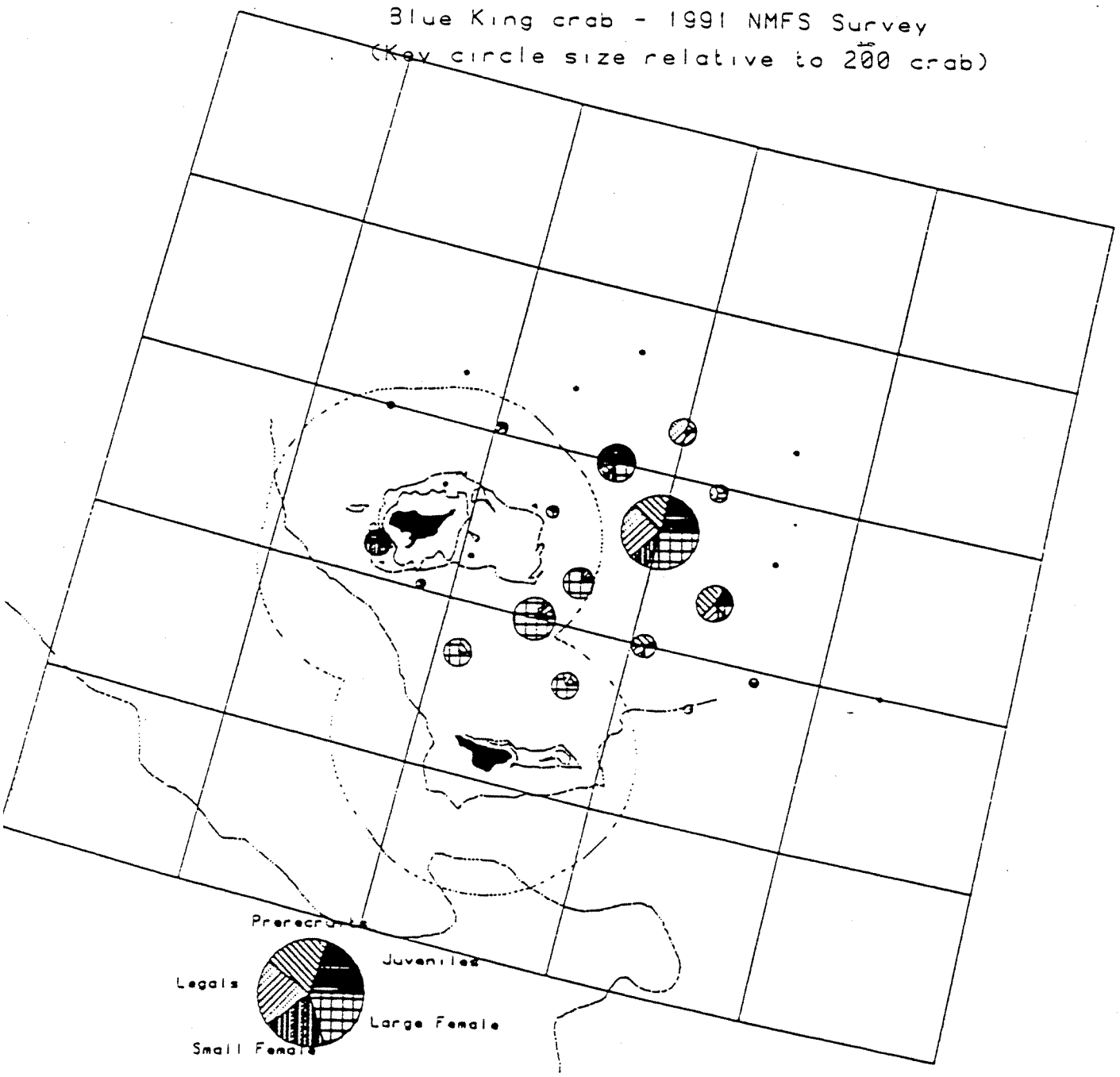


Figure A.19. Blue king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

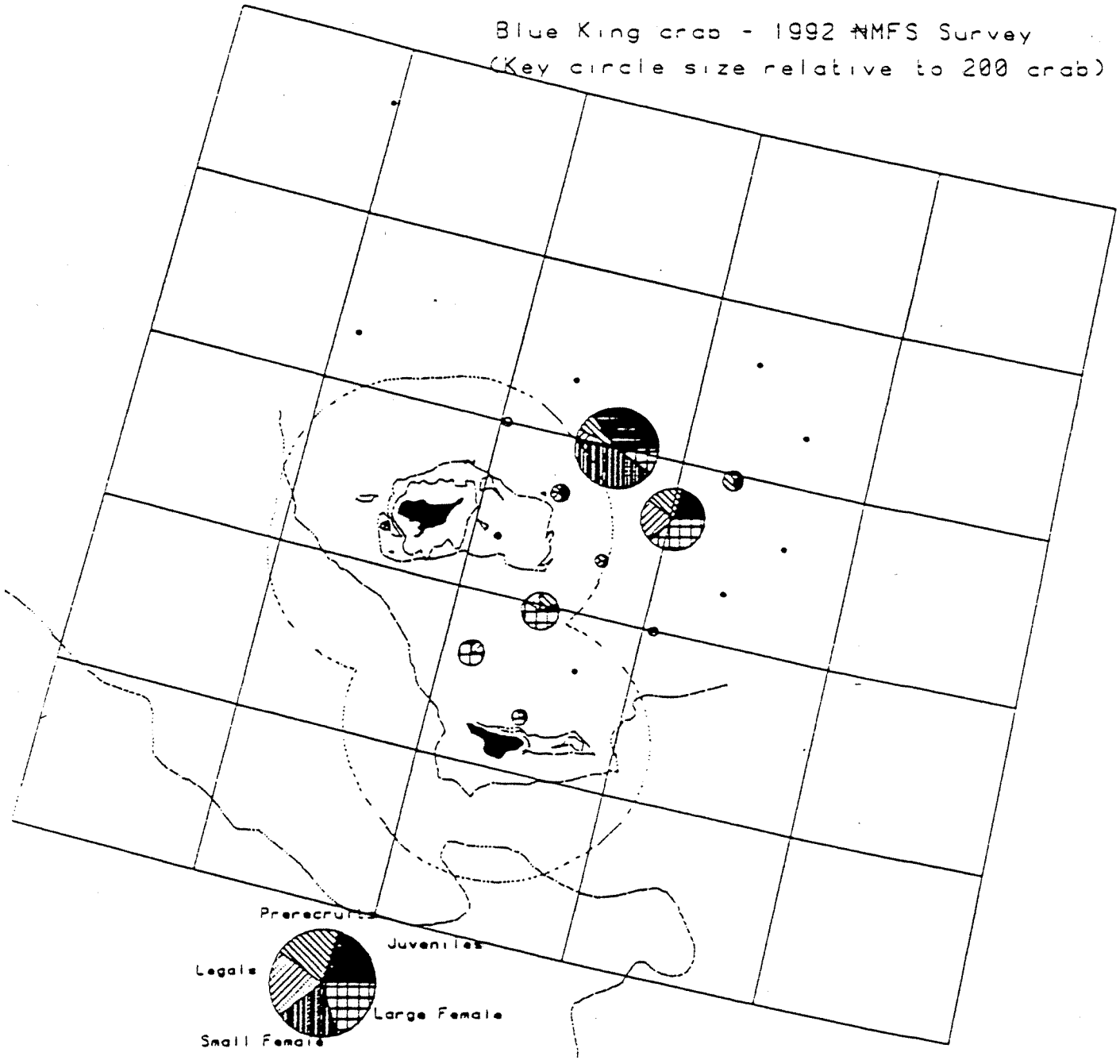


Figure A.20. Blue king crab catch in 1993 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

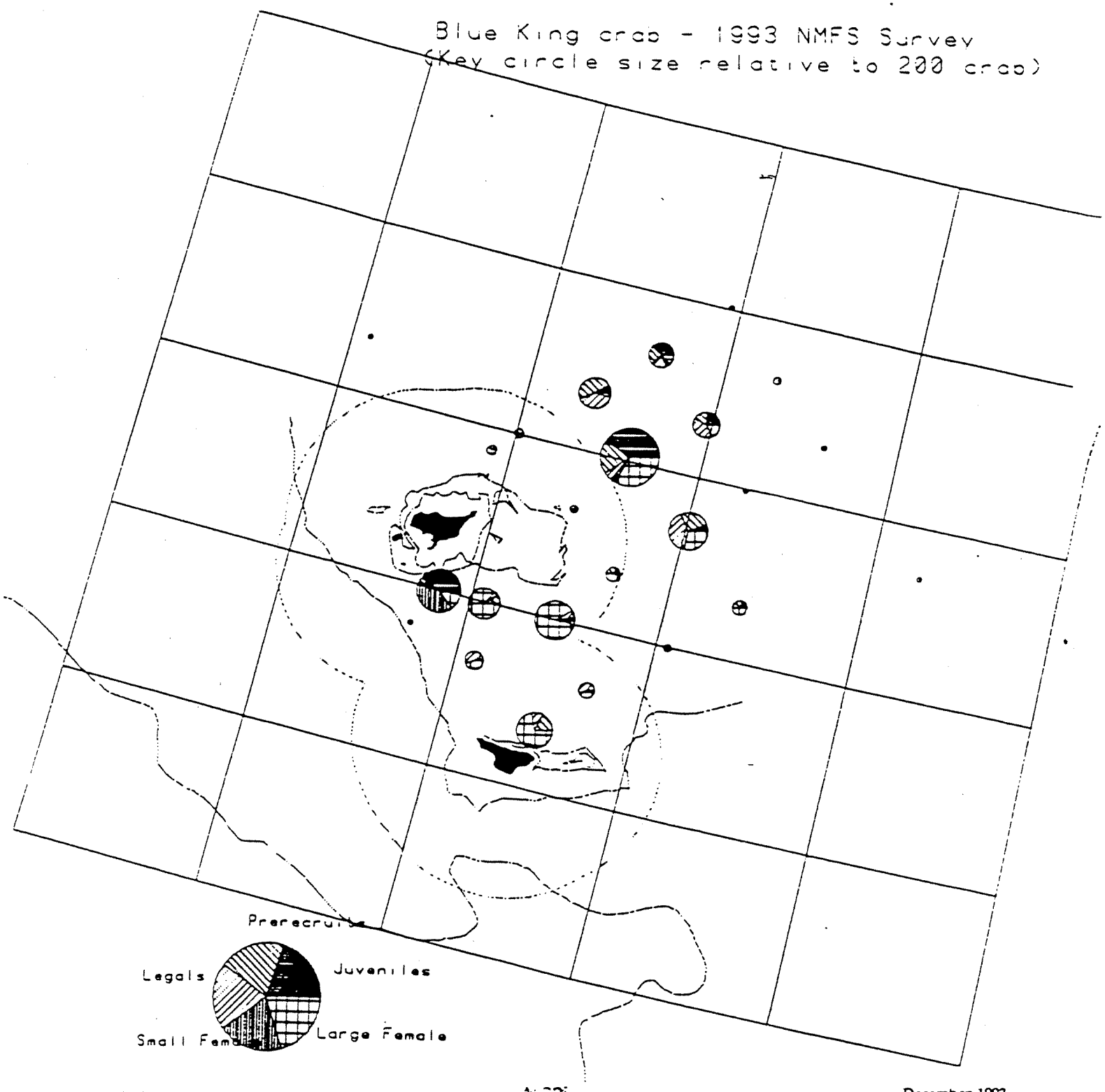


Figure A.21. Red king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

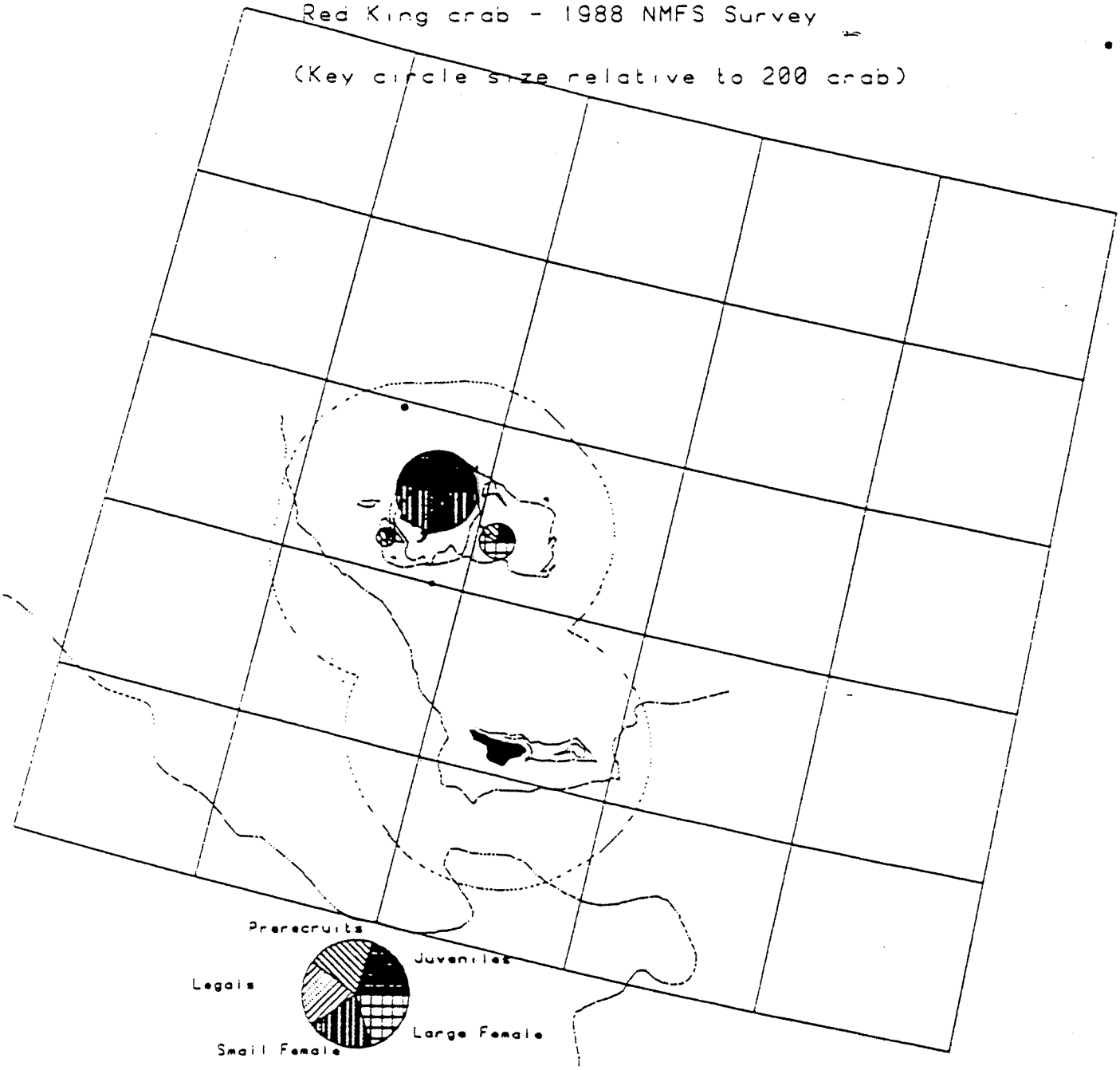


Figure A.22. Red king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

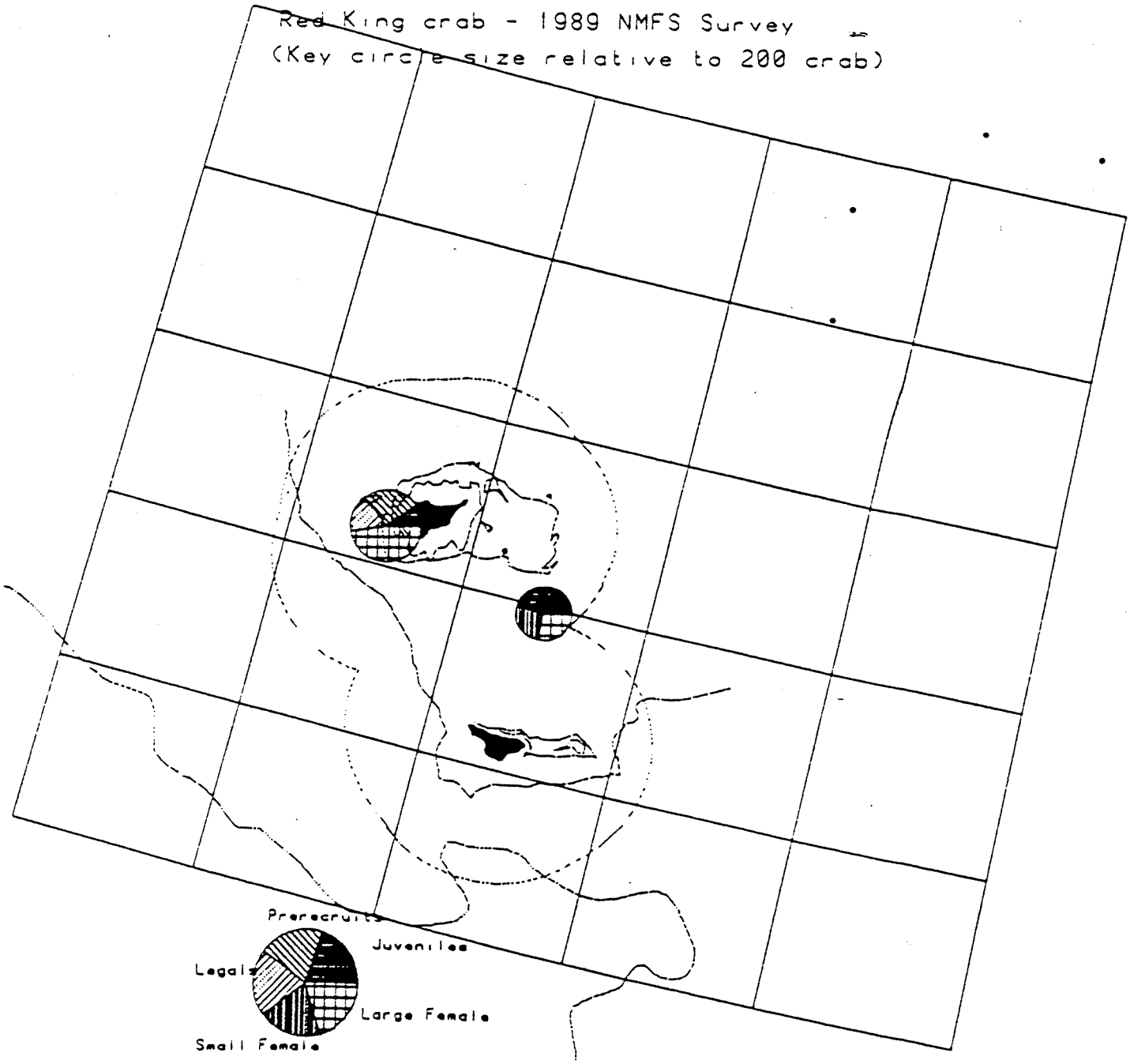


Figure A.23. Red king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

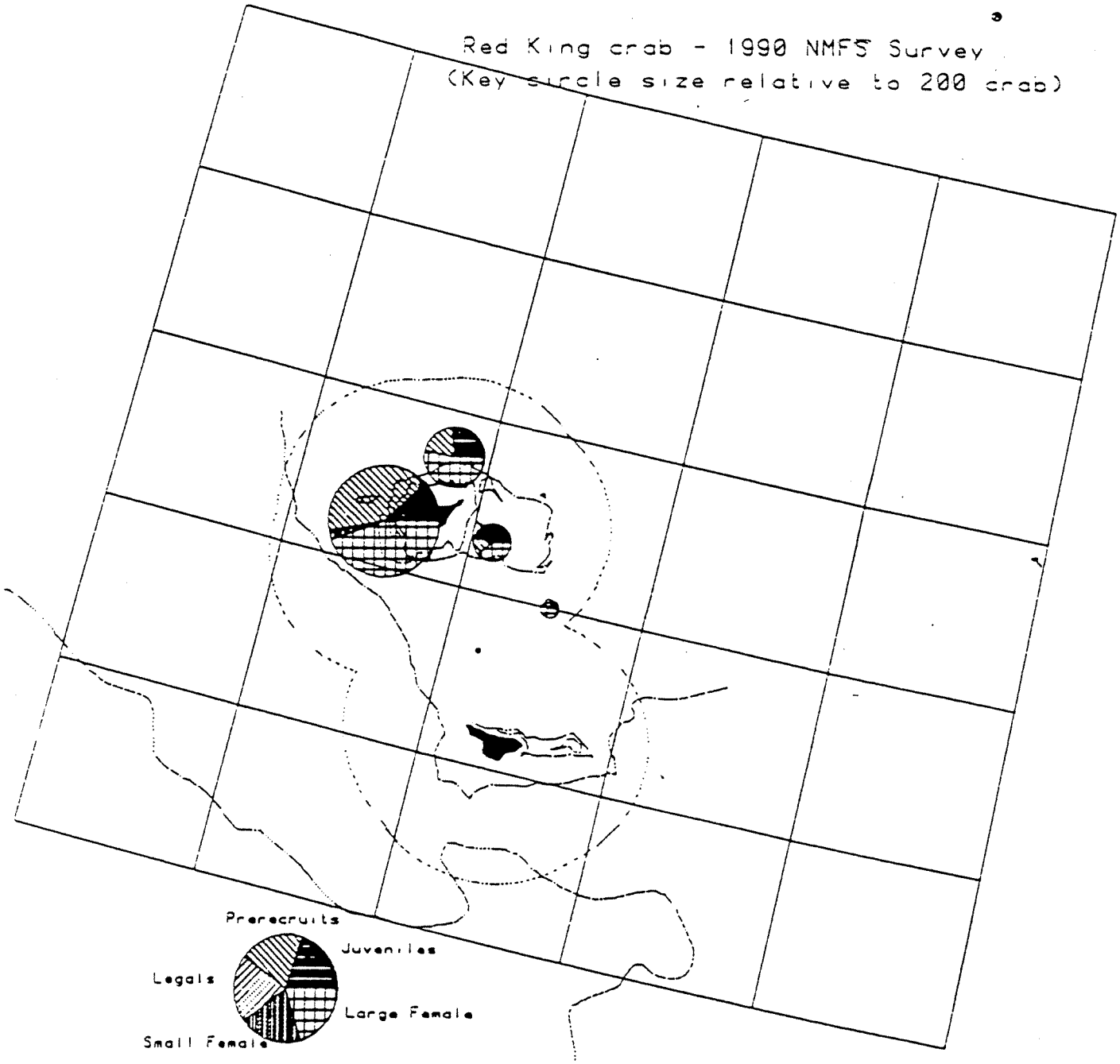


Figure A.24. Red king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

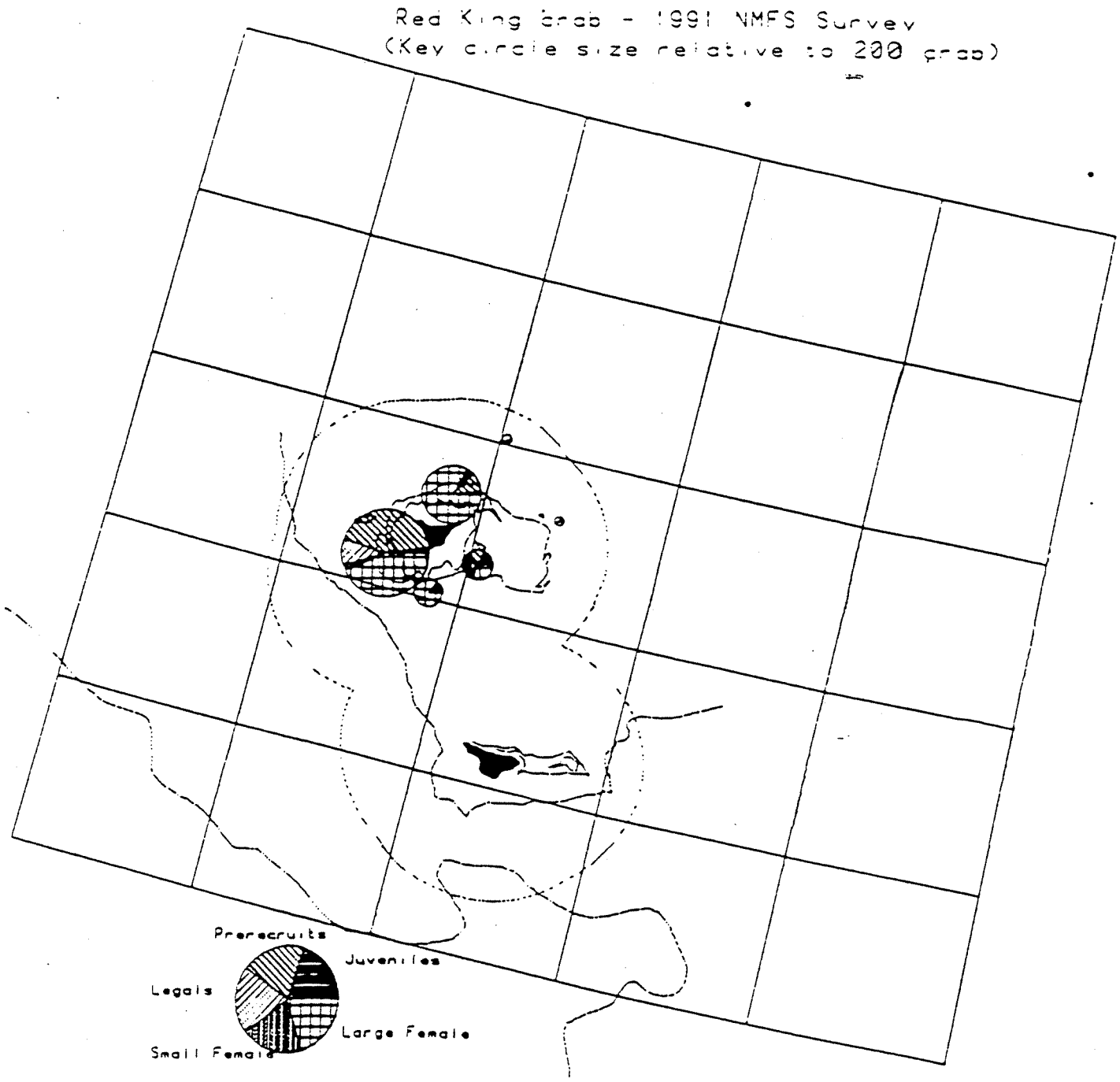


Figure A.25. Red king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

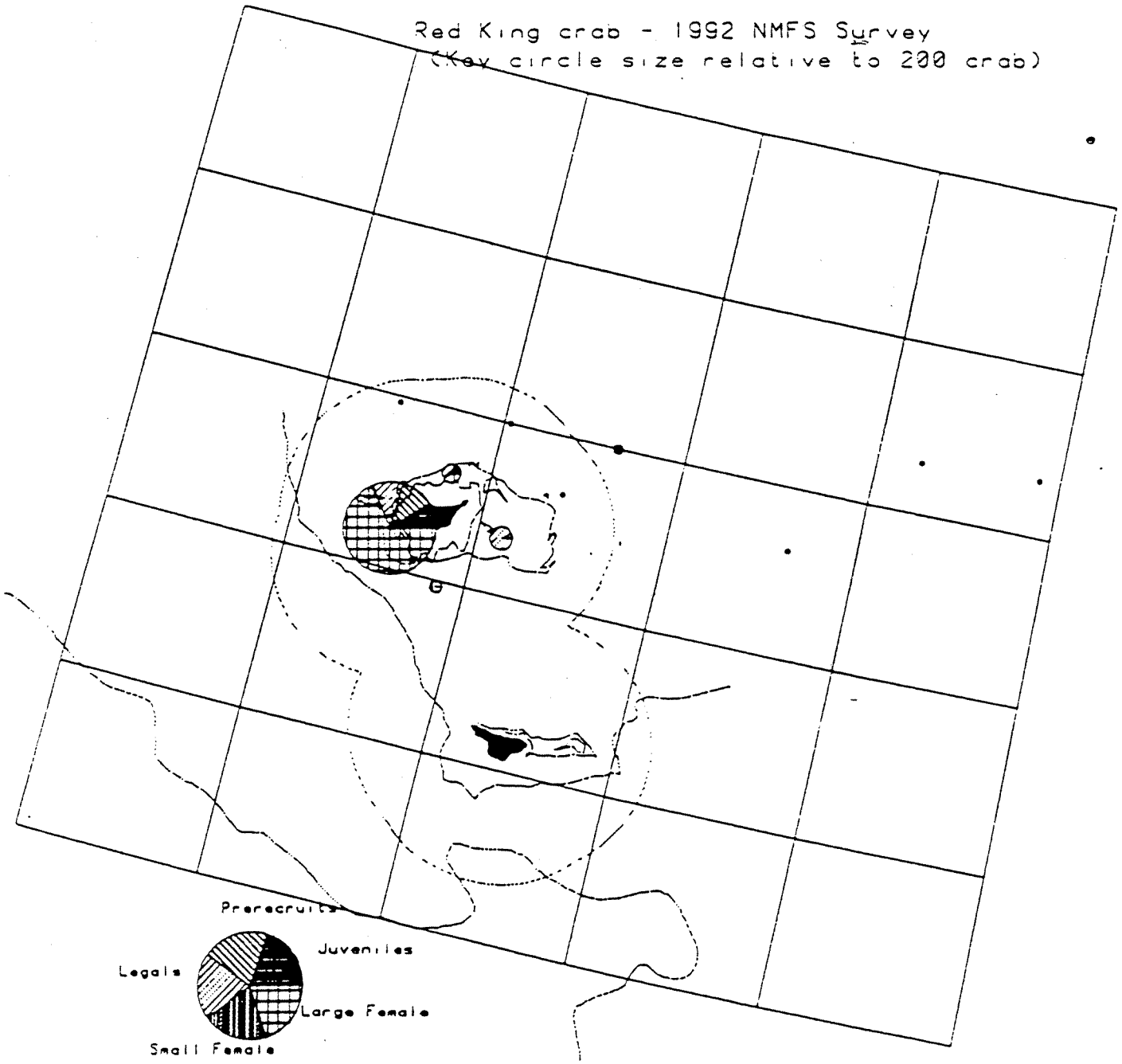


Figure A.26. C. bairdi Tanner crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

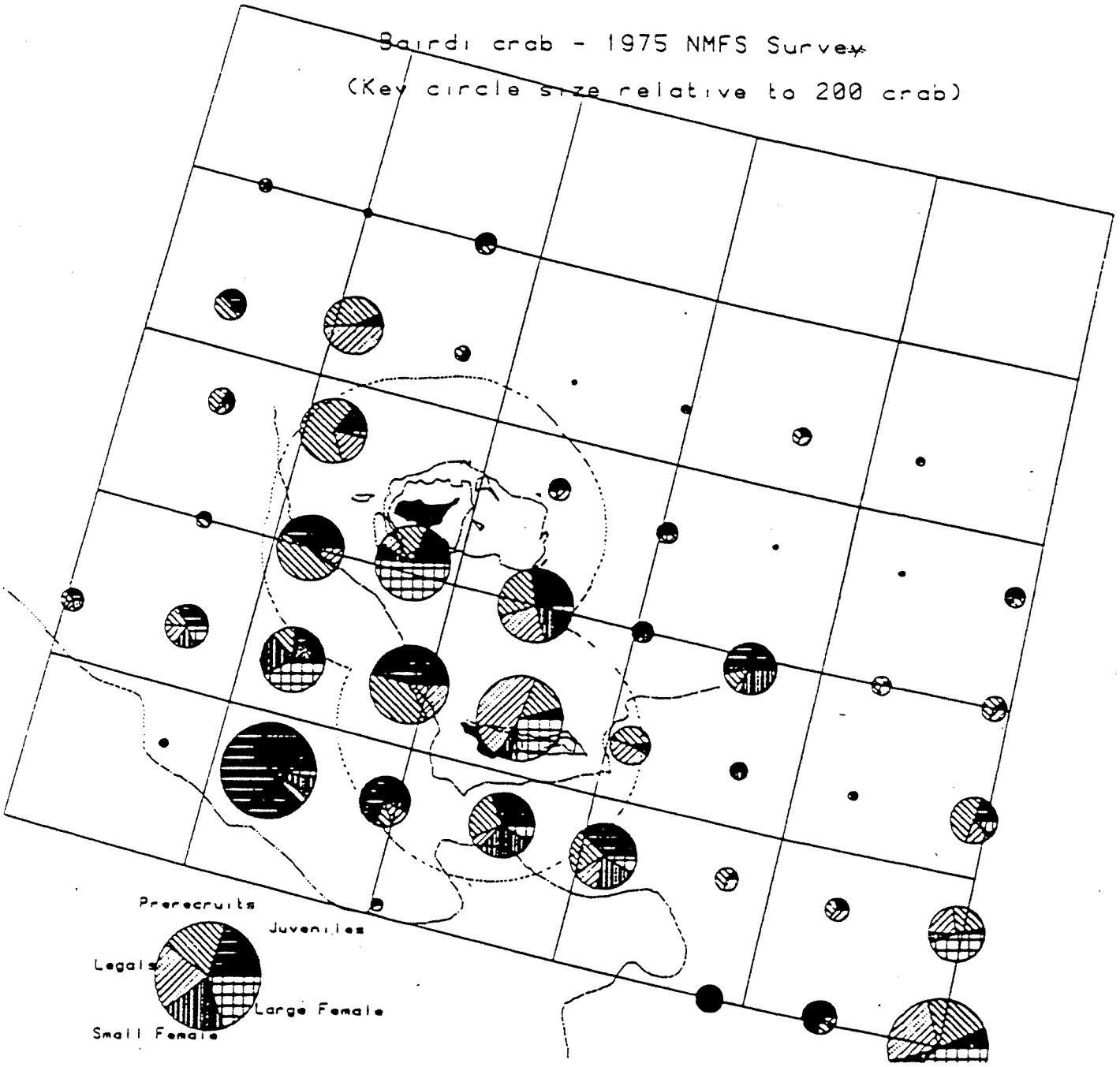


Figure A.27. C. bairdi Tanner crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

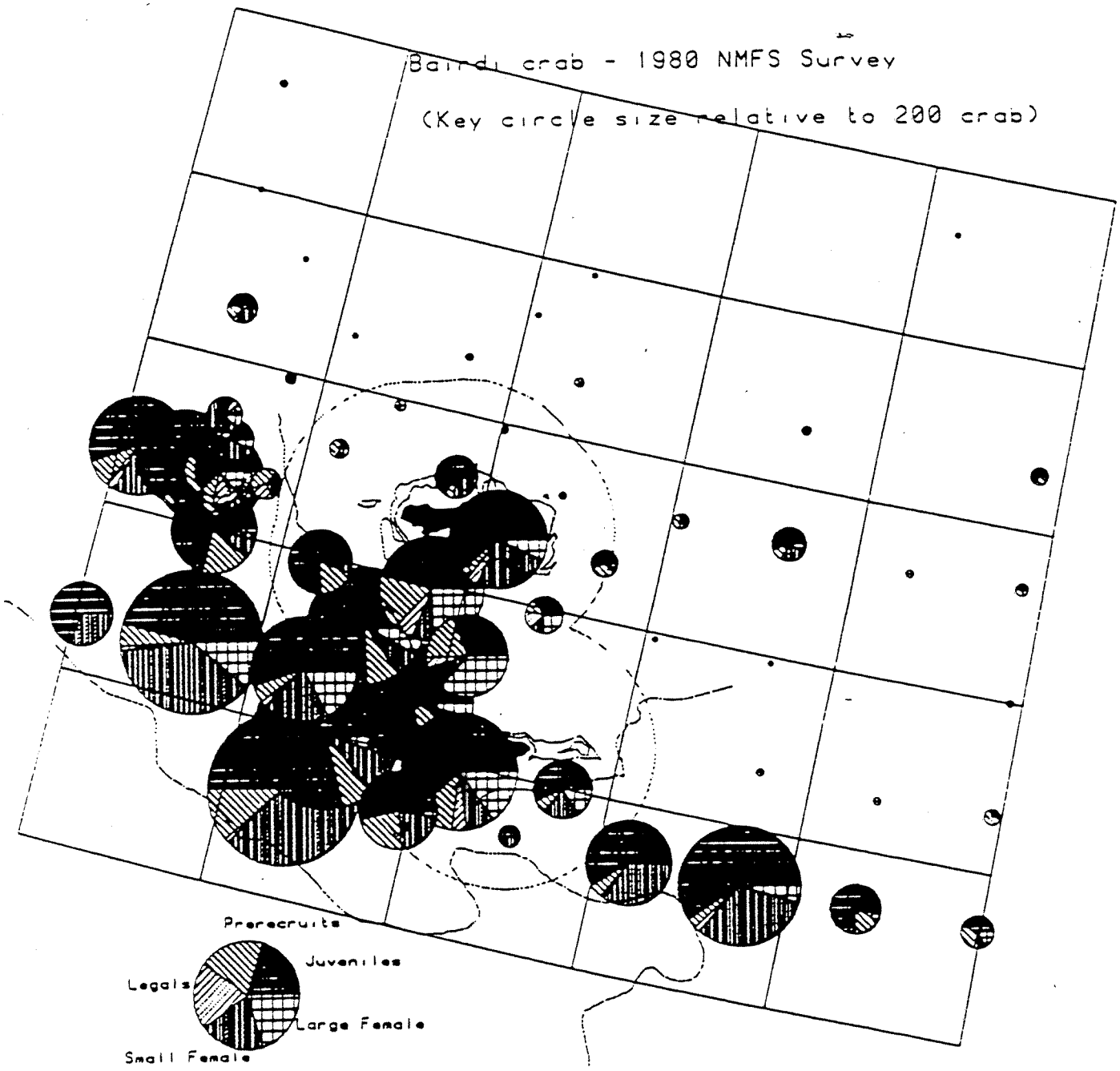


Figure A.28. C. bairdi Tanner crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

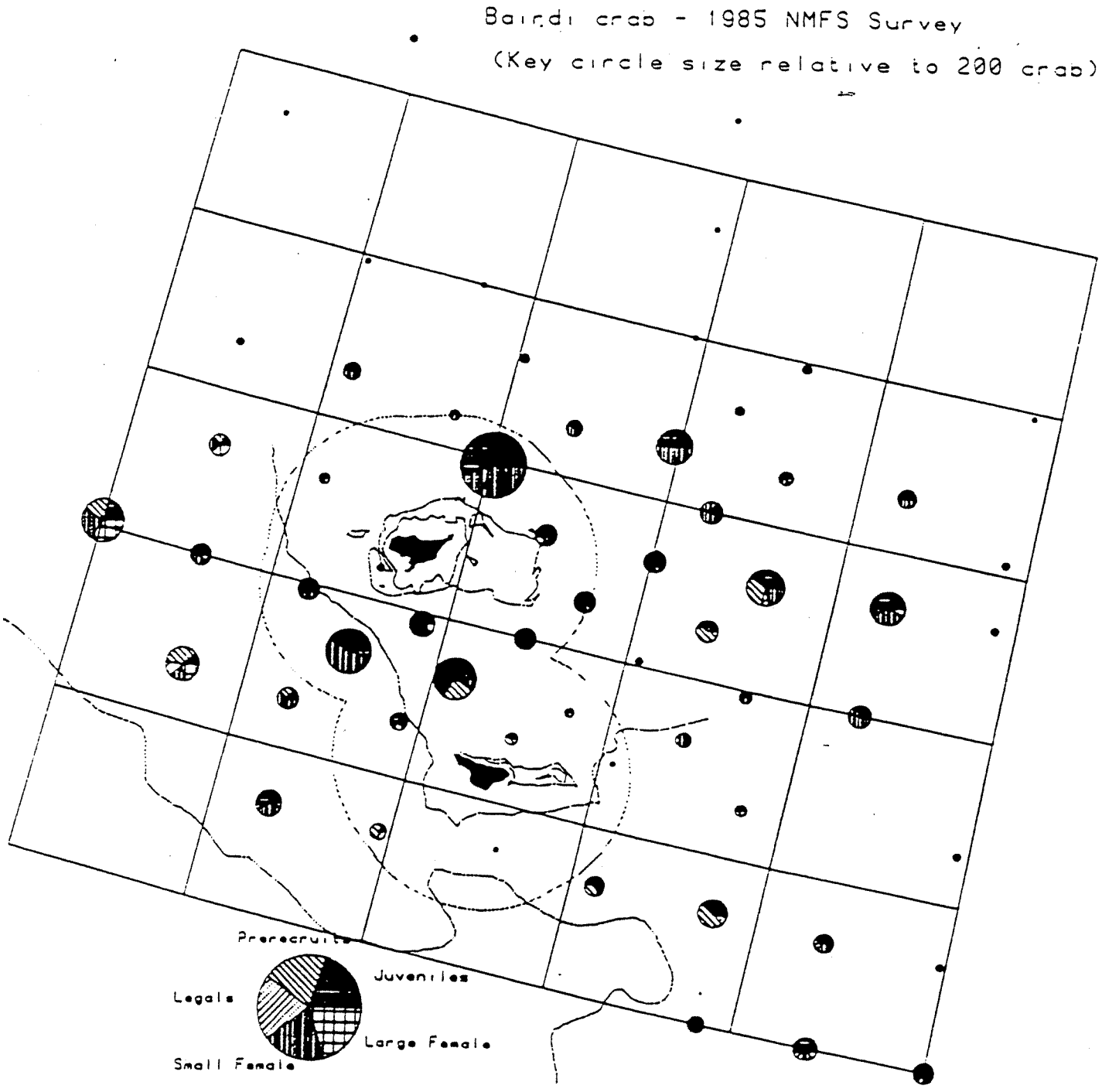
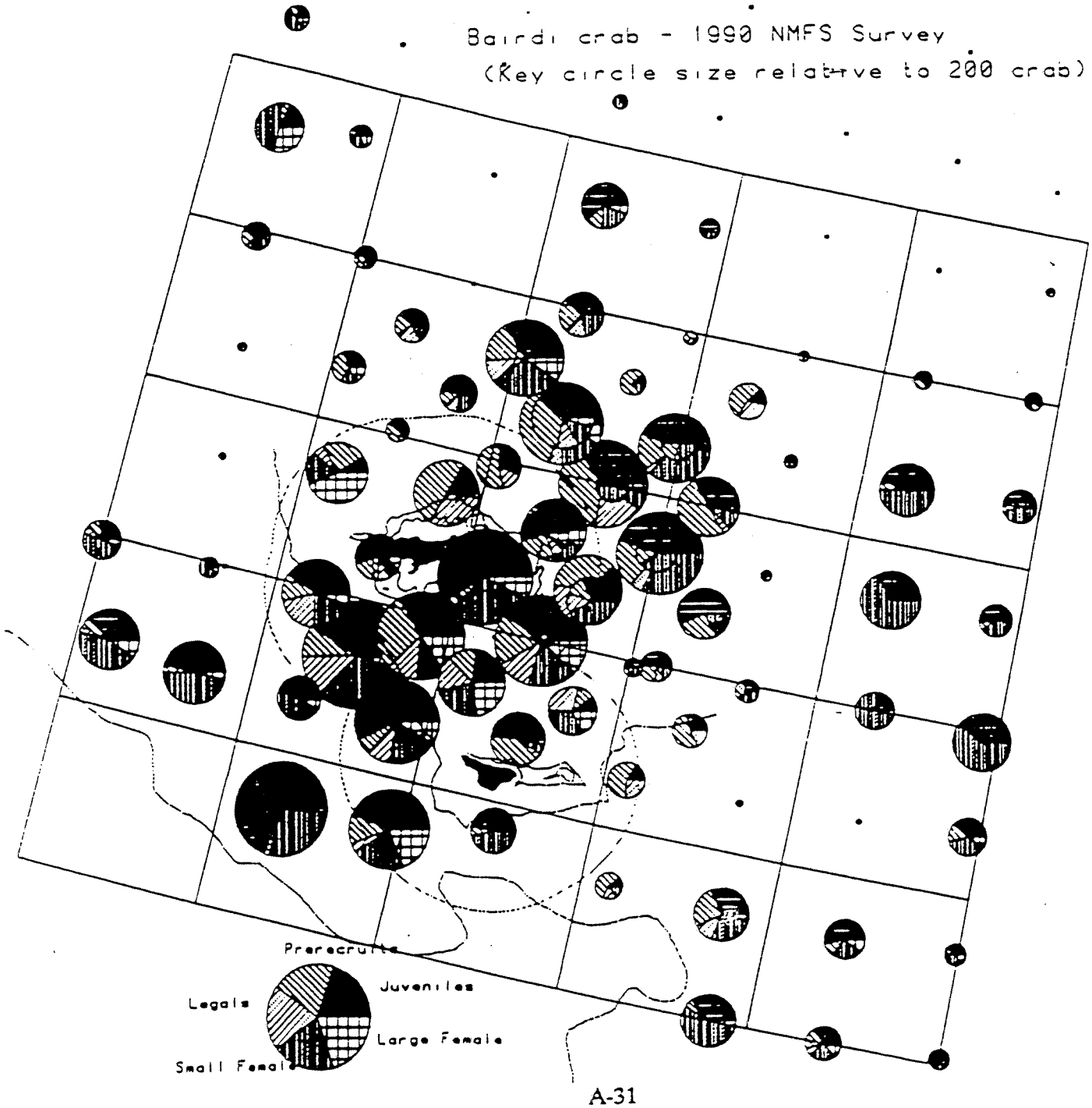


Figure A.29. C. bairdi Tanner crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.



Appendix B. Observed hauls for which species identification of crab bycatch was made. Foreign, 1982-1987; JV, 1985-1989; Domestic 1989 and 1991.

Figure B.1. Blue king crab bycatch in 1982 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.2. Blue king crab bycatch in 1983 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.3. Blue king crab bycatch in 1984 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.4. Blue king crab bycatch in 1985 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.5. Blue king crab bycatch in 1986 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.6. Blue king crab bycatch in 1987 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.7. Blue king crab bycatch in 1985 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.8. Blue king crab bycatch in 1986 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.9. Blue king crab bycatch in 1987 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.10. Blue king crab bycatch in 1988 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.11. Blue king crab bycatch in 1989 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.12. Blue king crab bycatch in 1989 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.13. Blue king crab bycatch in 1991 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.14. Number of blue king crab identified by observers from each year and target fishery.

Figure B.1. Blue king crab bycatch in 1982 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

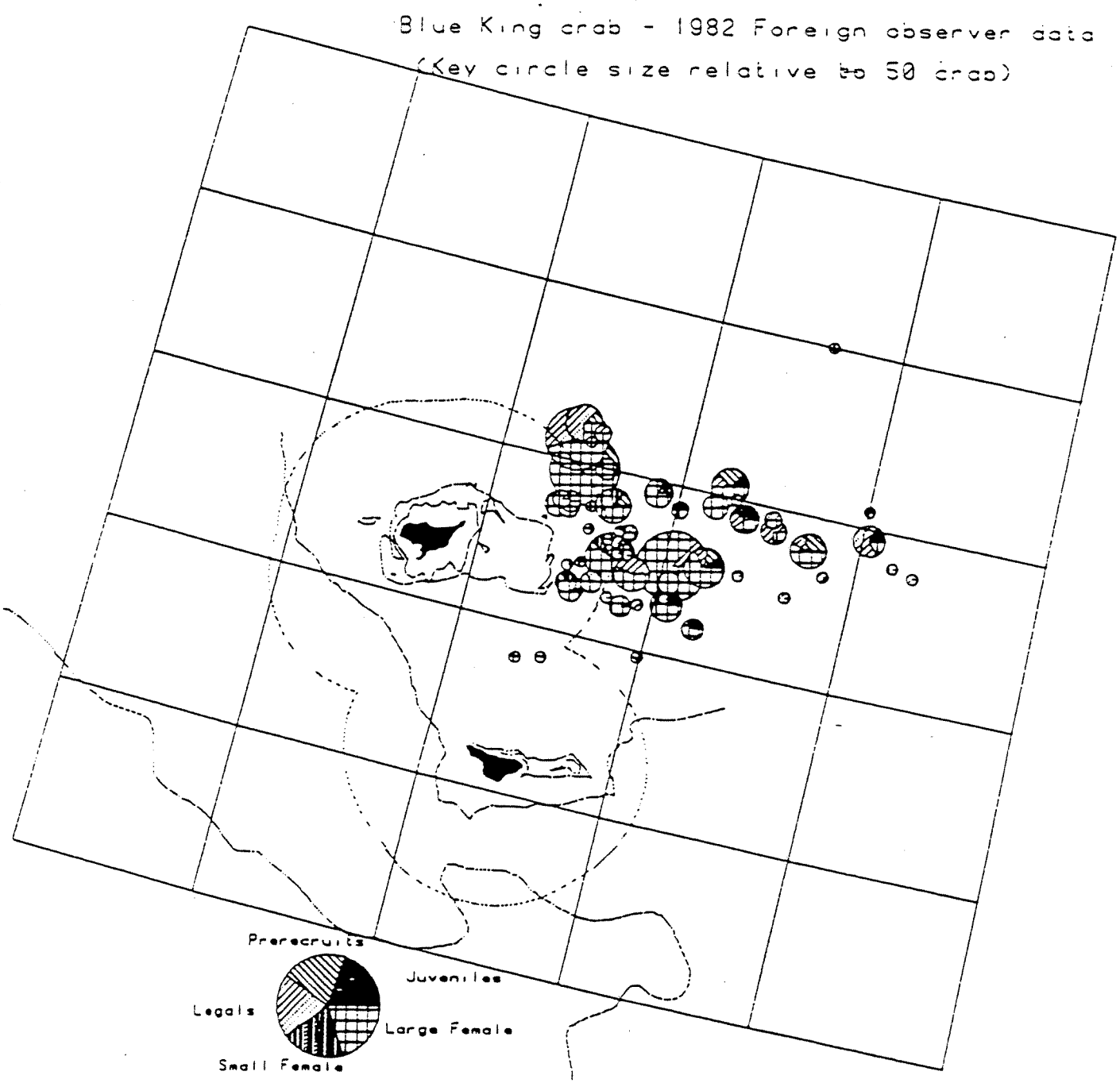


Figure B.2. Blue king crab bycatch in 1983 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

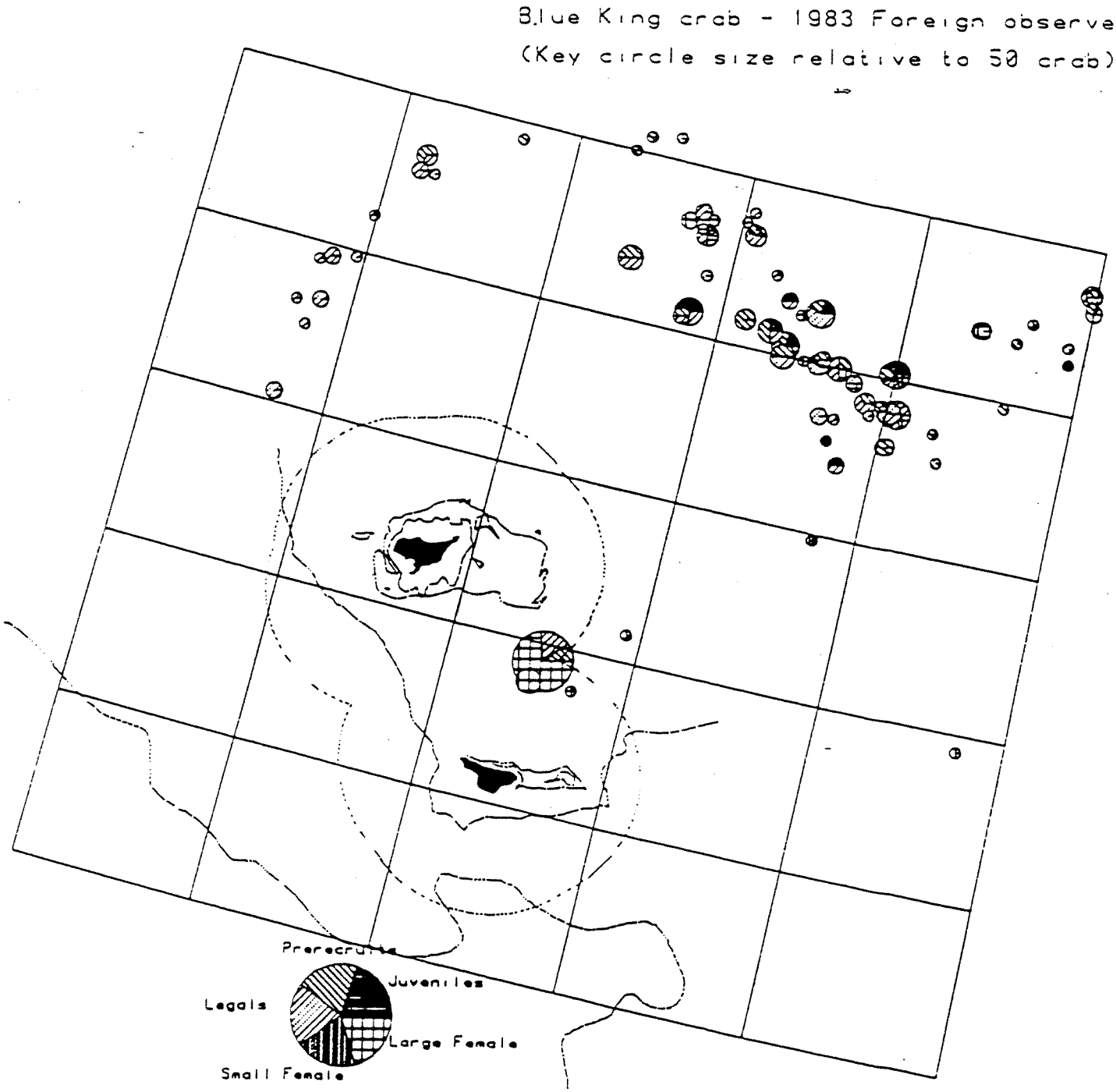


Figure B.3. Blue king crab bycatch in 1984 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

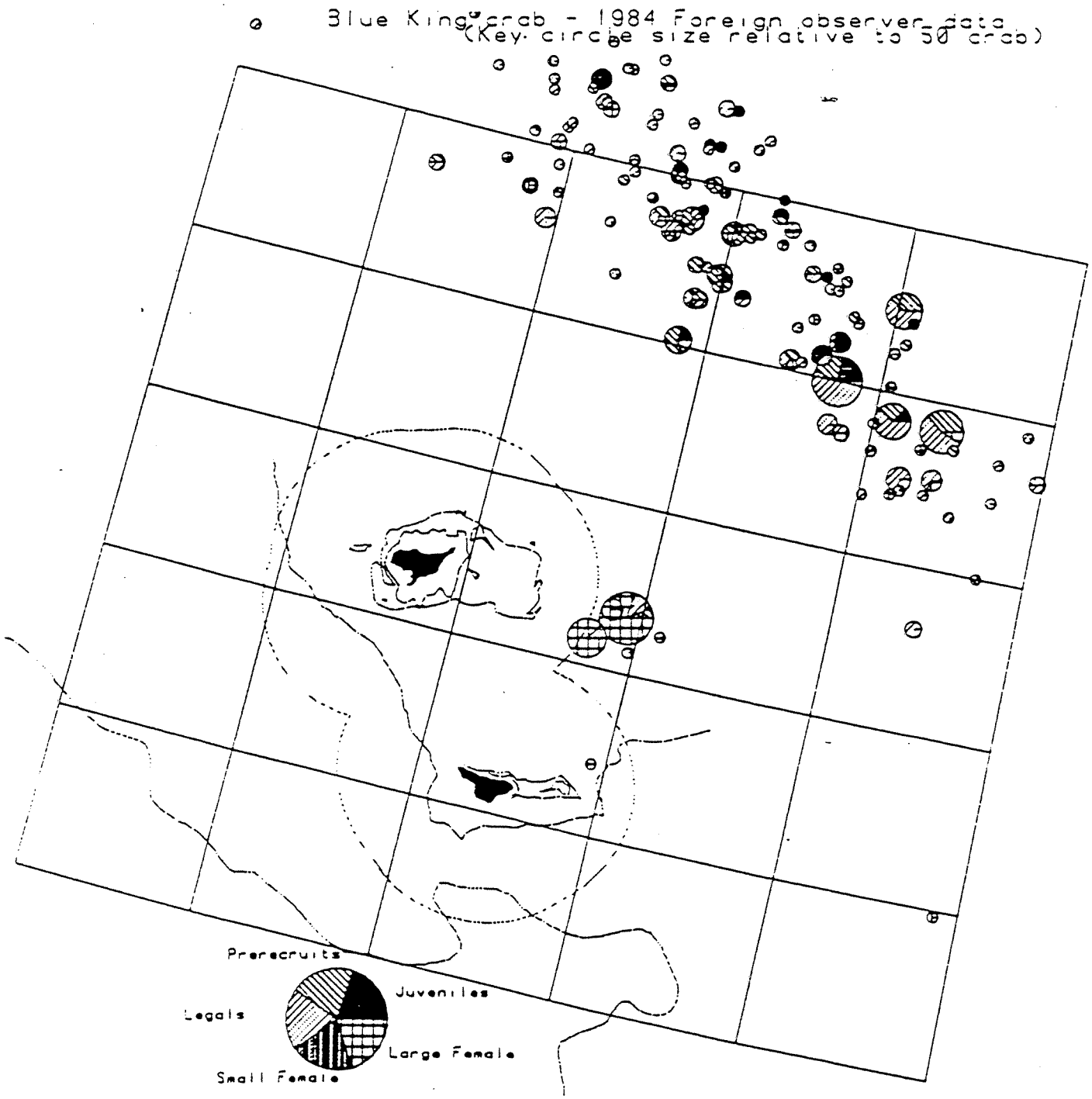


Figure B.4. Blue king crab bycatch in 1985 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

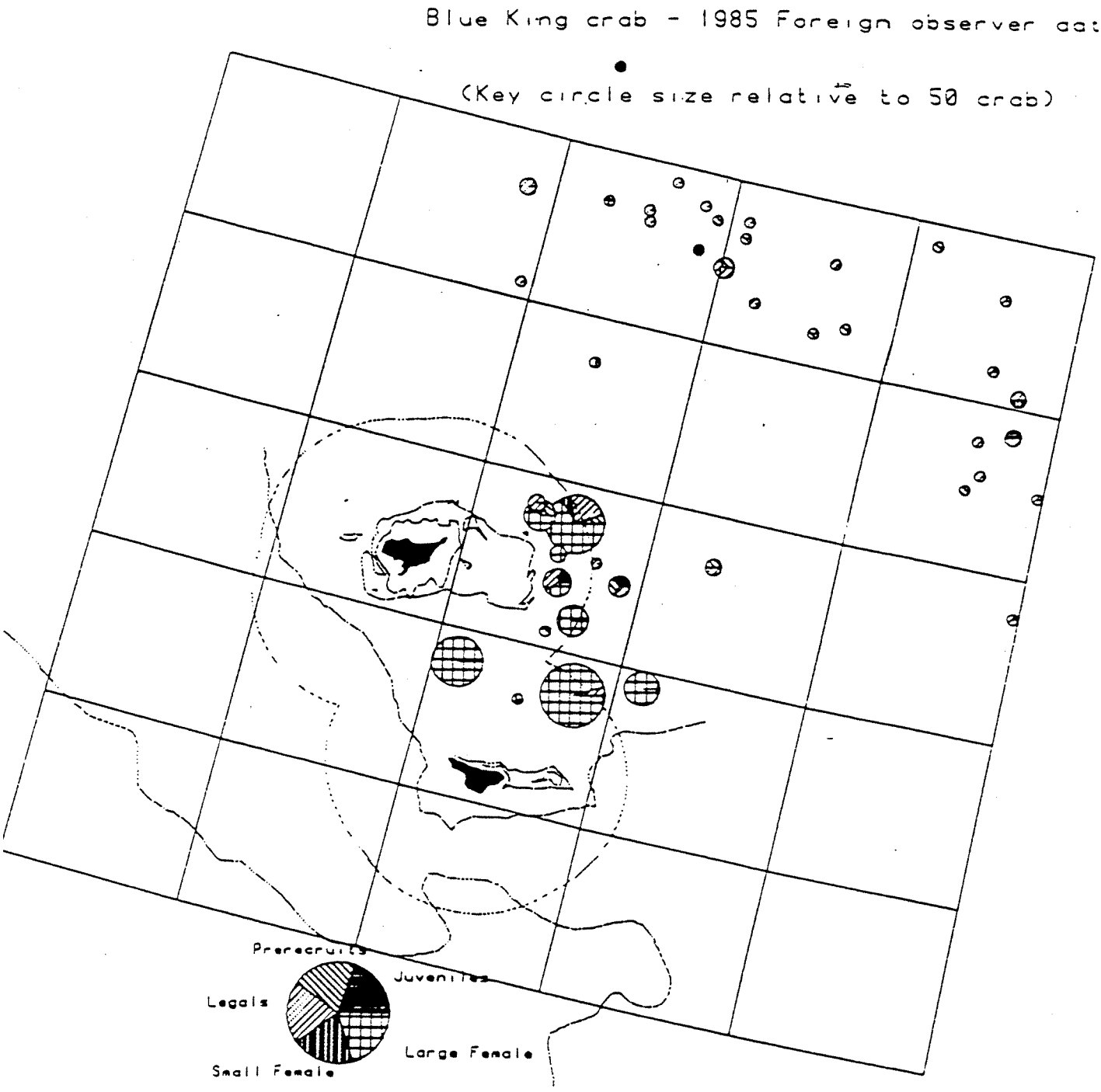


Figure B.5. Blue king crab bycatch in 1986 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

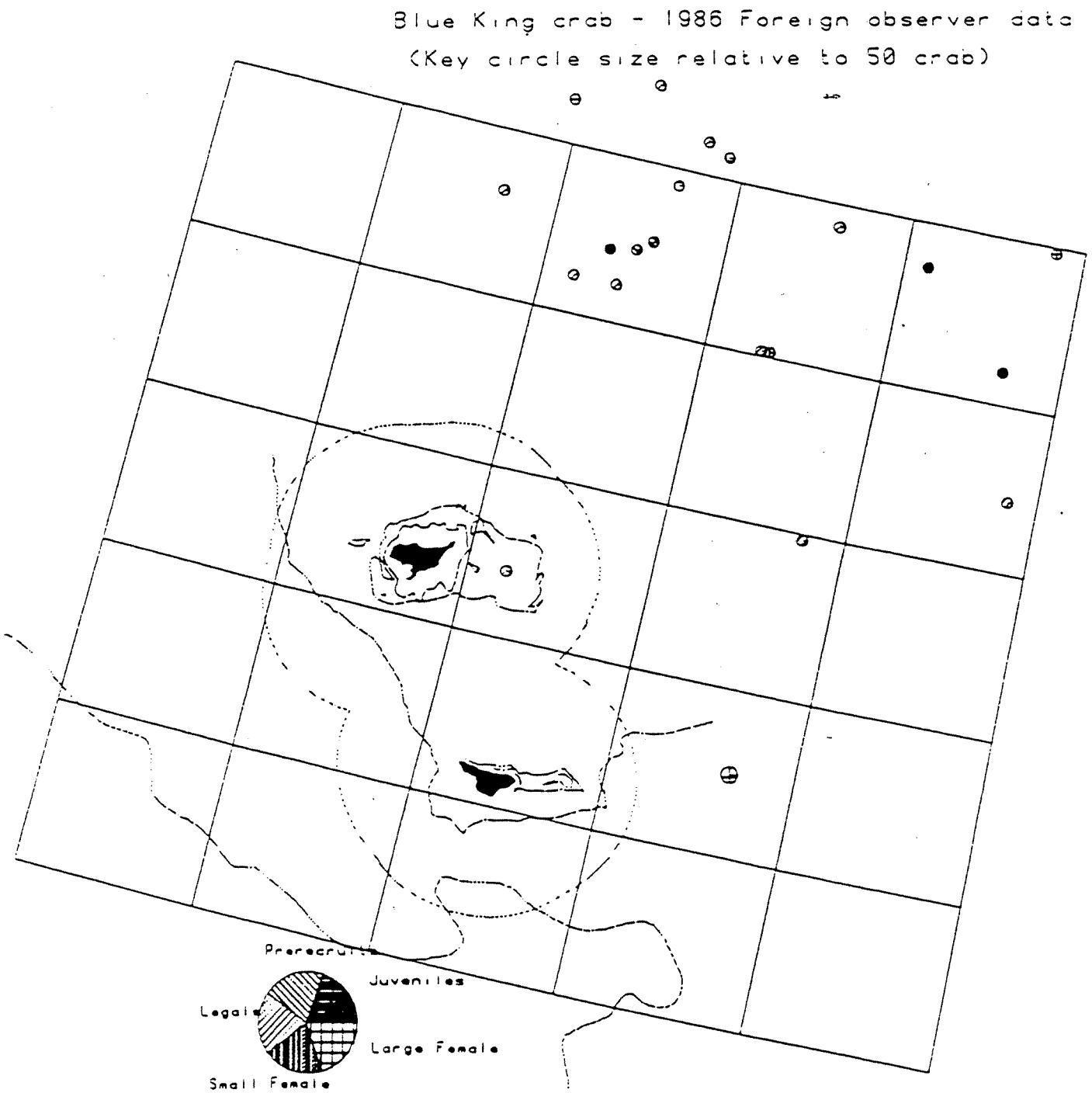


Figure B.6. Blue king crab bycatch in 1987 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

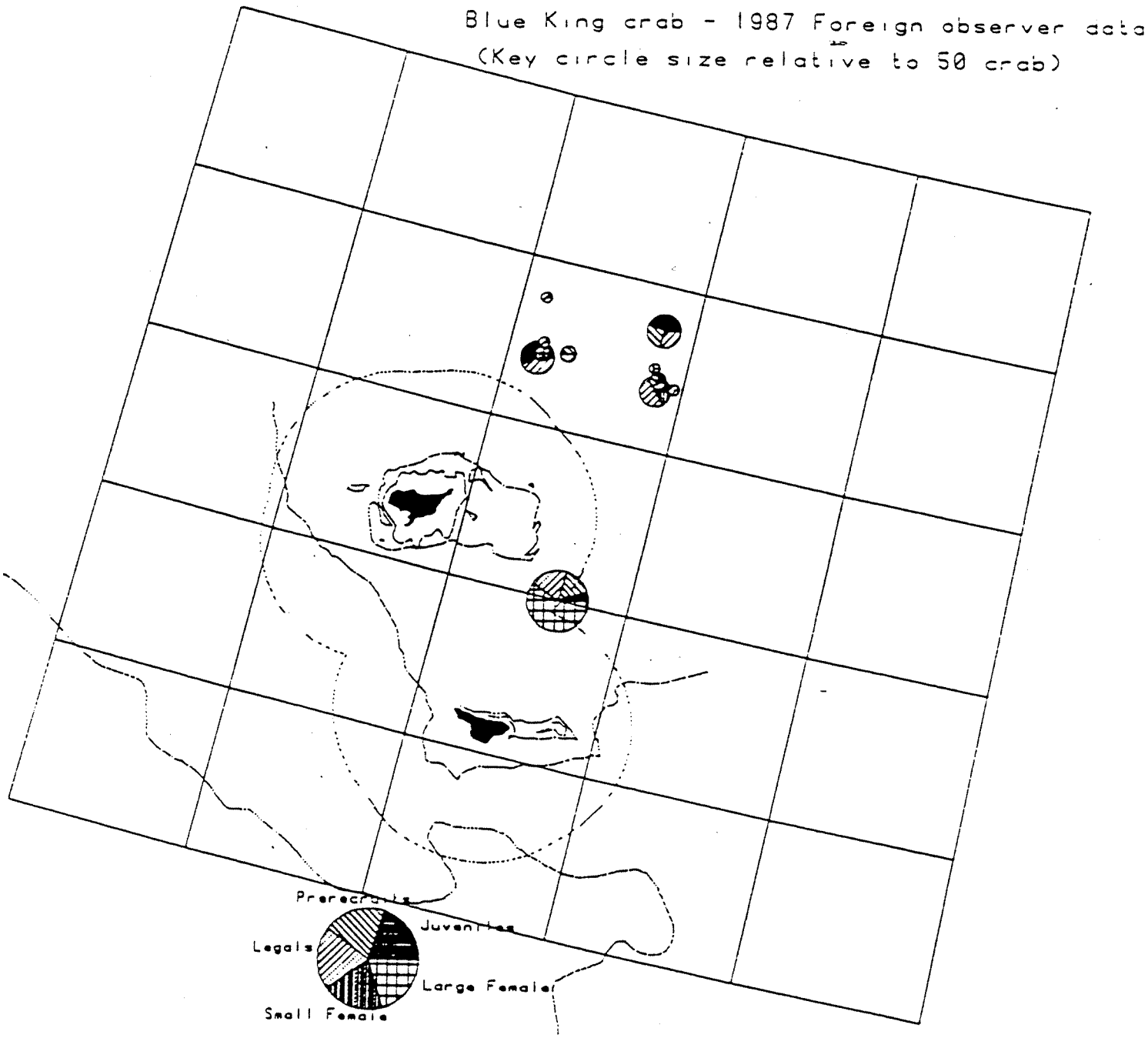


Figure B.7. Blue king crab bycatch in 1985 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

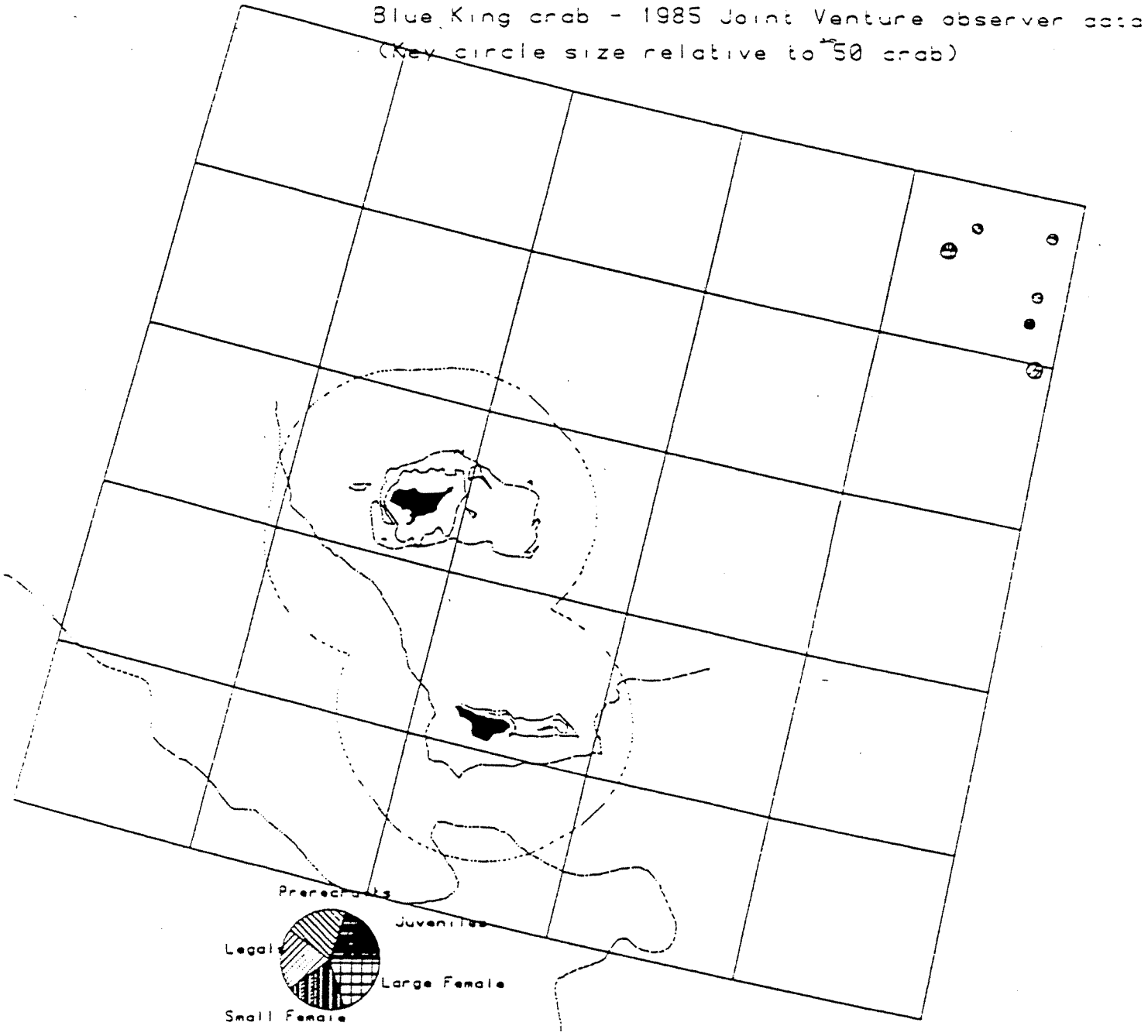
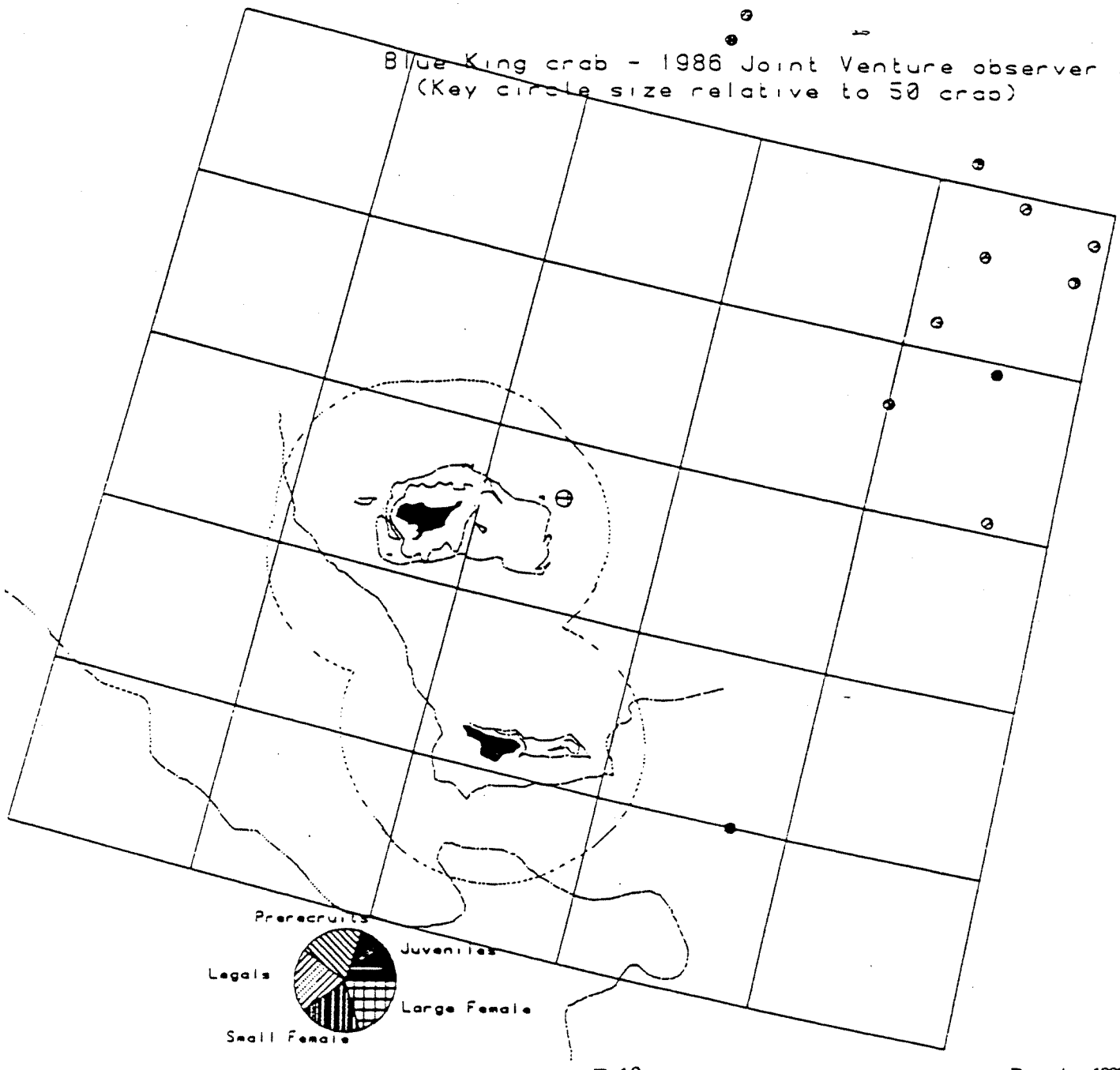


Figure B.8. Blue king crab bycatch in 1986 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.



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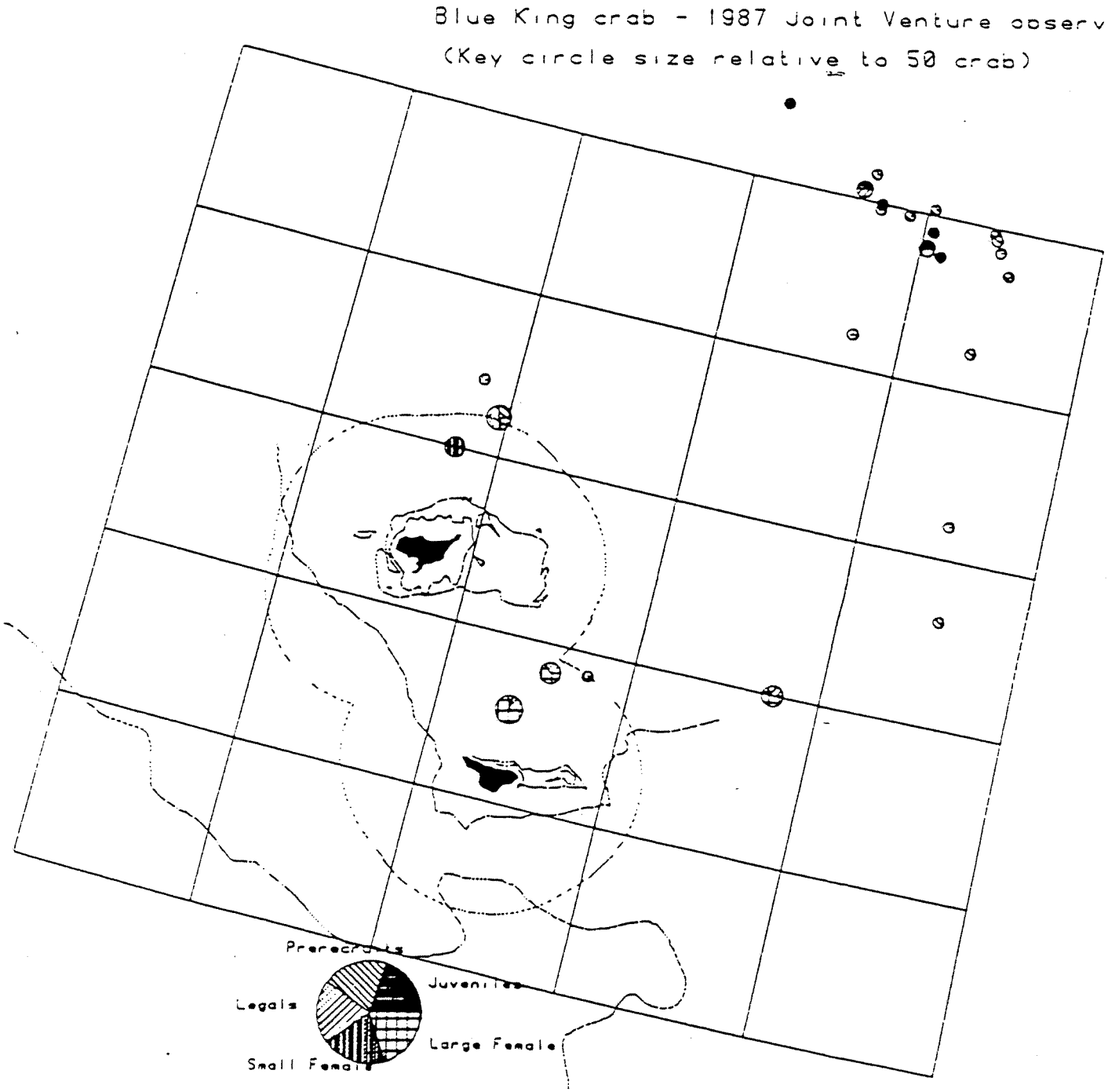


Figure B.10. Blue king crab bycatch in 1988 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

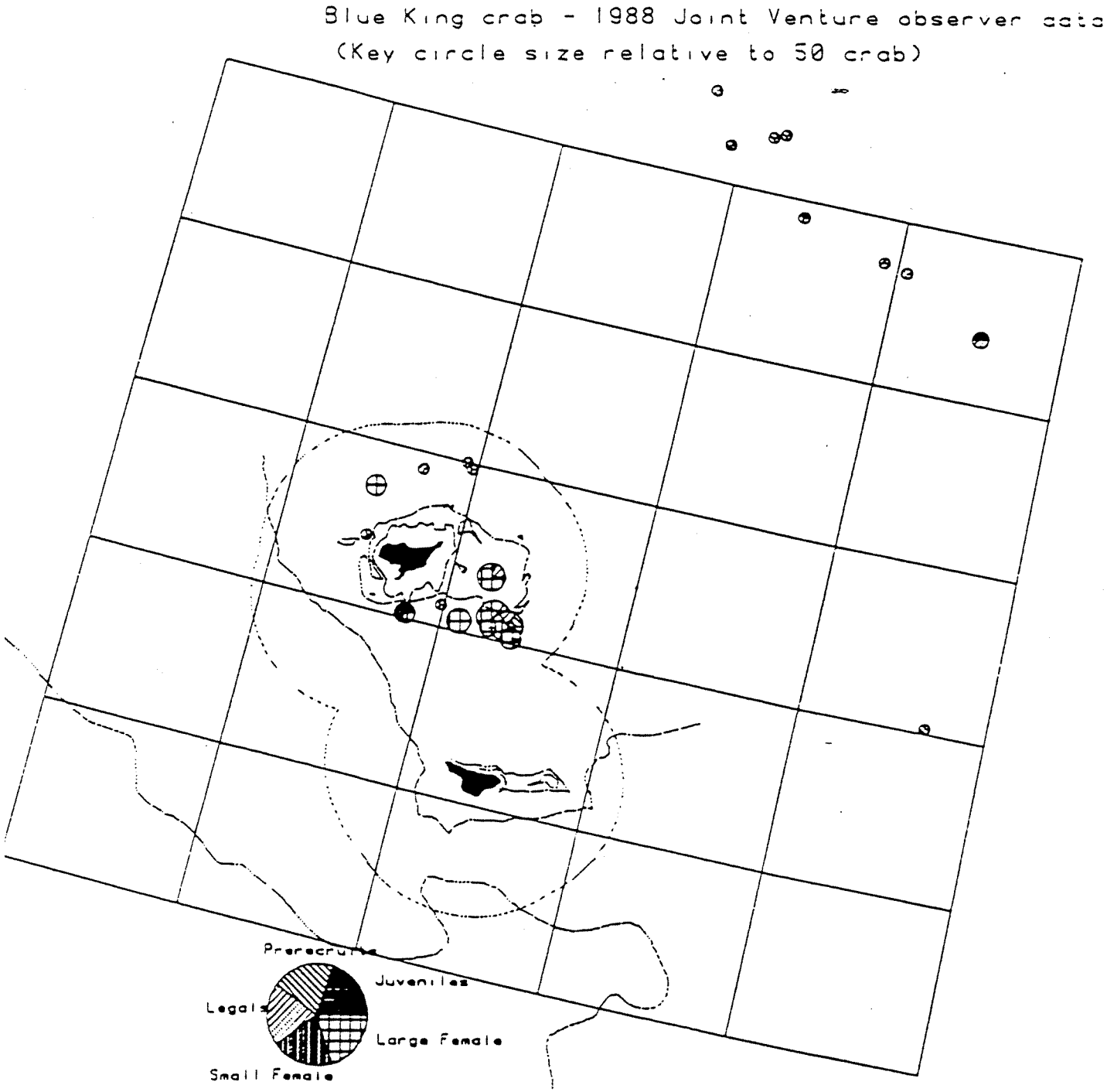


Figure B.11. Blue king crab bycatch in 1989 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

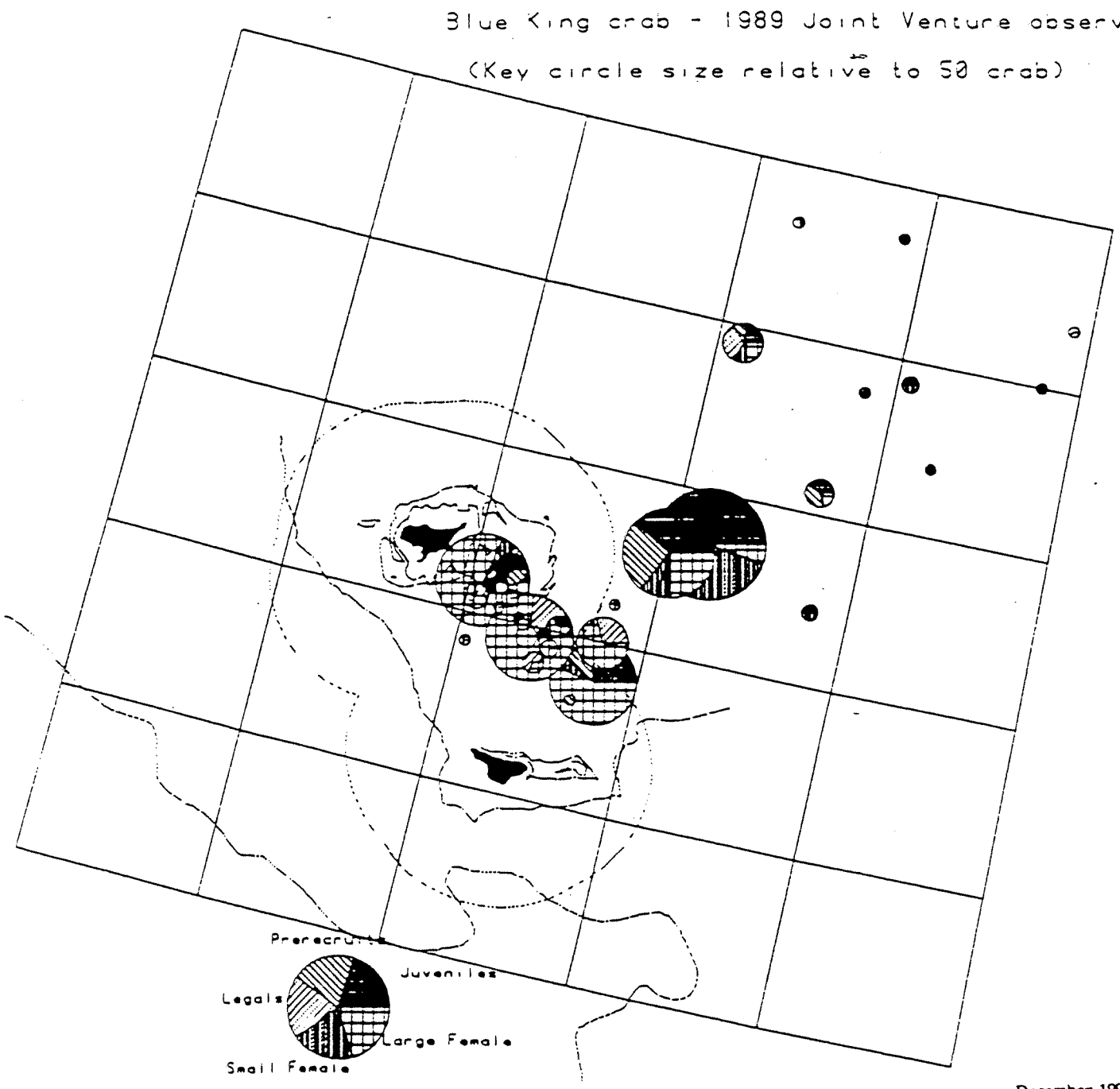


Figure B.12. Blue king crab bycatch in 1989 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

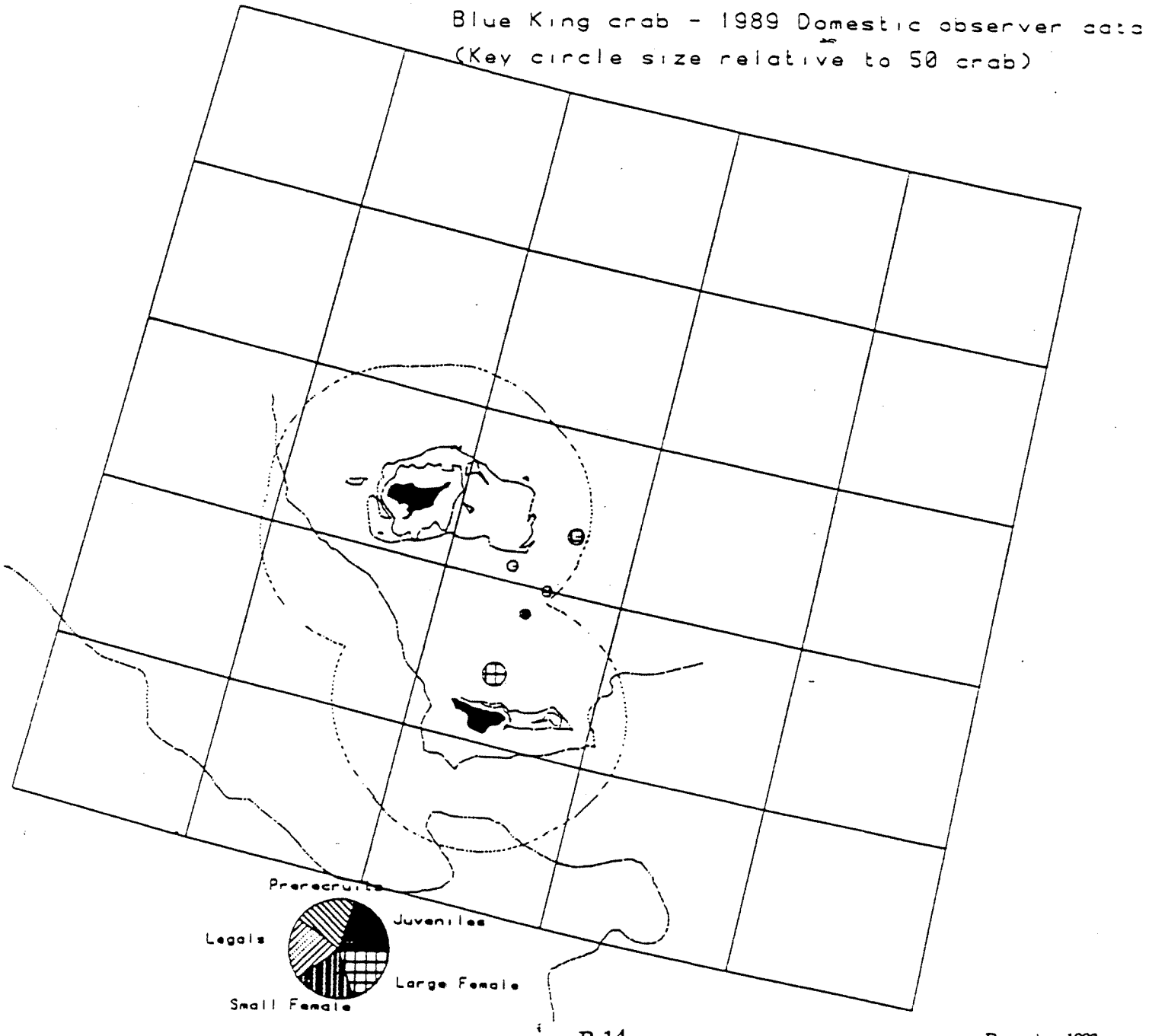


Figure B.13. Blue king crab bycatch in 1991 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

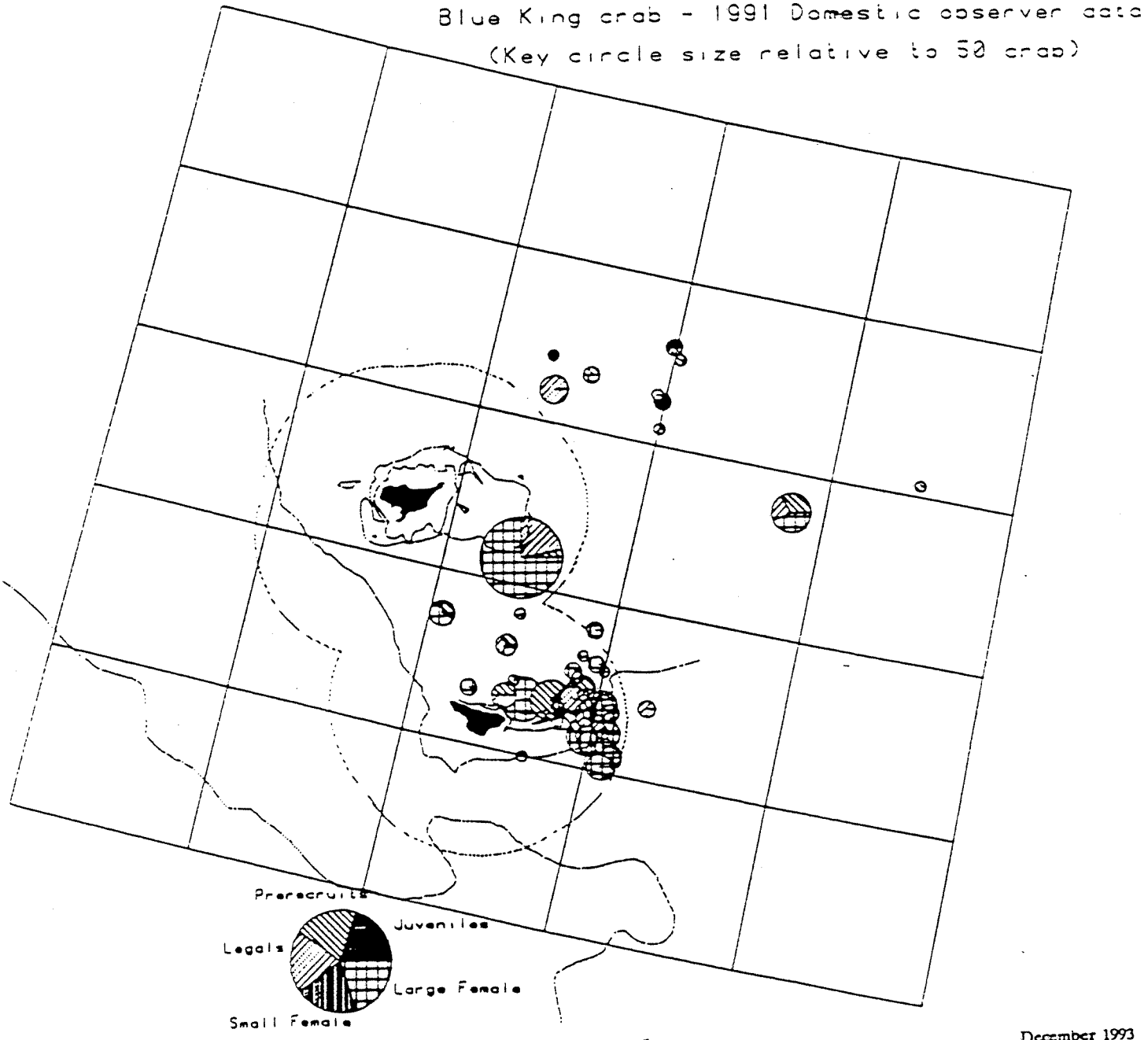
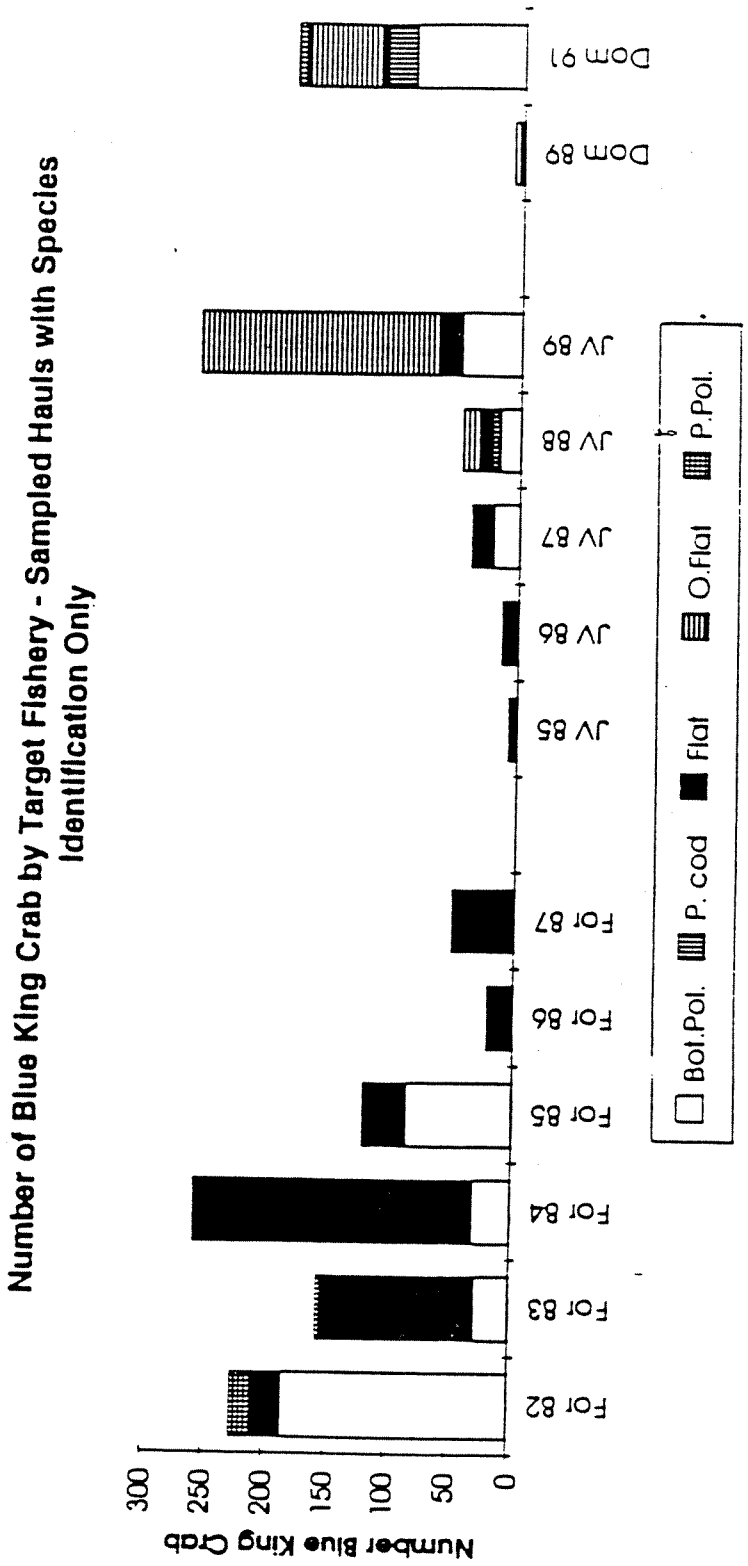


Figure B.14. Number of blue king crab identified by observers from each year and target fishery.



Appendix C. Location of seabird foraging areas near the Pribilof Islands. Provided by the U.S. Fish and Wildlife Service.

Appendix A. NMFS annual trawl survey of the eastern Bering Sea. Blue king crab, 1975-1992; Red king crab, 1988-1992; *C. bairdi* Tanner crab, 1975, 1980, 1985, and 1990.

Figure A.1. Locations of annual NMFS trawl surveys, 1975-1992.

Figure A.2. Blue king crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.3. Blue king crab catch in 1976 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.4. Blue king crab catch in 1977 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.5. Blue king crab catch in 1978 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

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Figure A.9. Blue king crab catch in 1982 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.10. Blue king crab catch in 1983 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.11. Blue king crab catch in 1984 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.12. Blue king crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of

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Figure A.14. Blue king crab catch in 1987 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.15. Blue king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.16. Blue king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.17. Blue king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.18. Blue king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.19. Blue king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.20. Blue king crab catch in 1993 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.21. Red king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.22. Red king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.23. Red king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

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Figure A.25. Red king crab catch in 1992 NMFS trawl survey of

the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.26. *C. bairdi* Tanner crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.27. *C. bairdi* Tanner crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.28. *C. bairdi* Tanner crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.29. *C. bairdi* Tanner crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

Figure A.1. Locations of annual NMFS trawl surveys, 1975-1992.

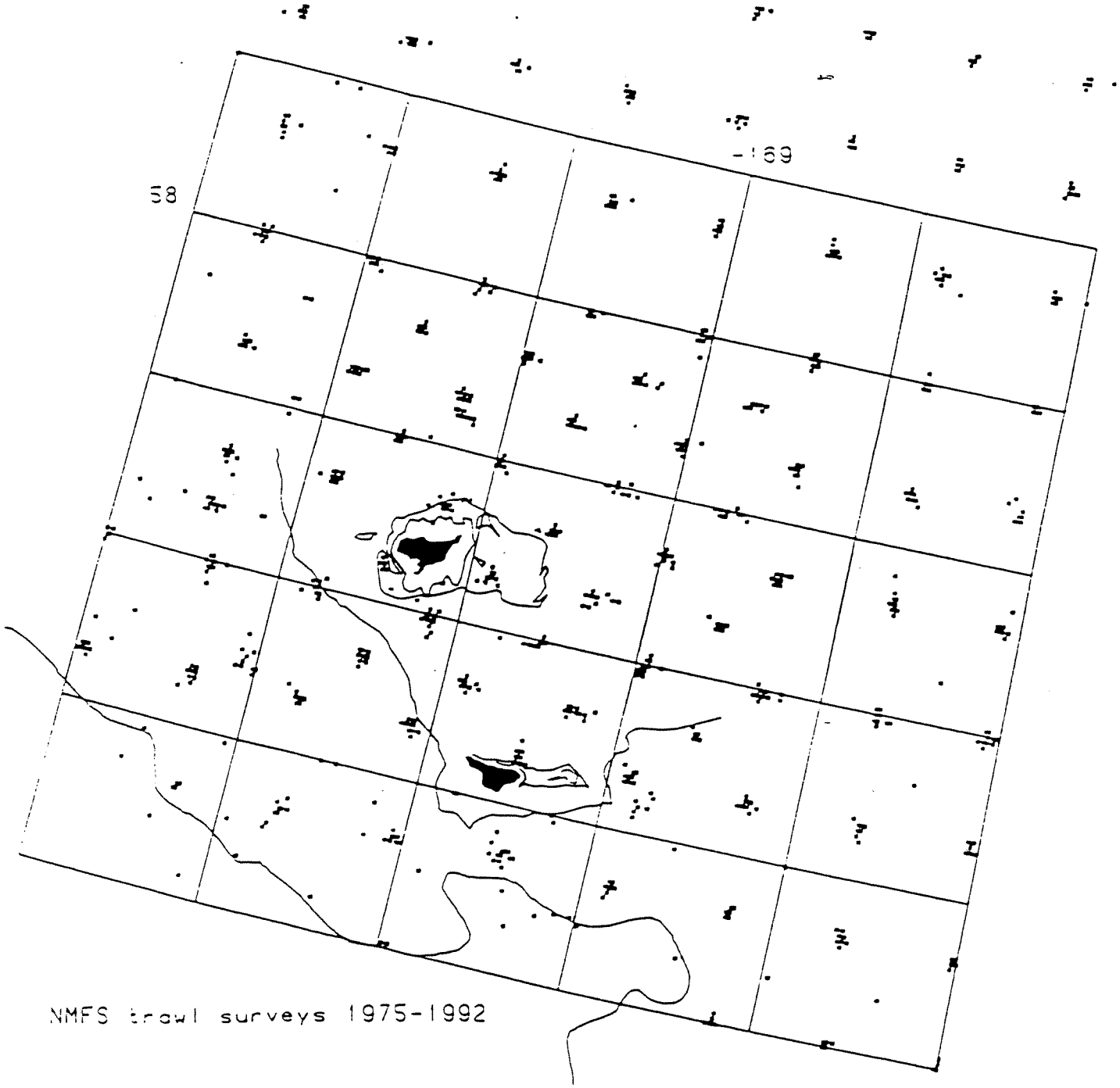


Figure A.2. Blue king crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

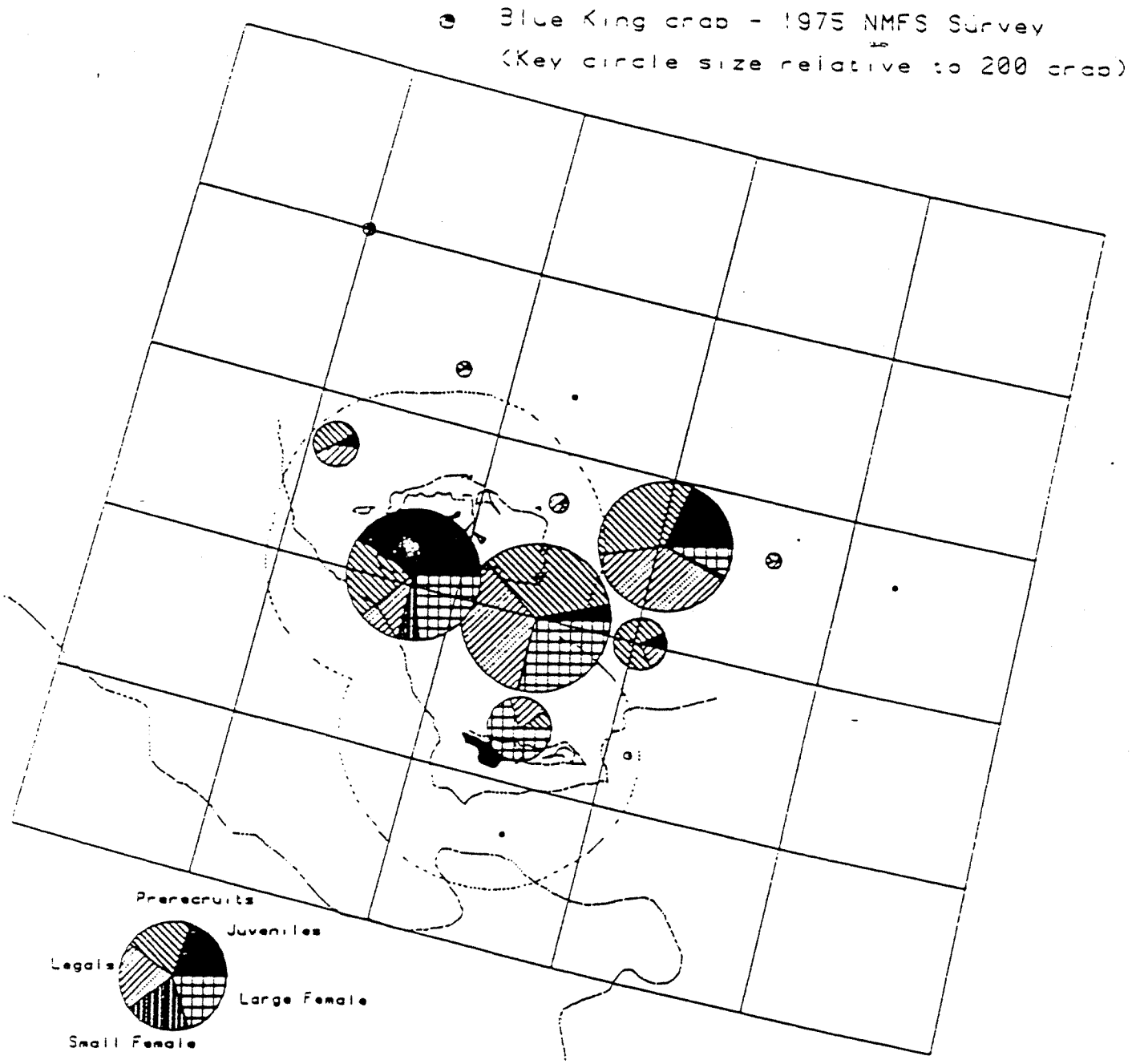


Figure A.1. Blue king crab catch in 1976 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

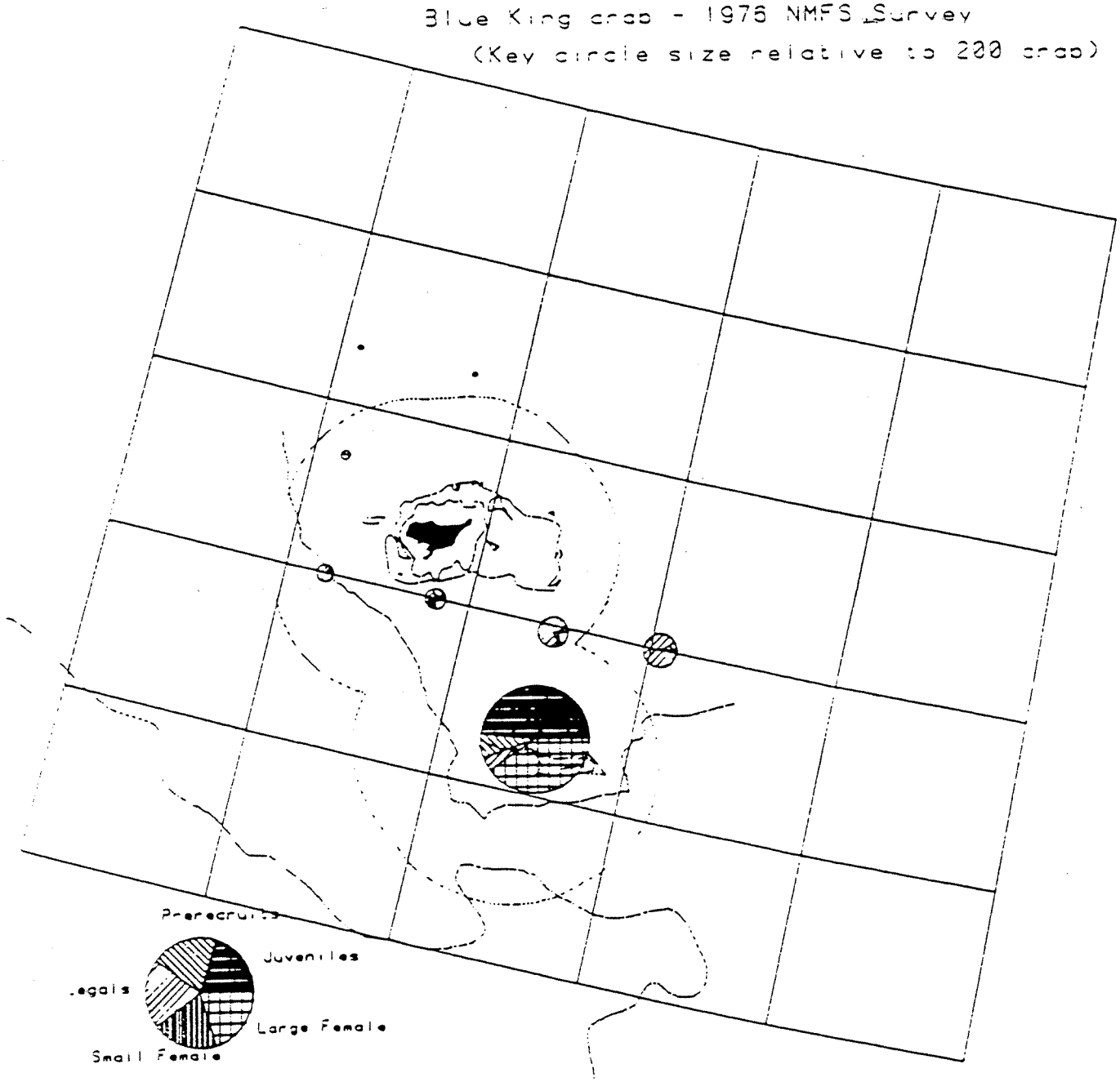


Figure A.4. Blue king crab catch in 1977 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

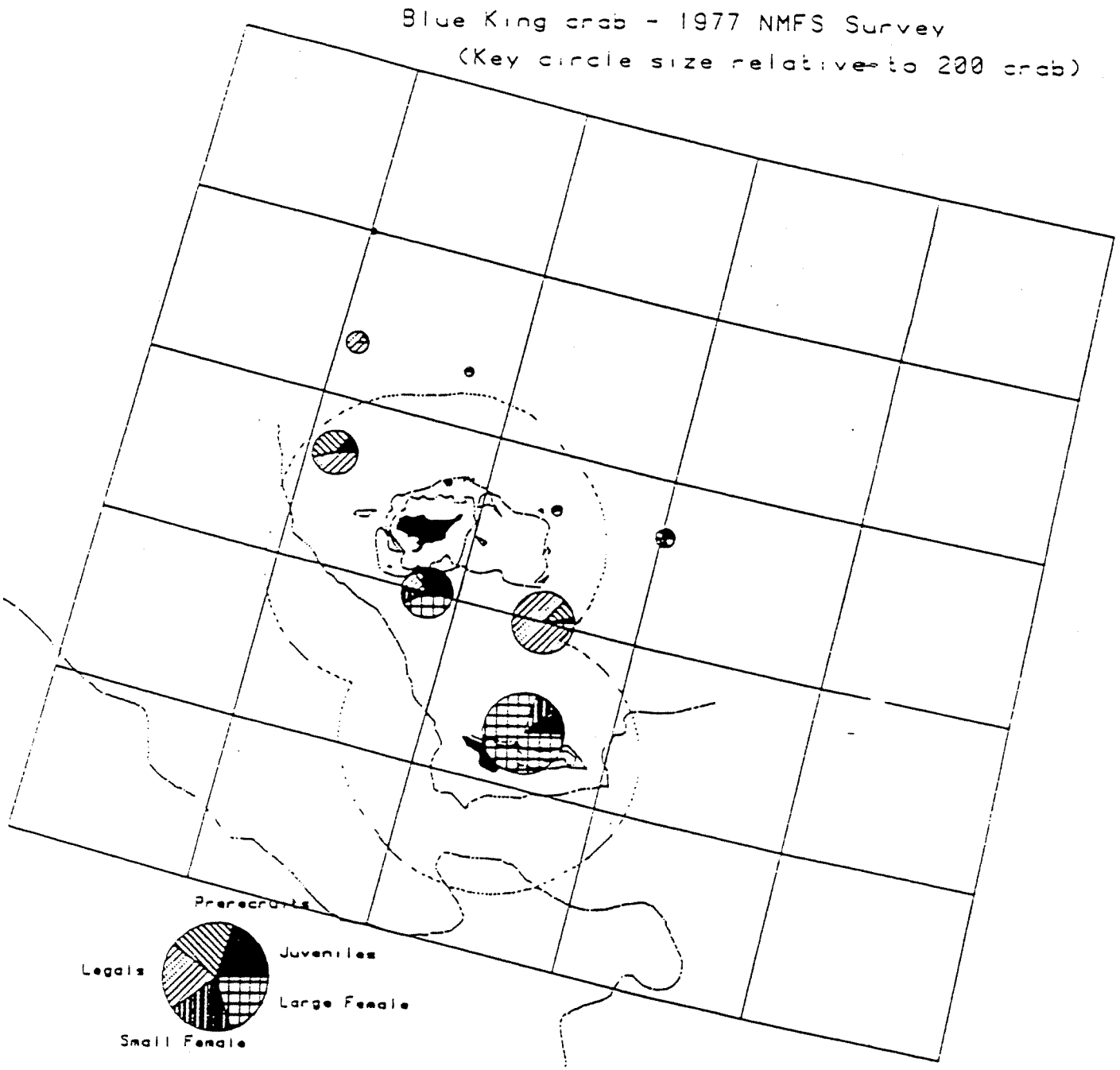


Figure A.5. Blue king crab catch in 1978 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

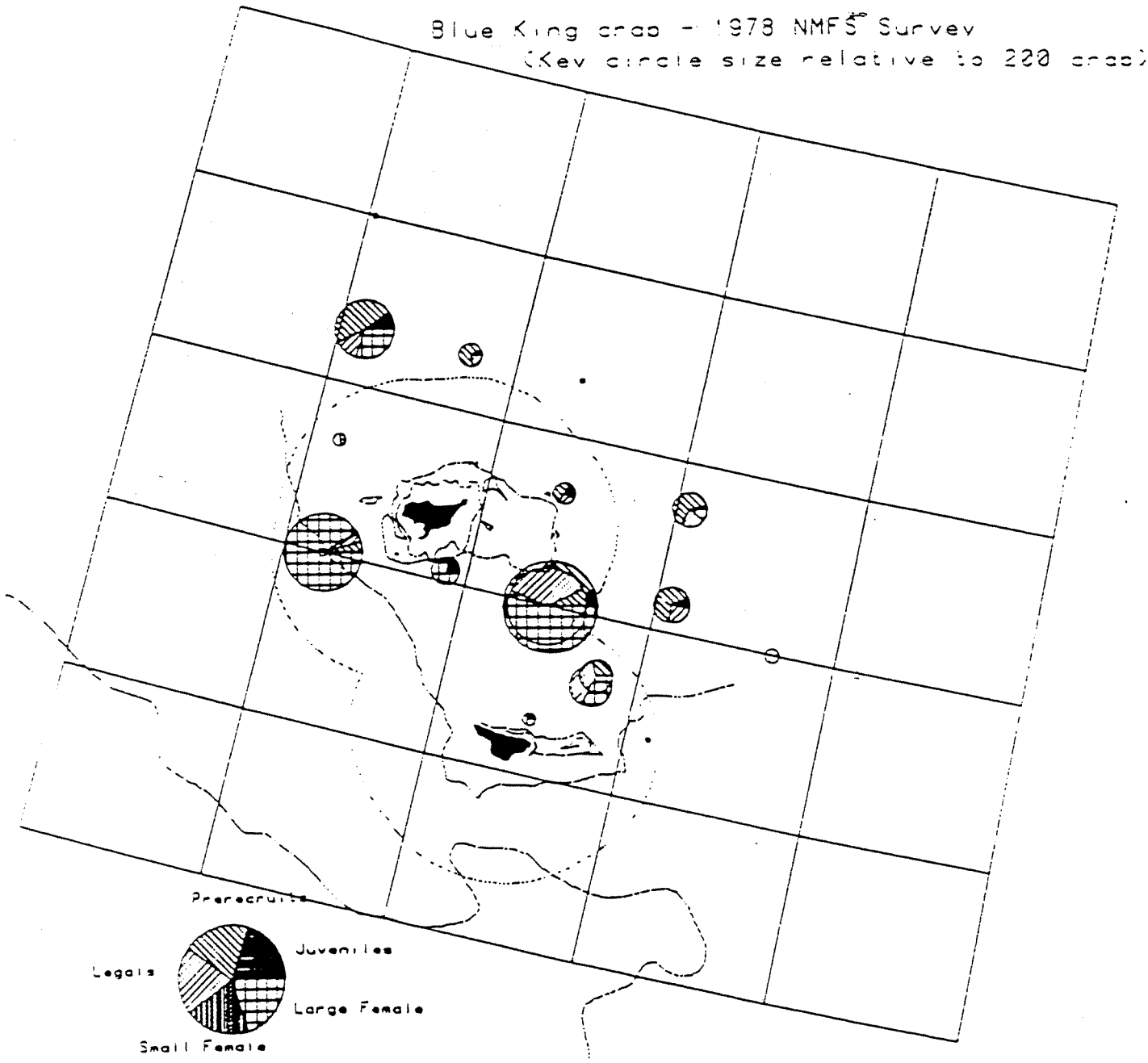


Figure A.6. Blue king crab catch in 1979 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

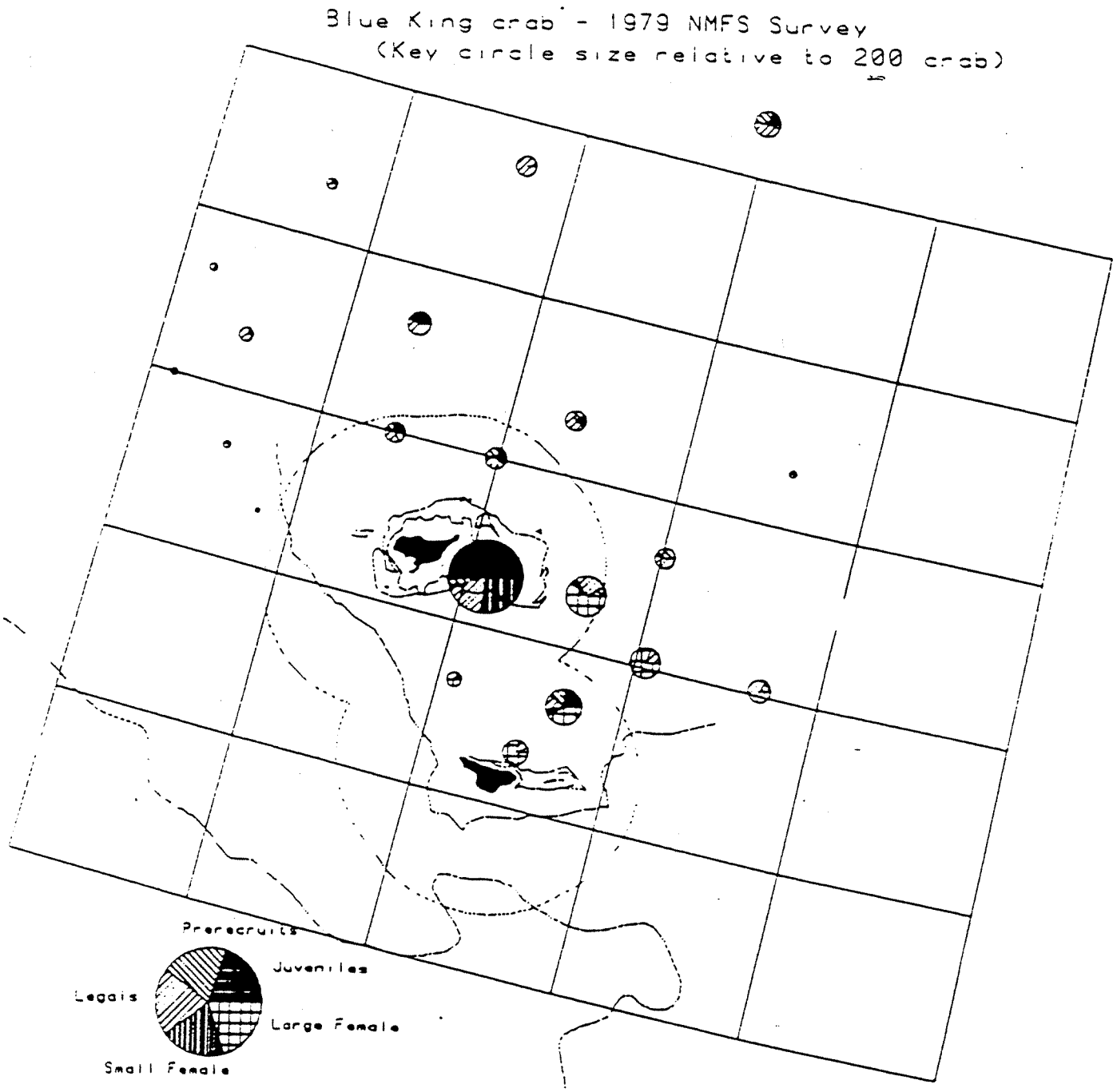


Figure A.7. Blue king crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

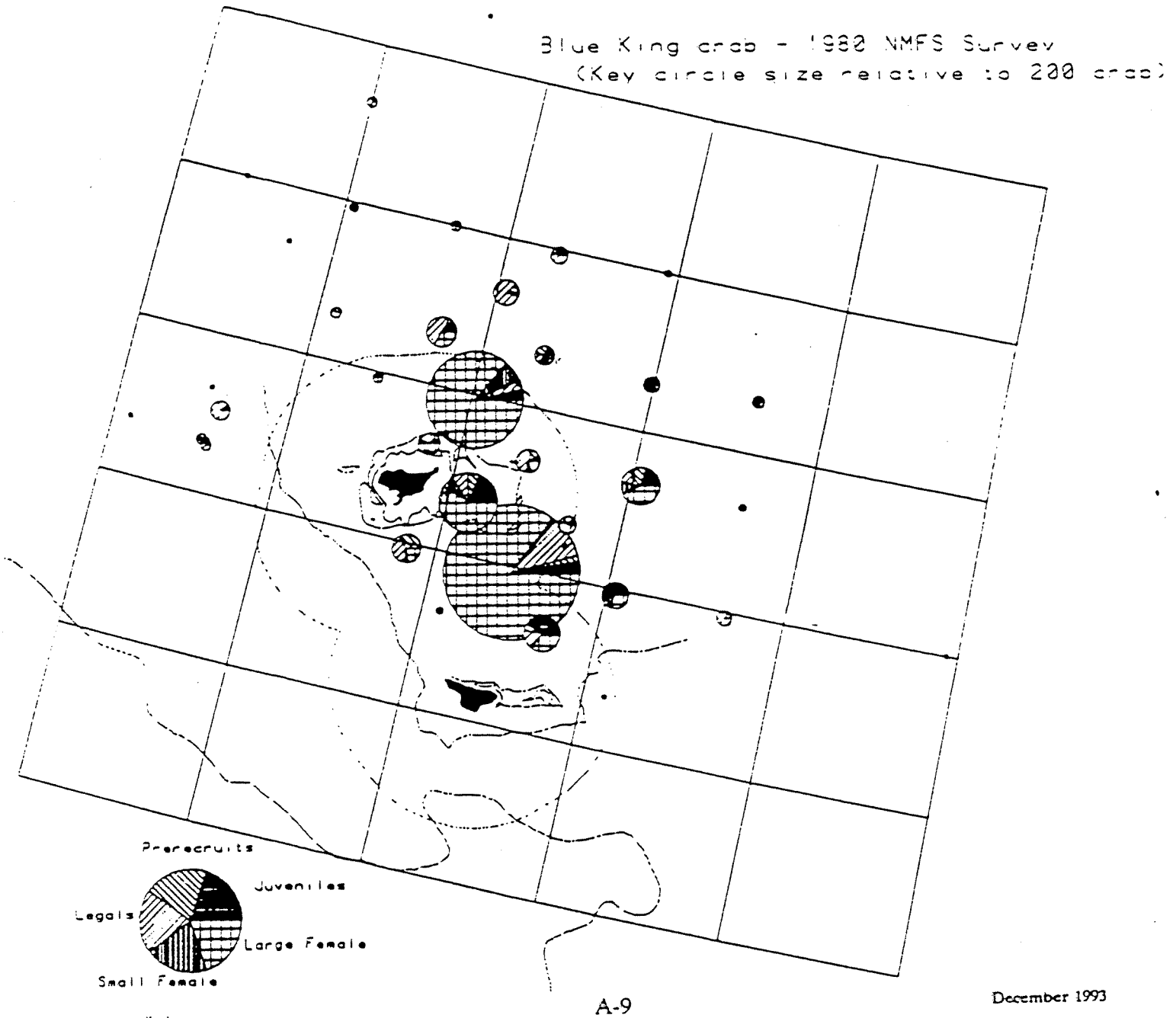


Figure A.6. Blue king crab catch in 1981 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

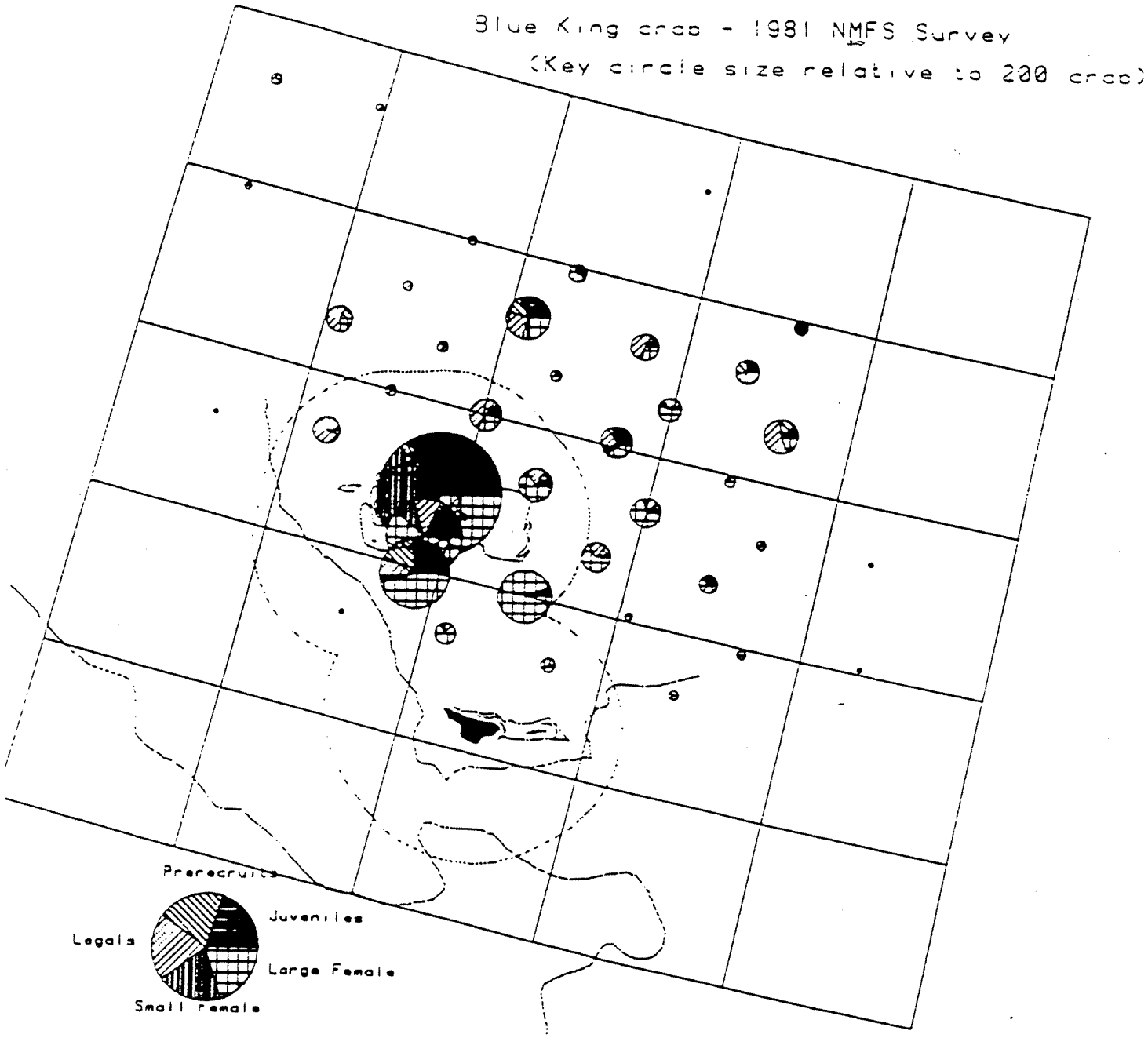


Figure A.9. Blue king crab catch in 1982 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

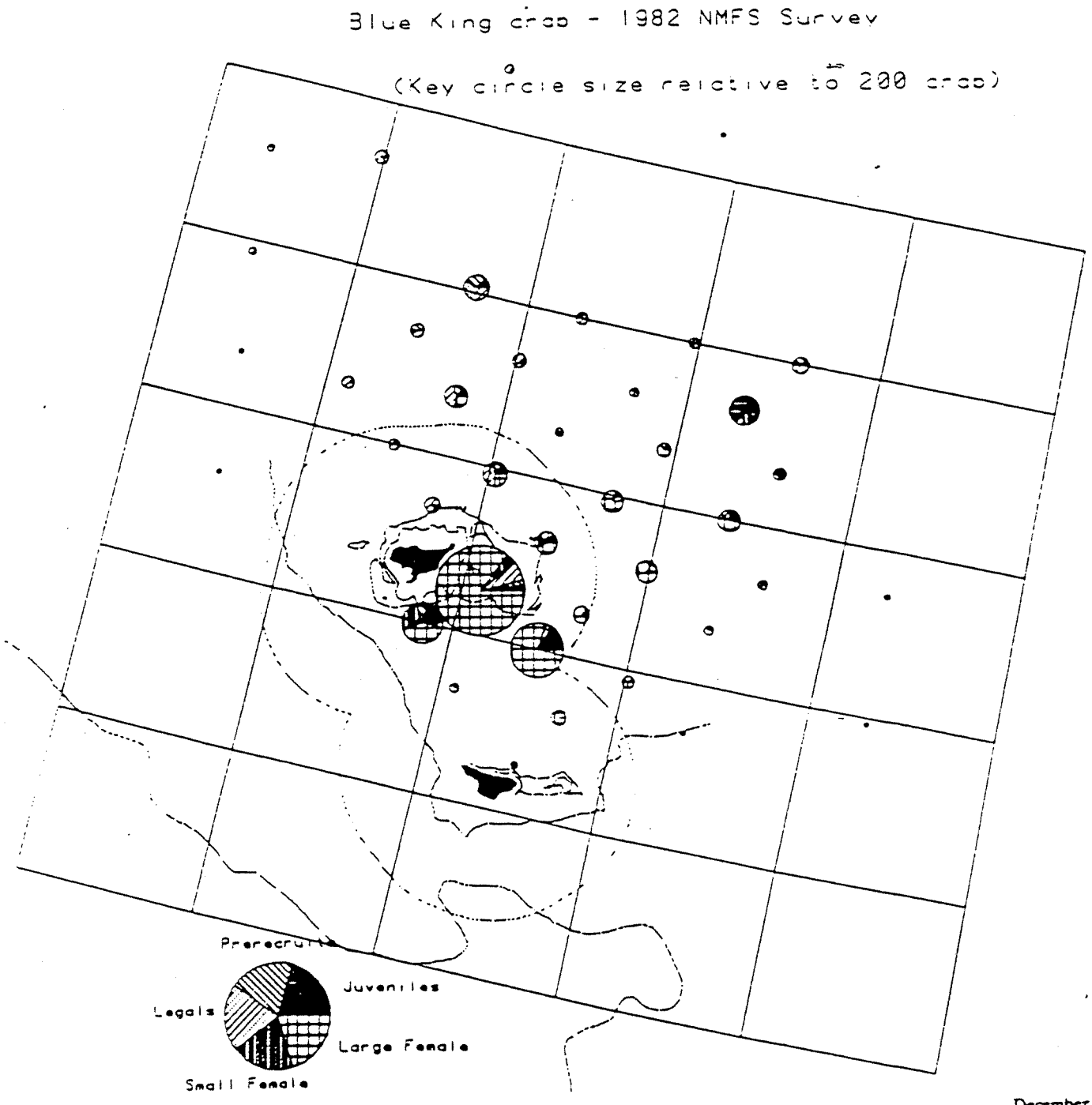


Figure A.10. Blue King crab catch in 1983 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

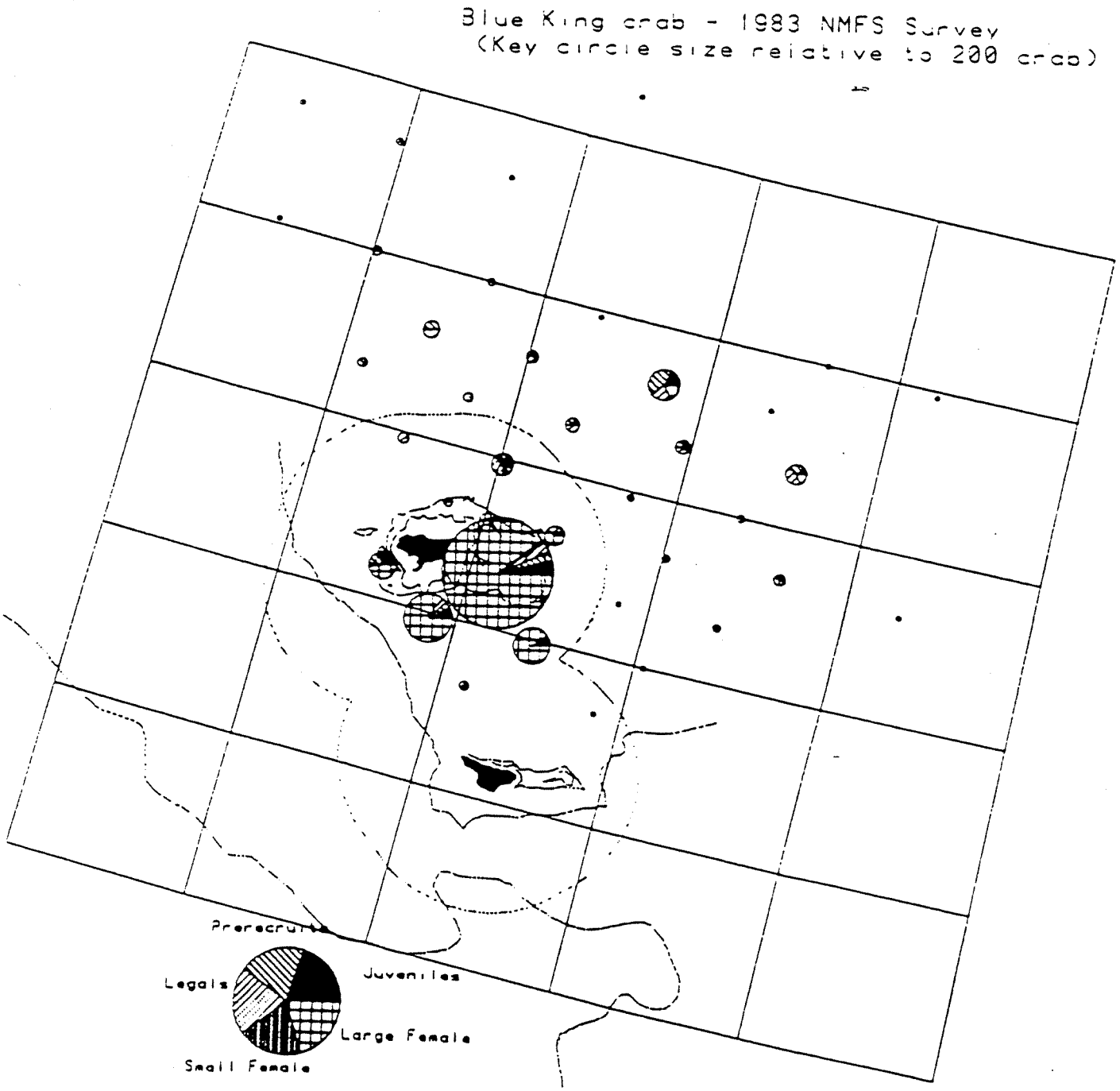


Figure A.11. Blue king crab catch in 1984 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

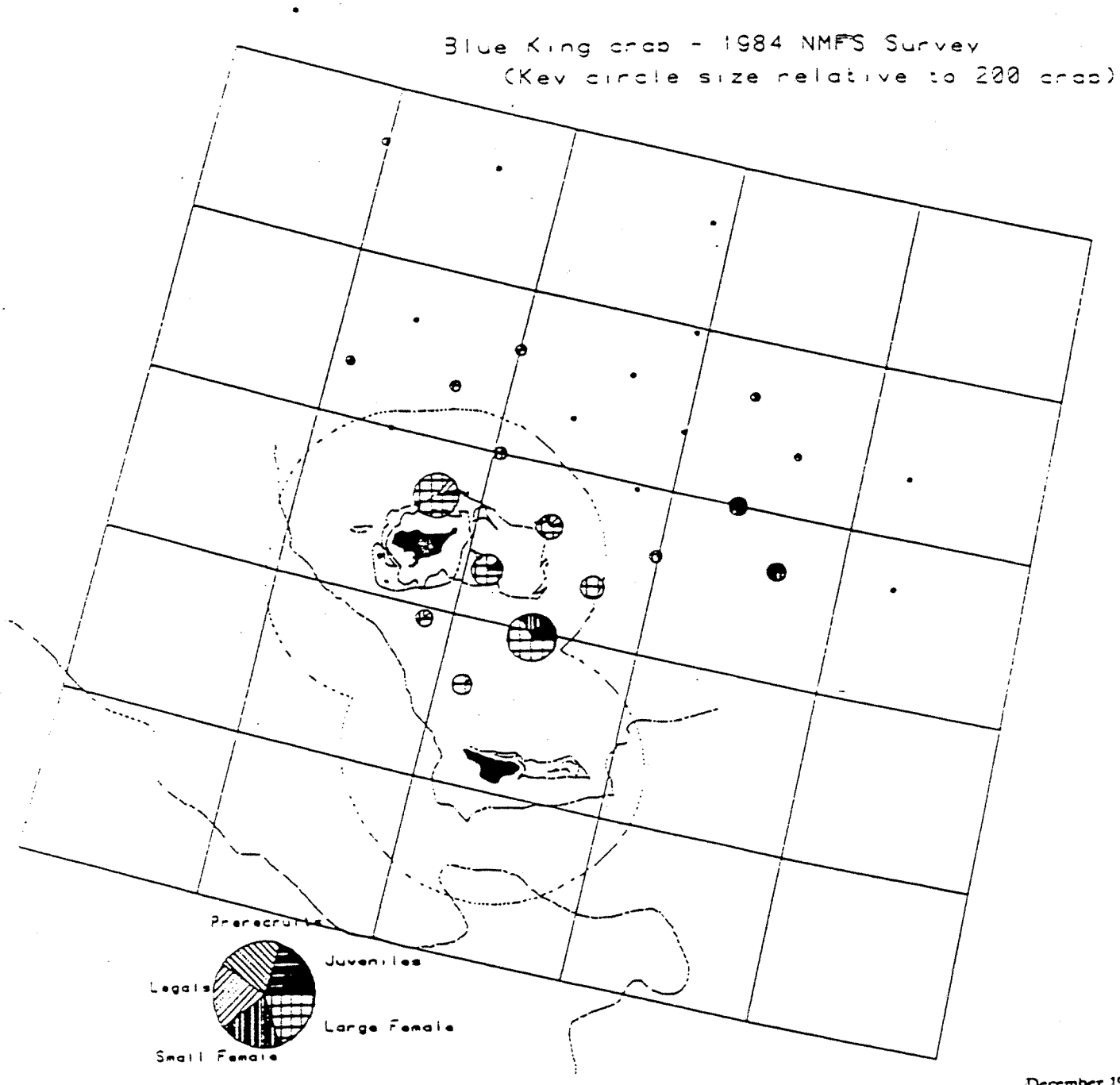


Figure A.12. Blue King crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

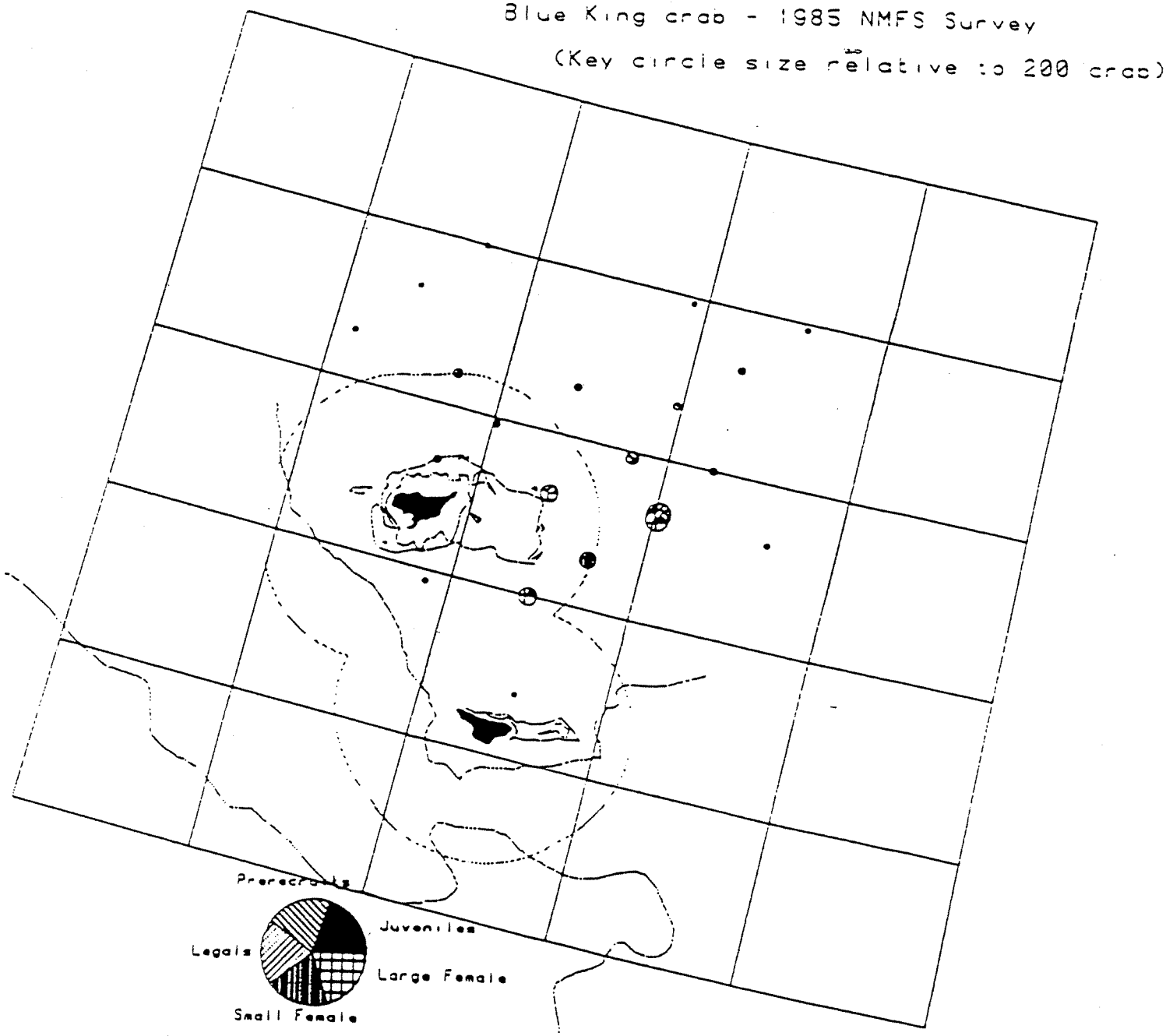


Figure A.13. Blue king crab catch in 1986 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

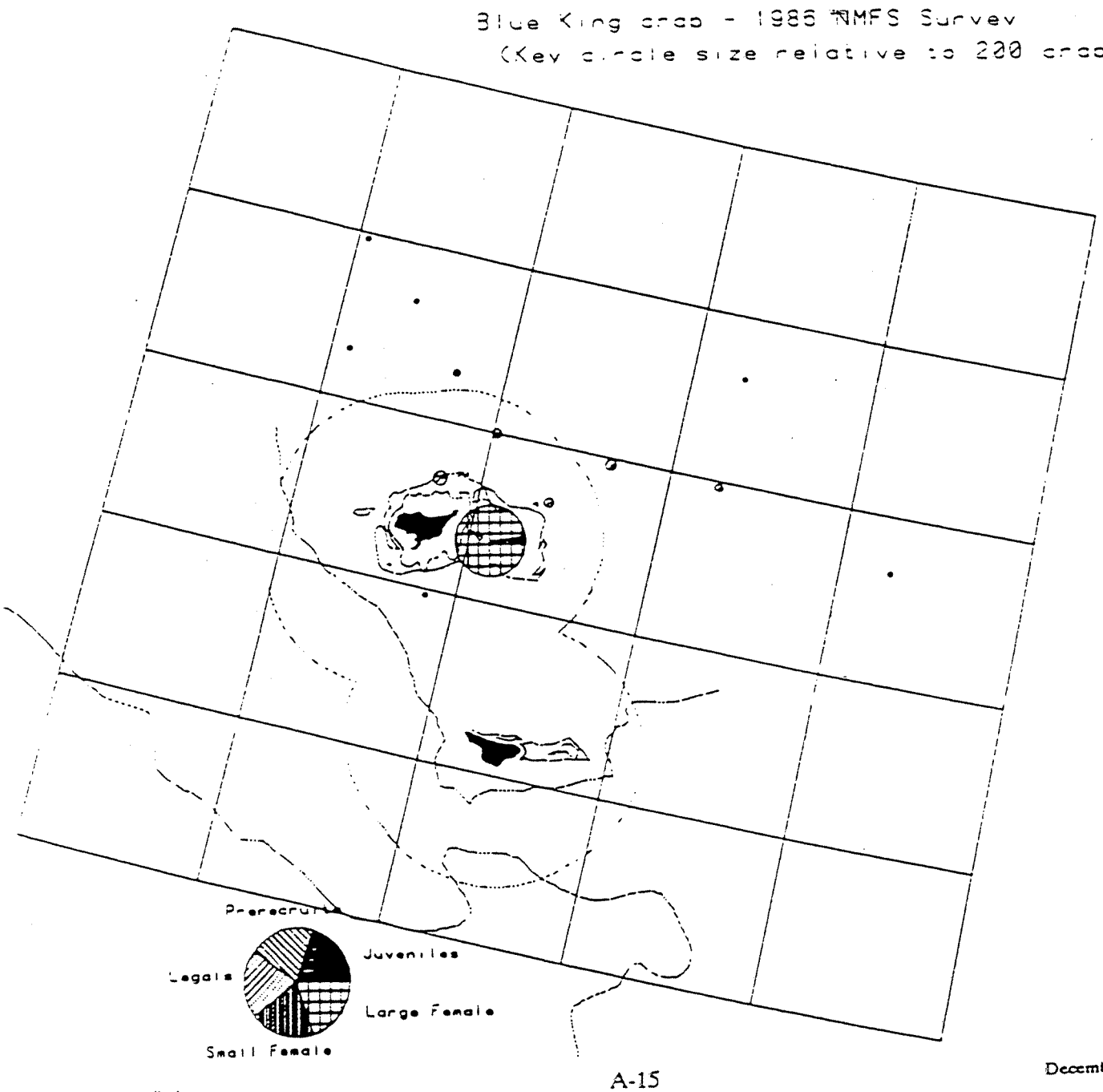


Figure A.14. Blue King crab catch in 1987 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

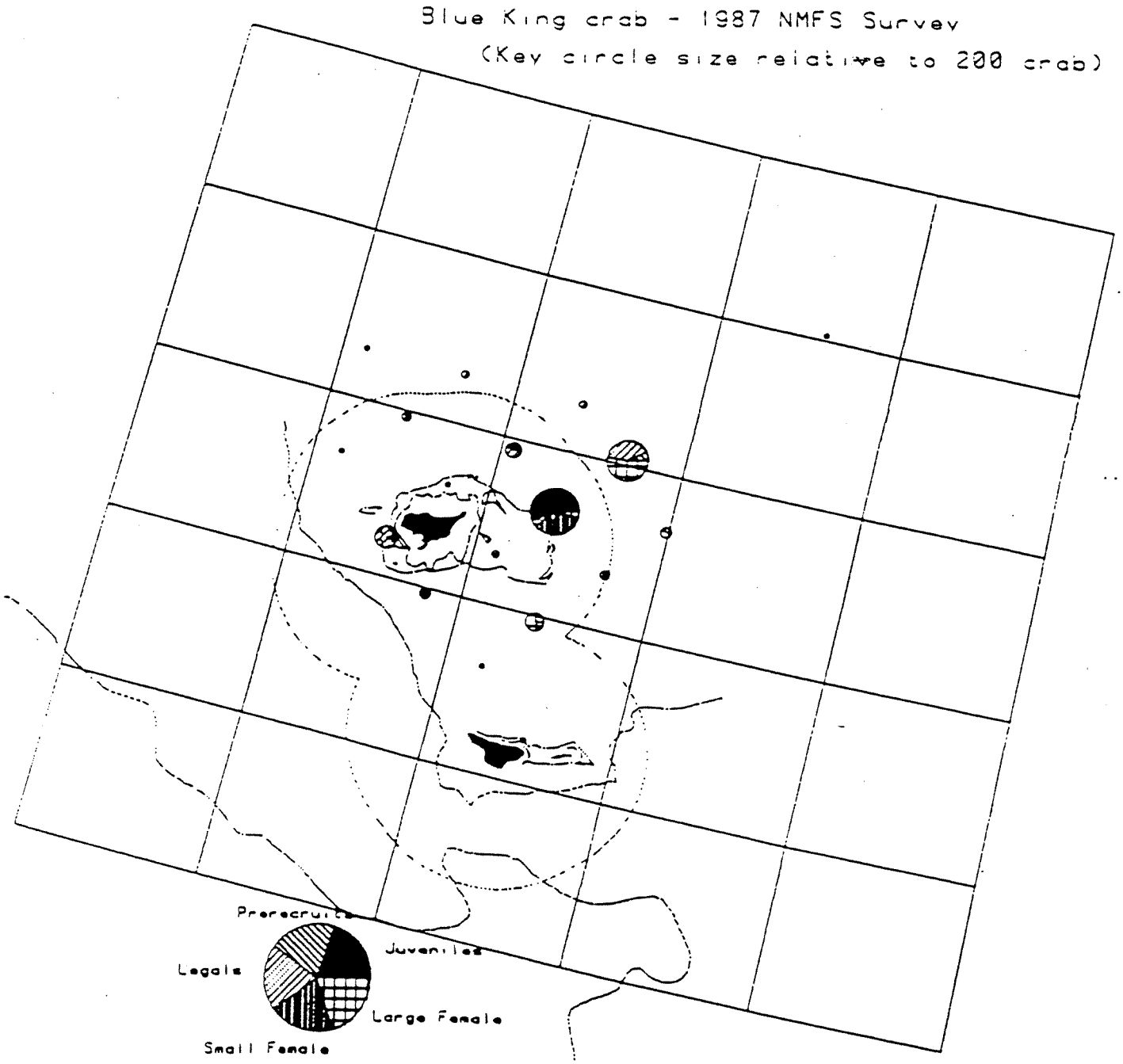


Figure A.15. Blue king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

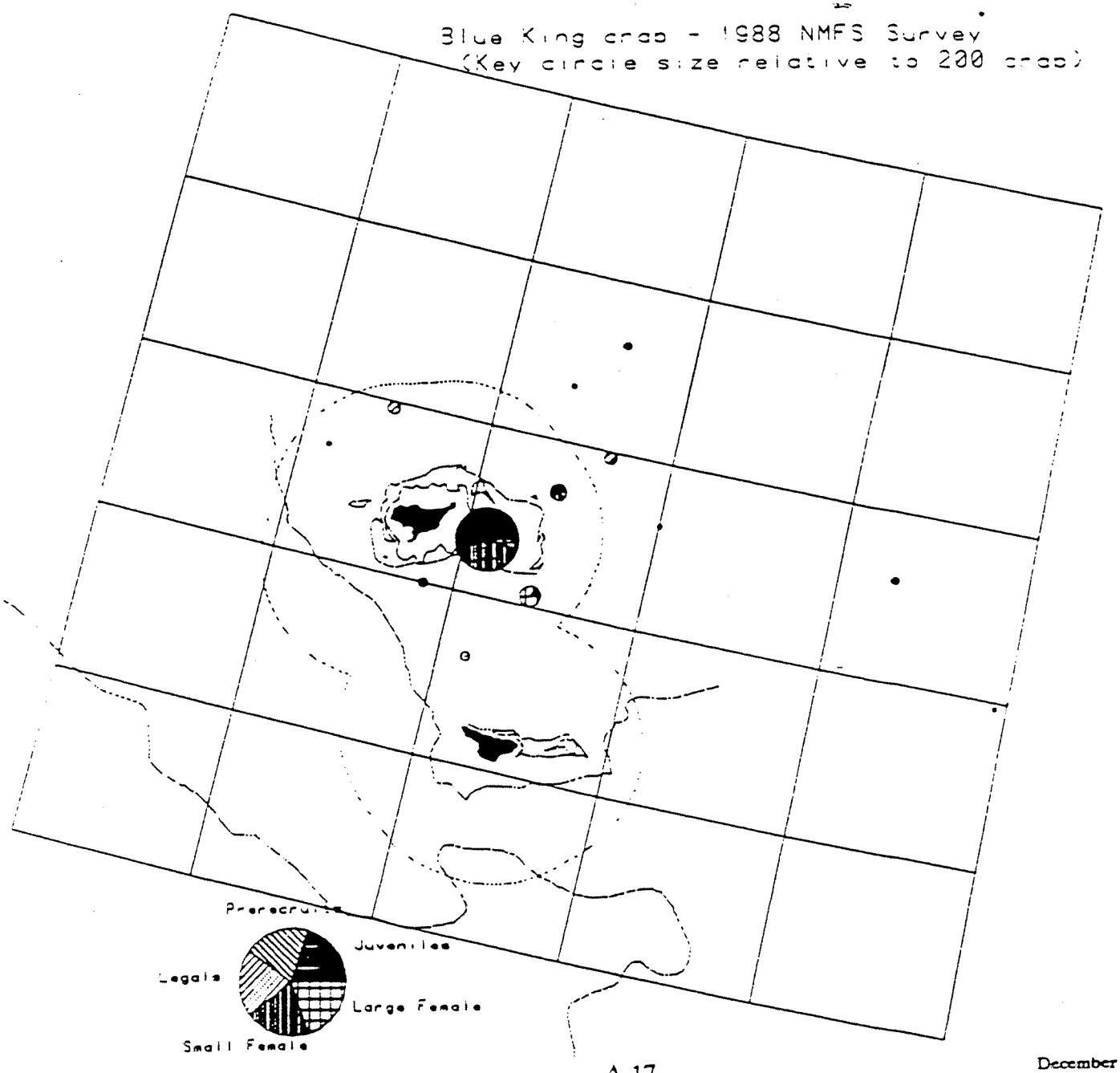


Figure A.16. Blue king crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

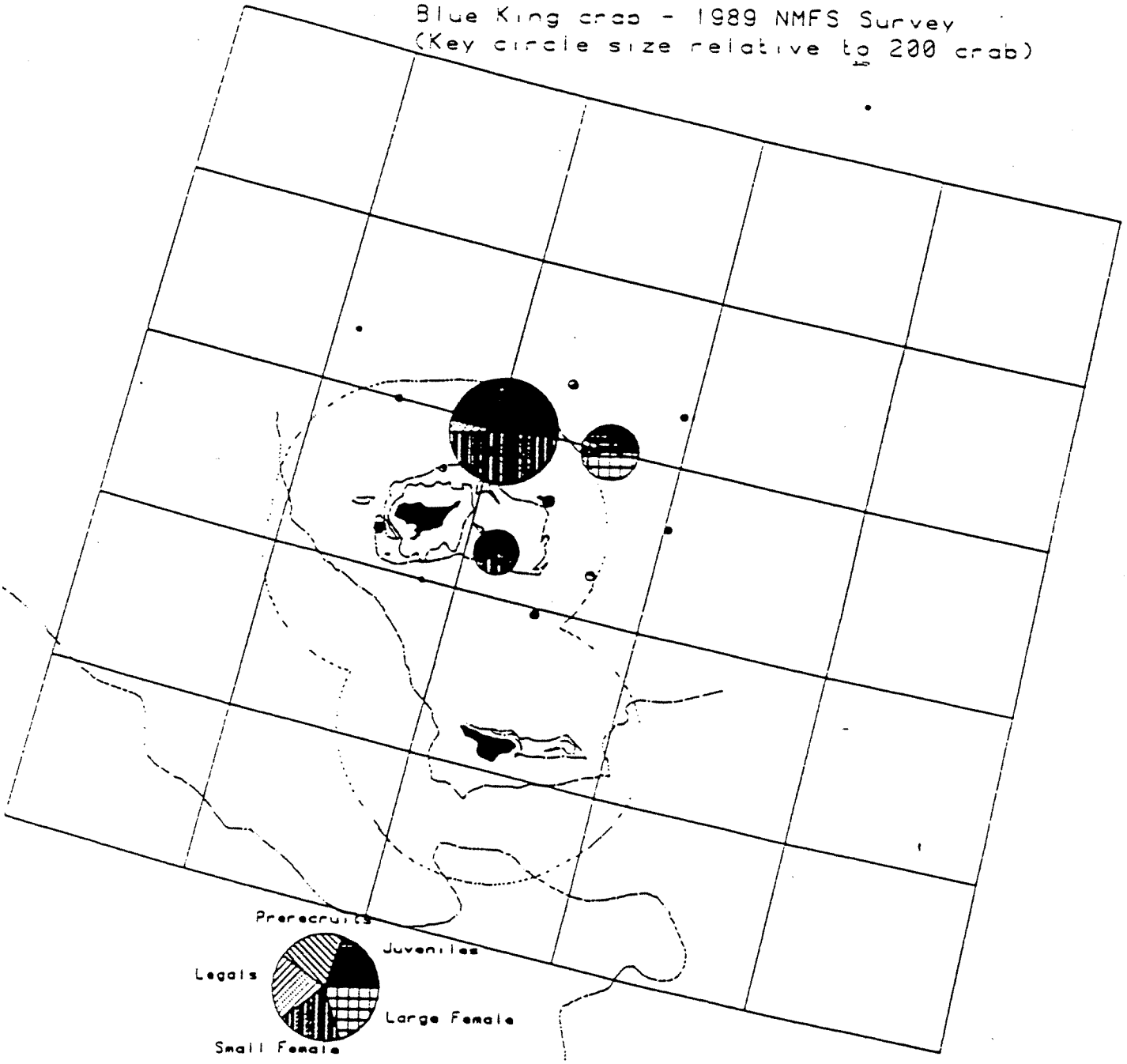


Figure A.17. Blue king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

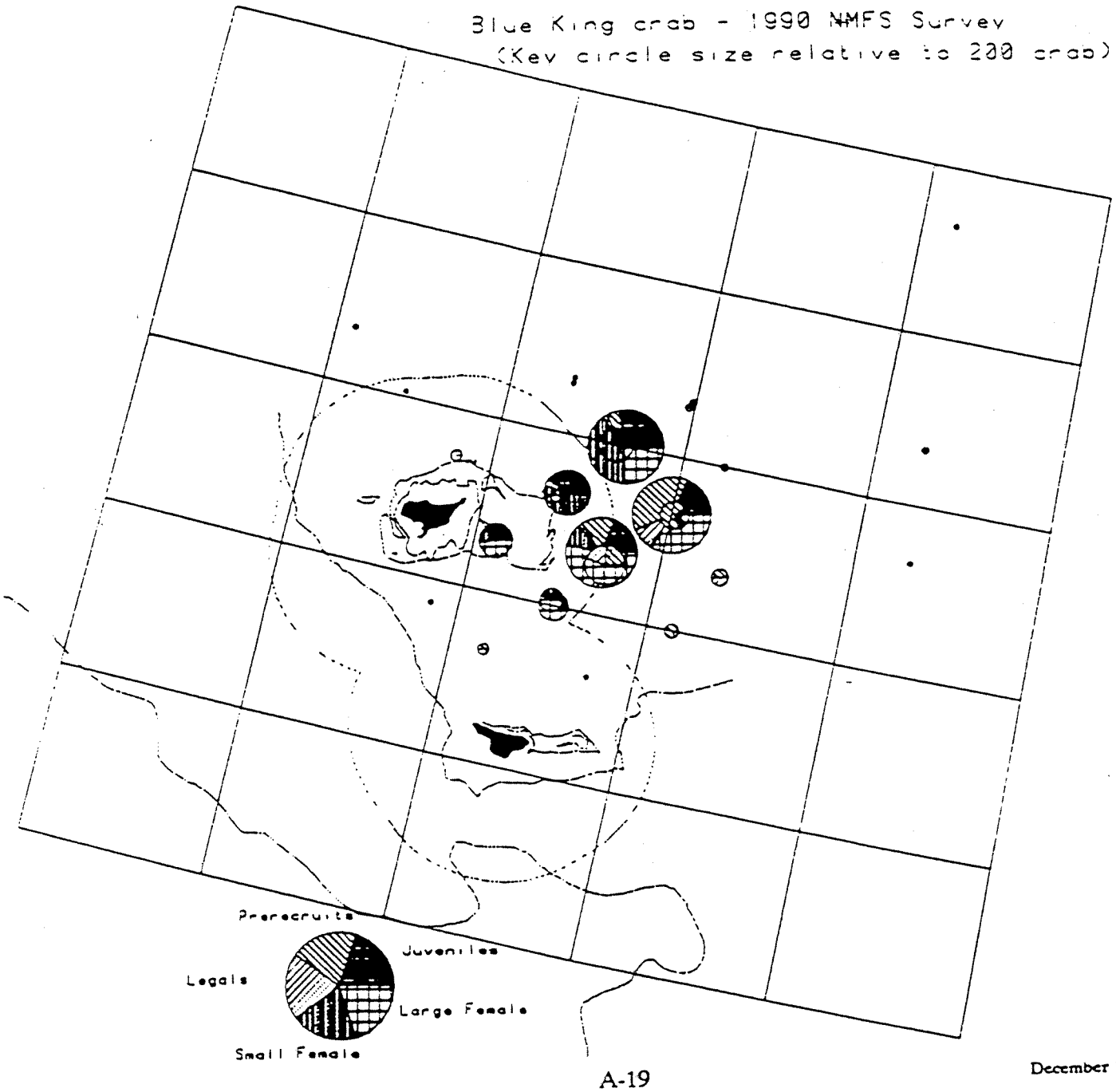


Figure A.13. Blue king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

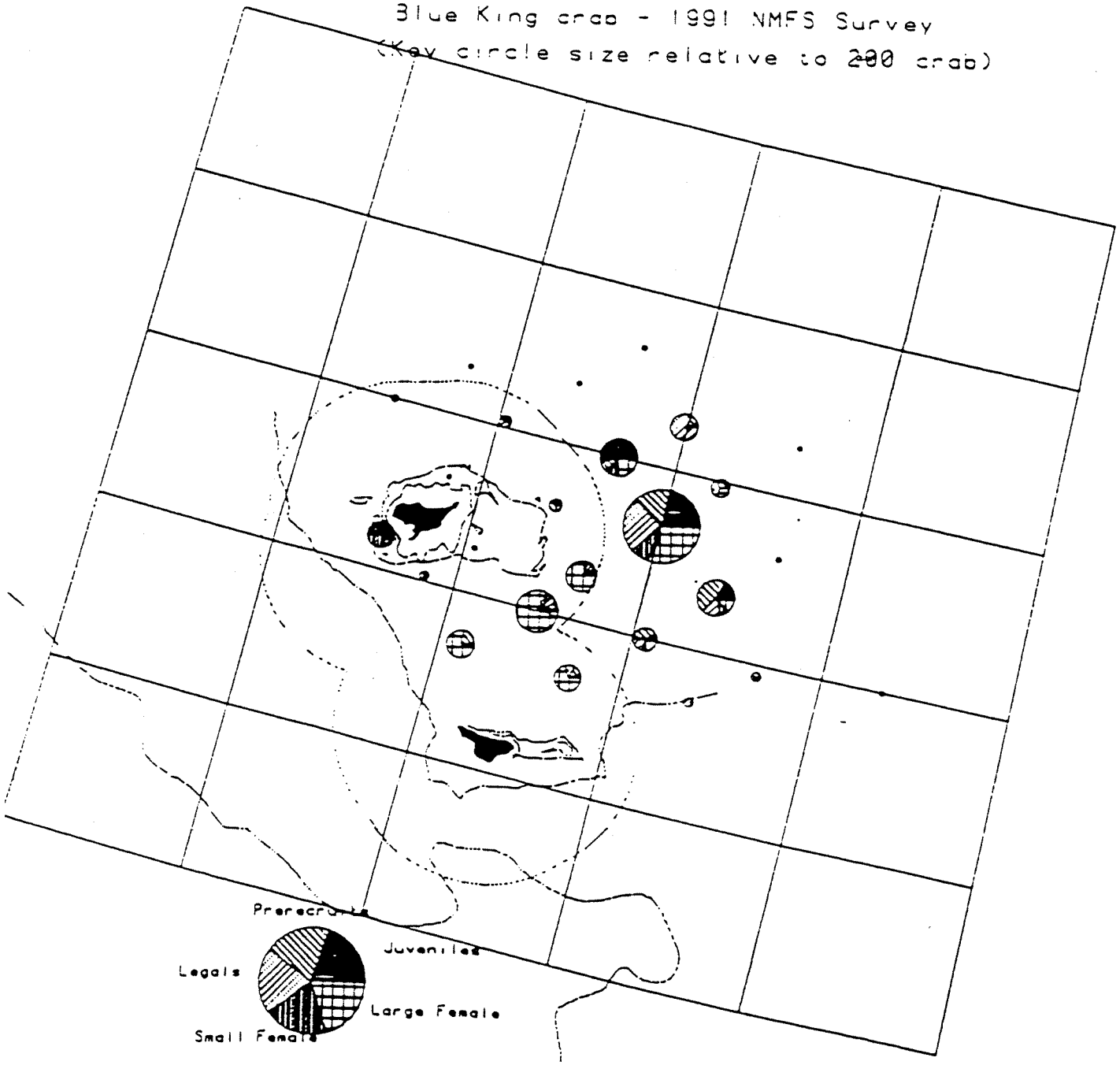


Figure A.19. Blue king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

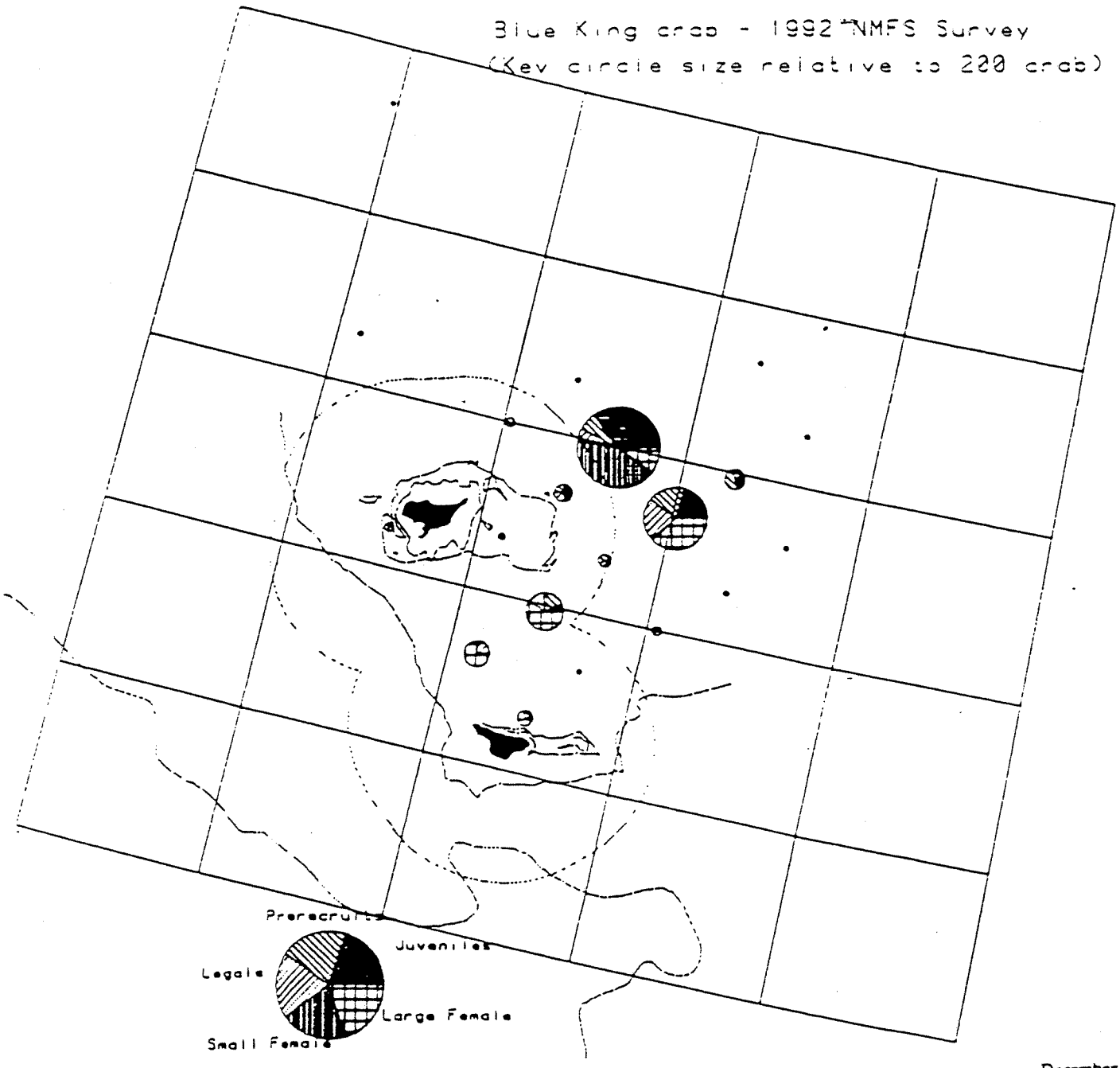


Figure A.20. Blue king crab catch in 1993 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

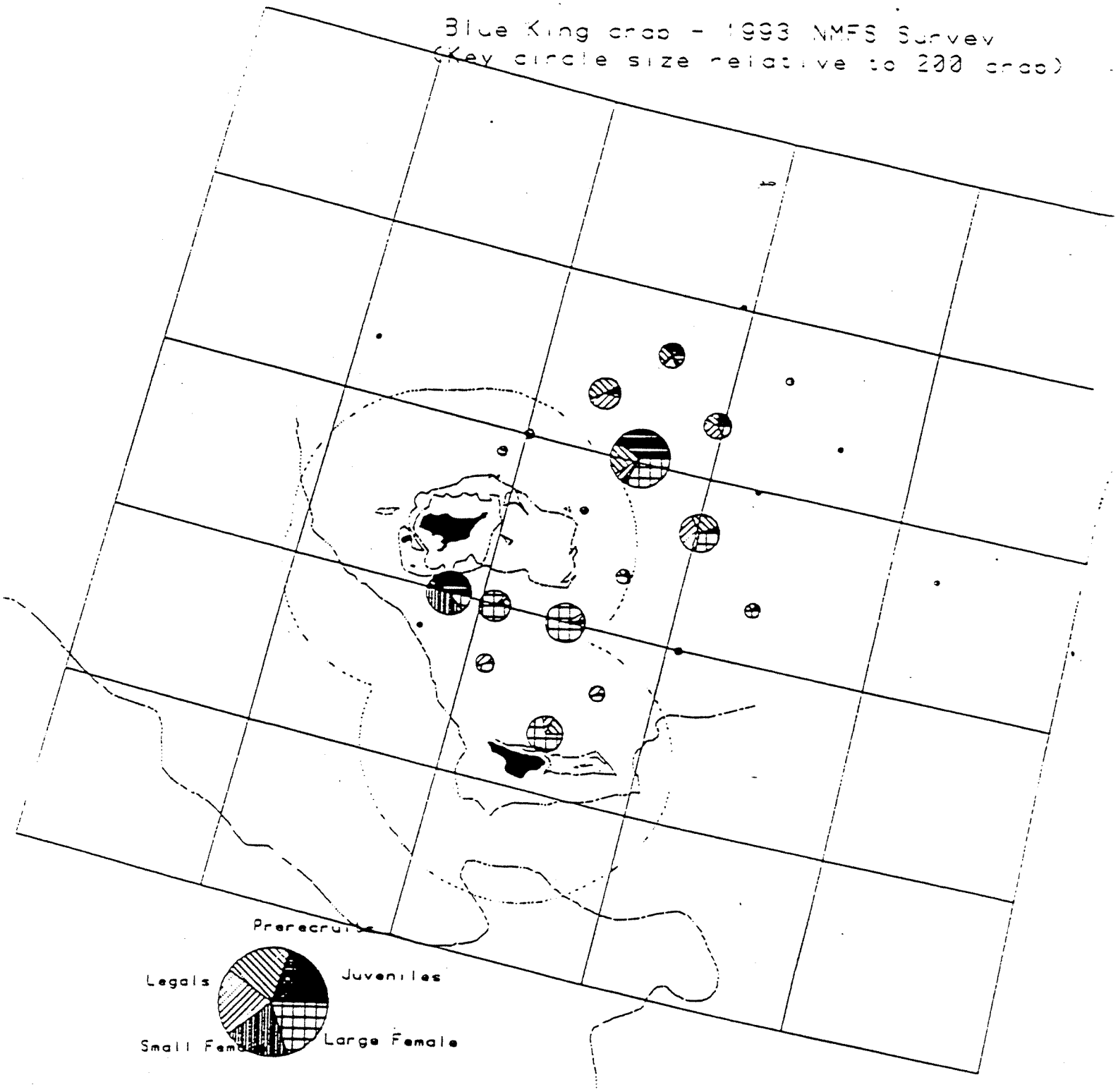


Figure A.21. Red king crab catch in 1988 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

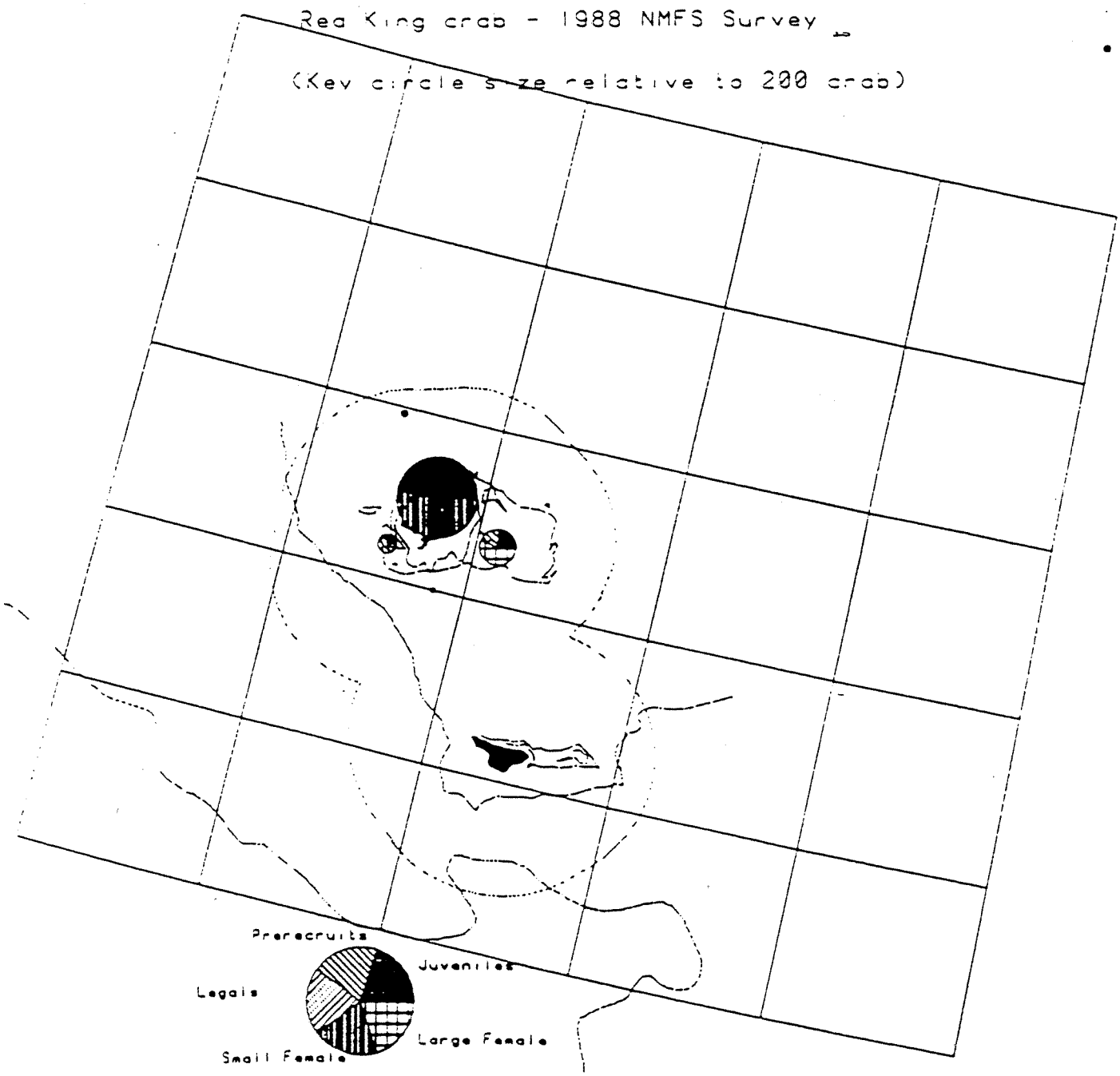


Figure A.22. Red King crab catch in 1989 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

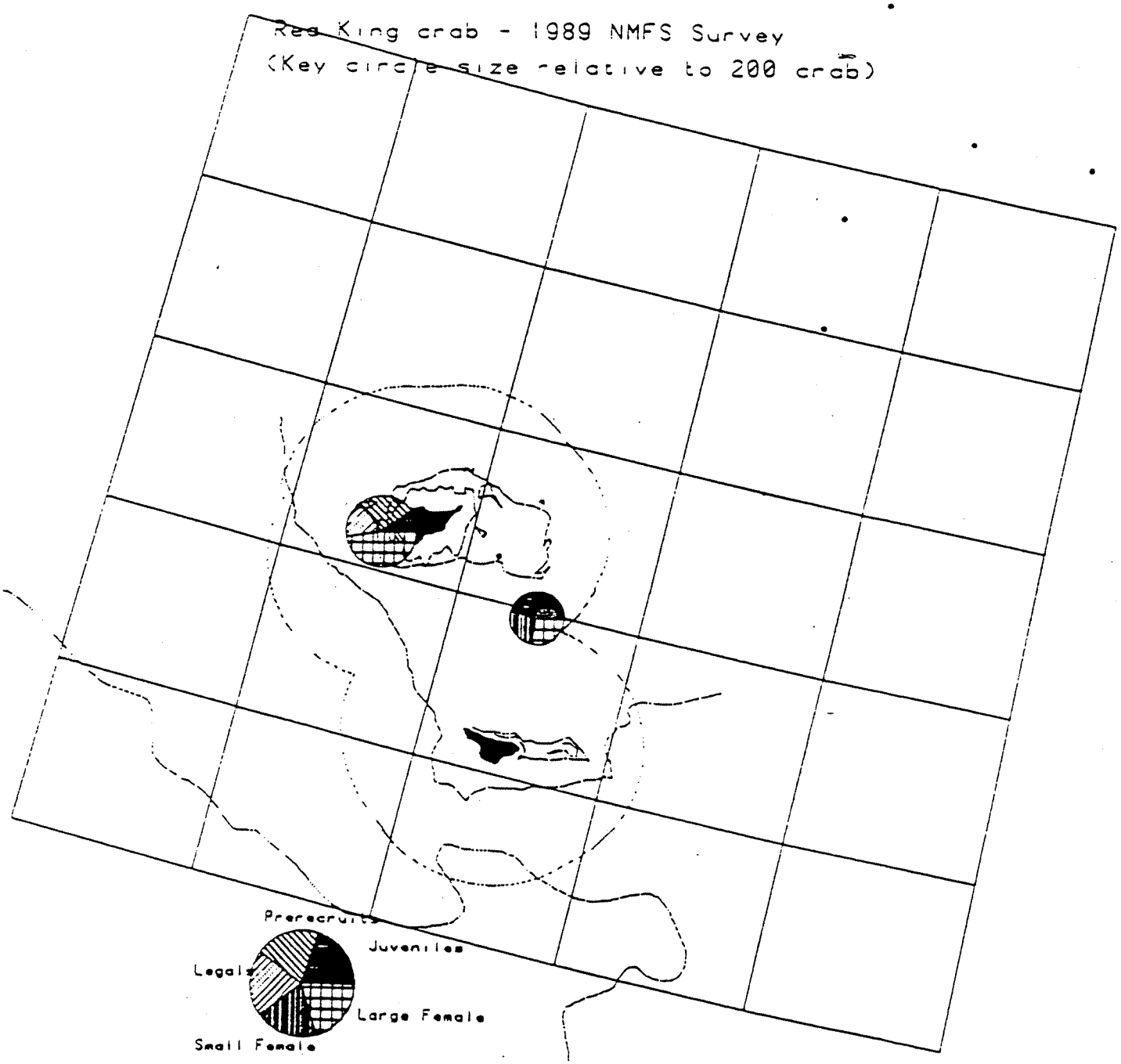


Figure A.23. Red king crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

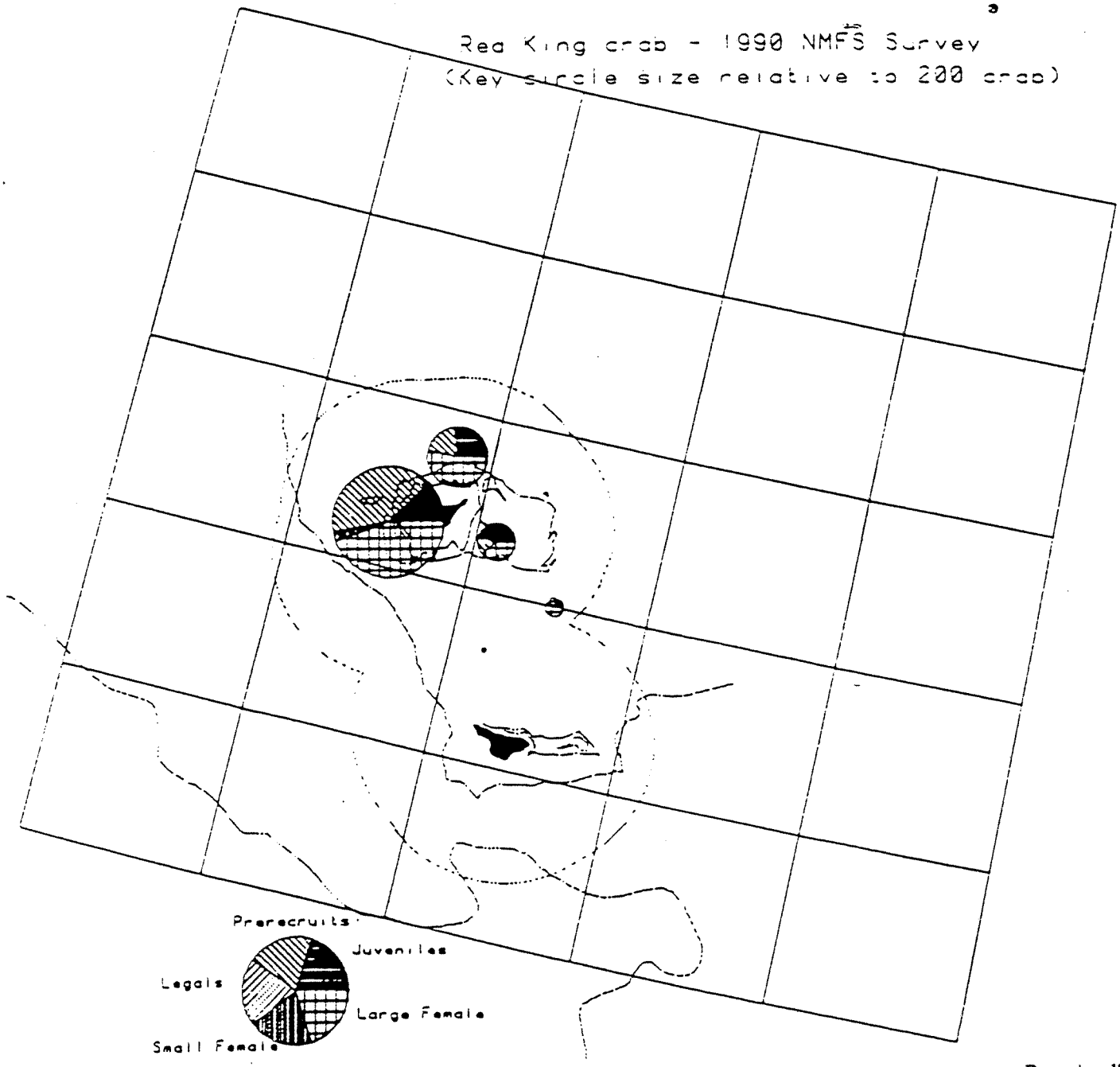


Figure A.24. Red king crab catch in 1991 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

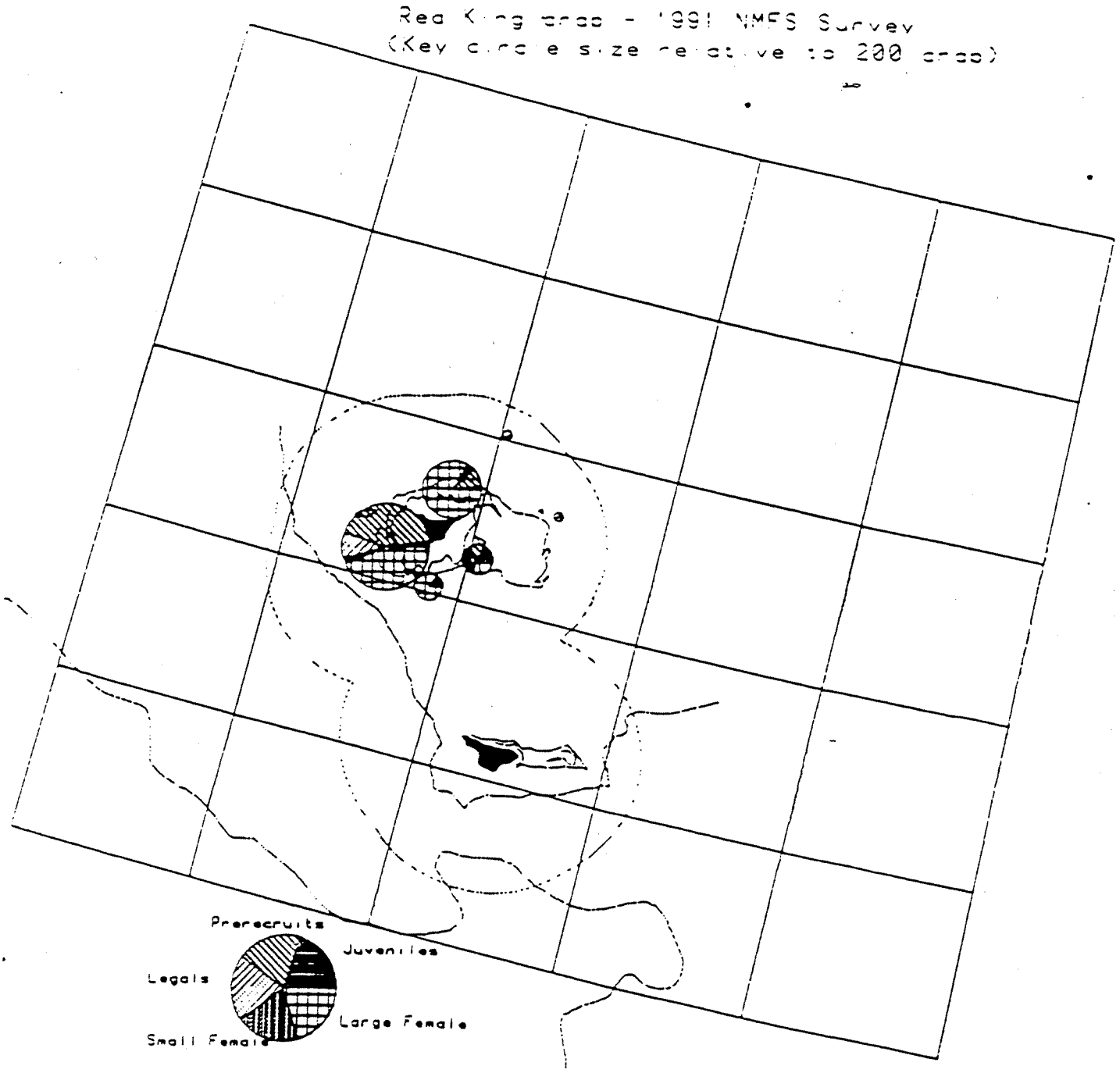


Figure A.25. Red king crab catch in 1992 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

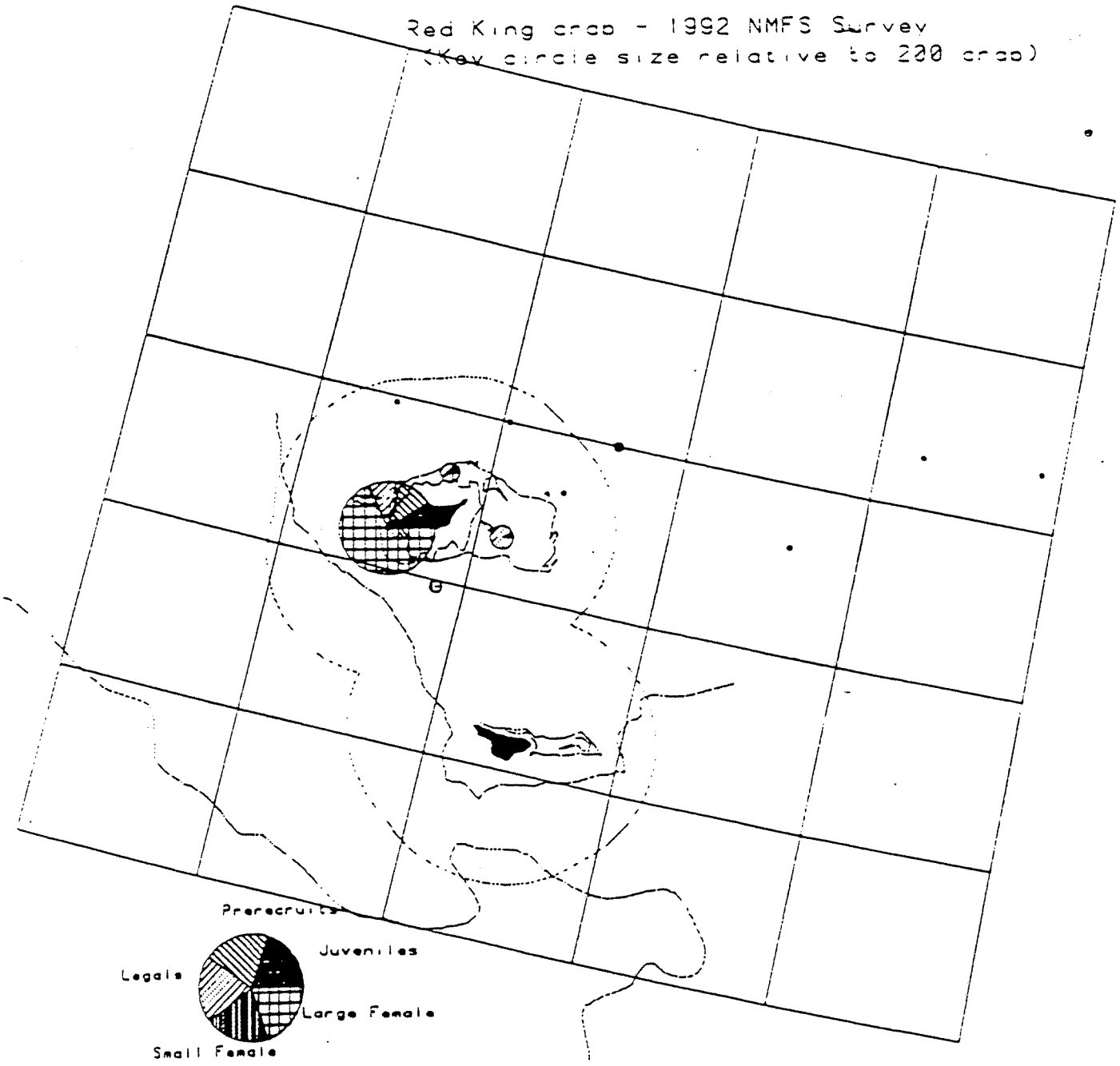


Figure A.26. C. bairdi Tanner crab catch in 1975 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

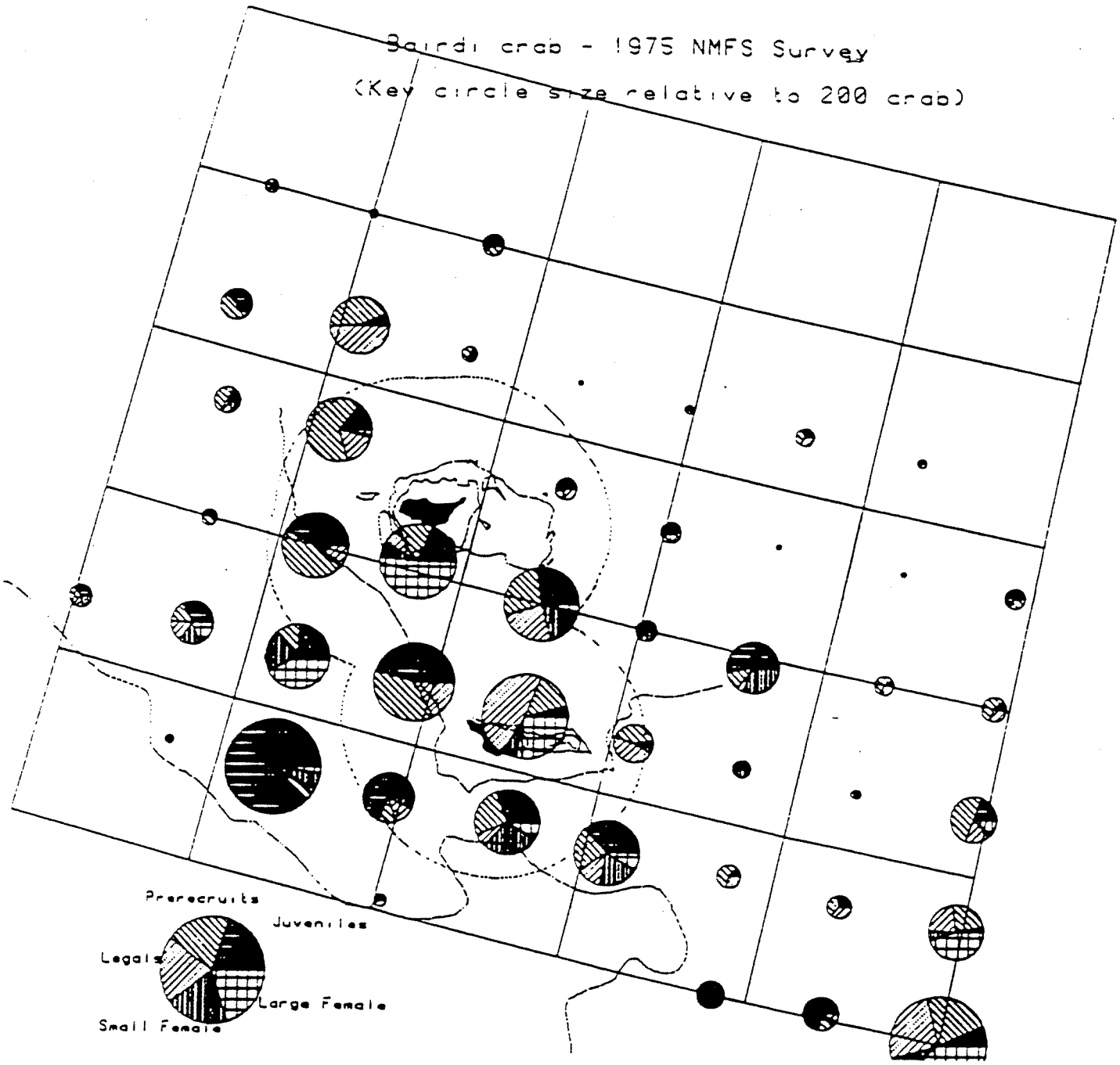


Figure A.27. C. bairdi Tanner crab catch in 1980 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

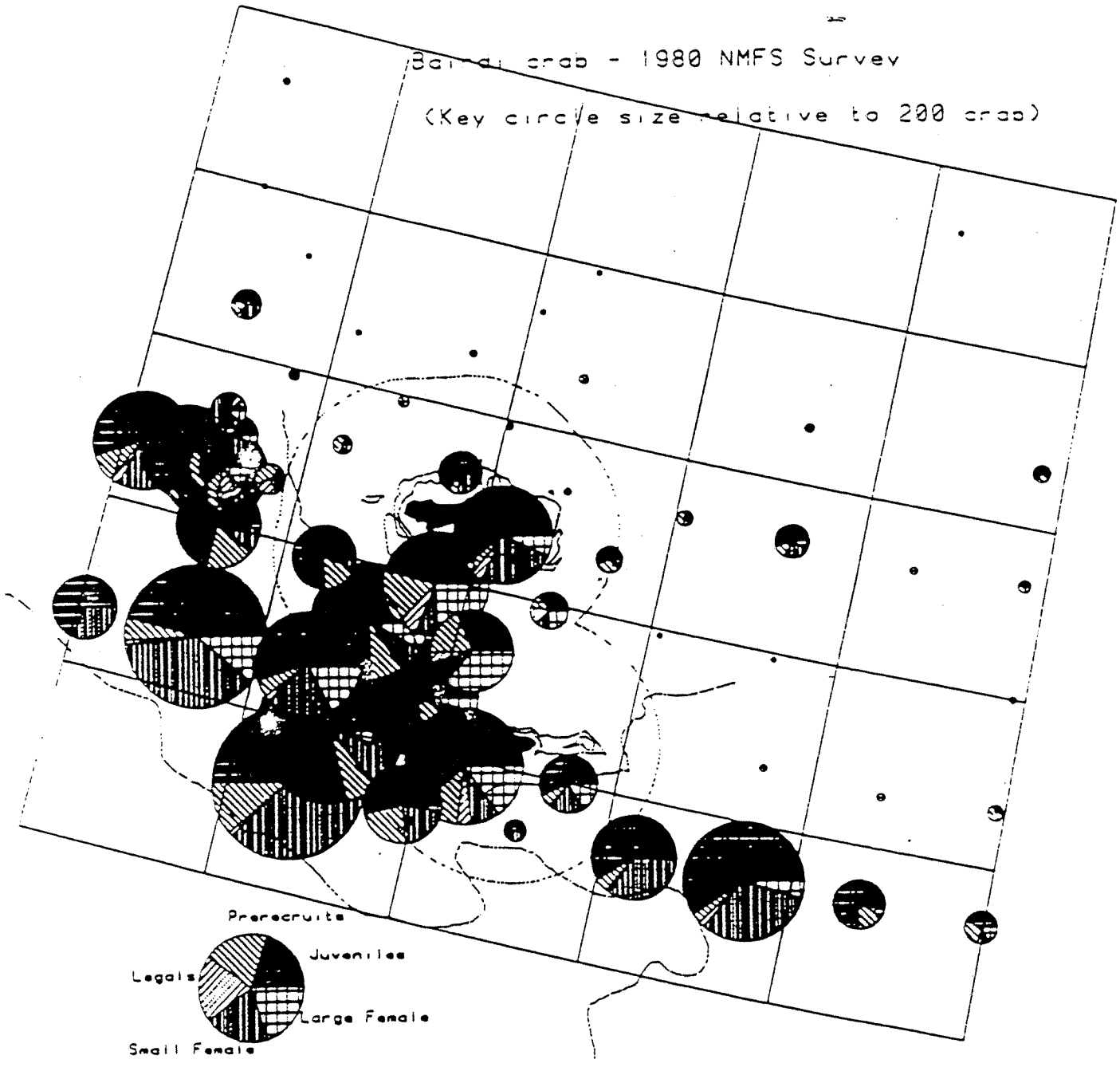


Figure A.28. C. bairdi Tanner crab catch in 1985 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.

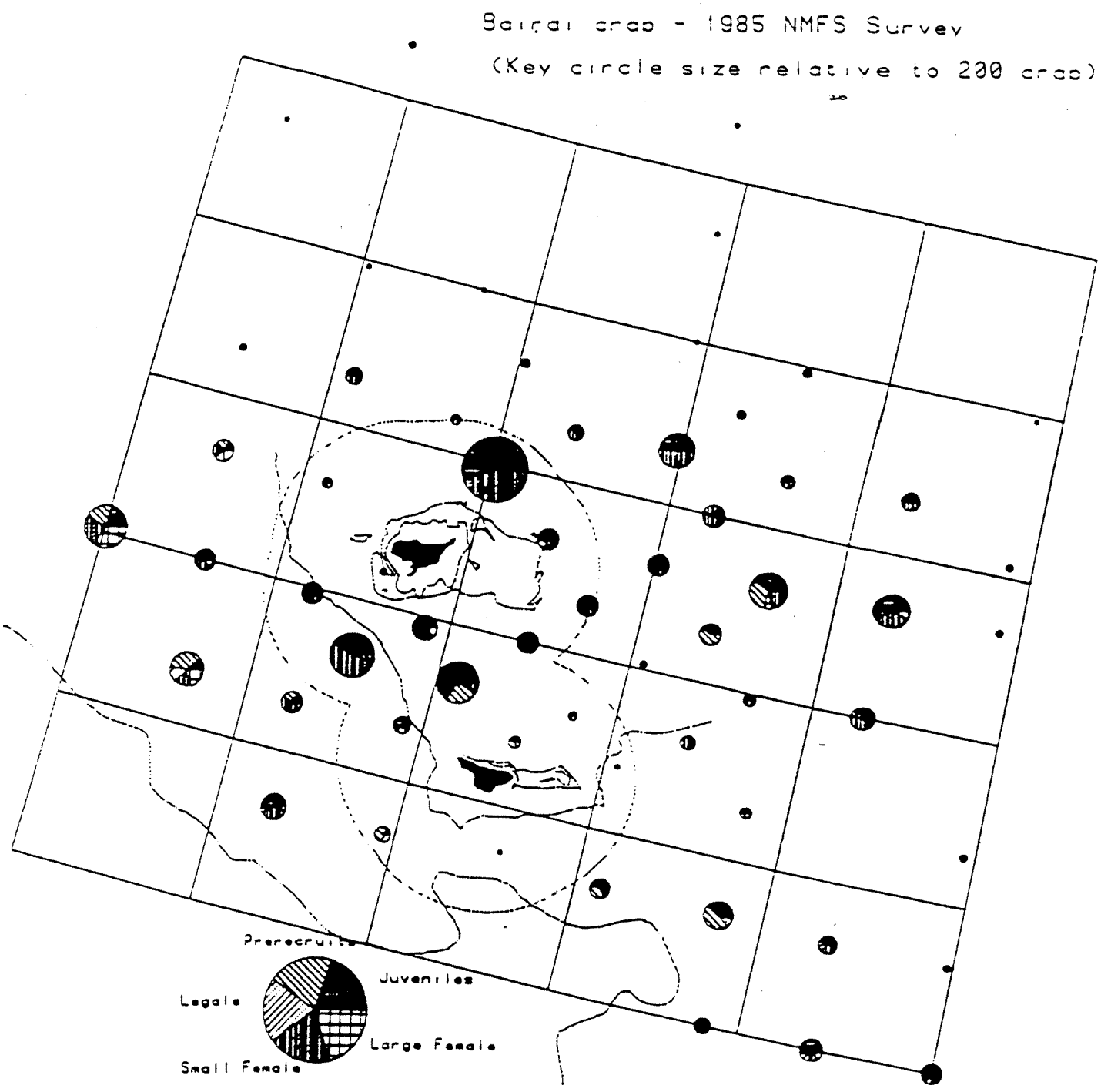
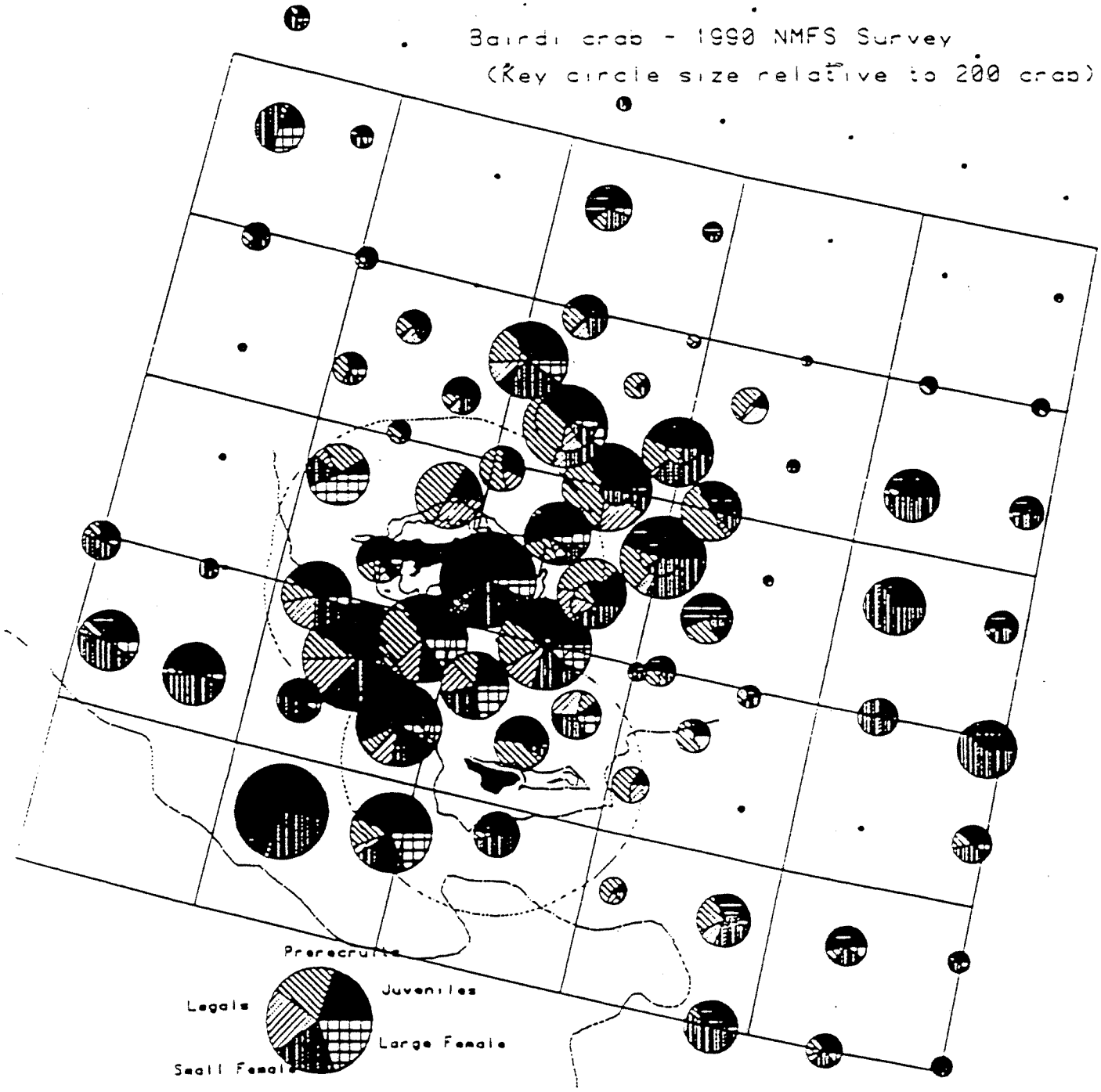


Figure A.29. C. bairdi Tanner crab catch in 1990 NMFS trawl survey of the eastern Bering Sea. Size of circle is relative to number of crab. Size of key legend circle = 200 crab.



Appendix B. Observed hauls for which species identification of crab bycatch was made. Foreign, 1982-1987; joint venture, 1985-1989; Domestic 1989 and 1991.

Figure B.1. Blue king crab bycatch in 1982 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.2. Blue king crab bycatch in 1983 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.3. Blue king crab bycatch in 1984 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.4. Blue king crab bycatch in 1985 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.5. Blue king crab bycatch in 1986 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.6. Blue king crab bycatch in 1987 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.7. Blue king crab bycatch in 1985 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.8. Blue king crab bycatch in 1986 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.9. Blue king crab bycatch in 1987 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.10. Blue king crab bycatch in 1988 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.11. Blue king crab bycatch in 1989 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.12. Blue king crab bycatch in 1989 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.13. Blue king crab bycatch in 1991 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

Figure B.14. Number of blue king crab identified by observers from each year and target fishery.

Figure B.1. Blue king crab bycatch in 1982 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

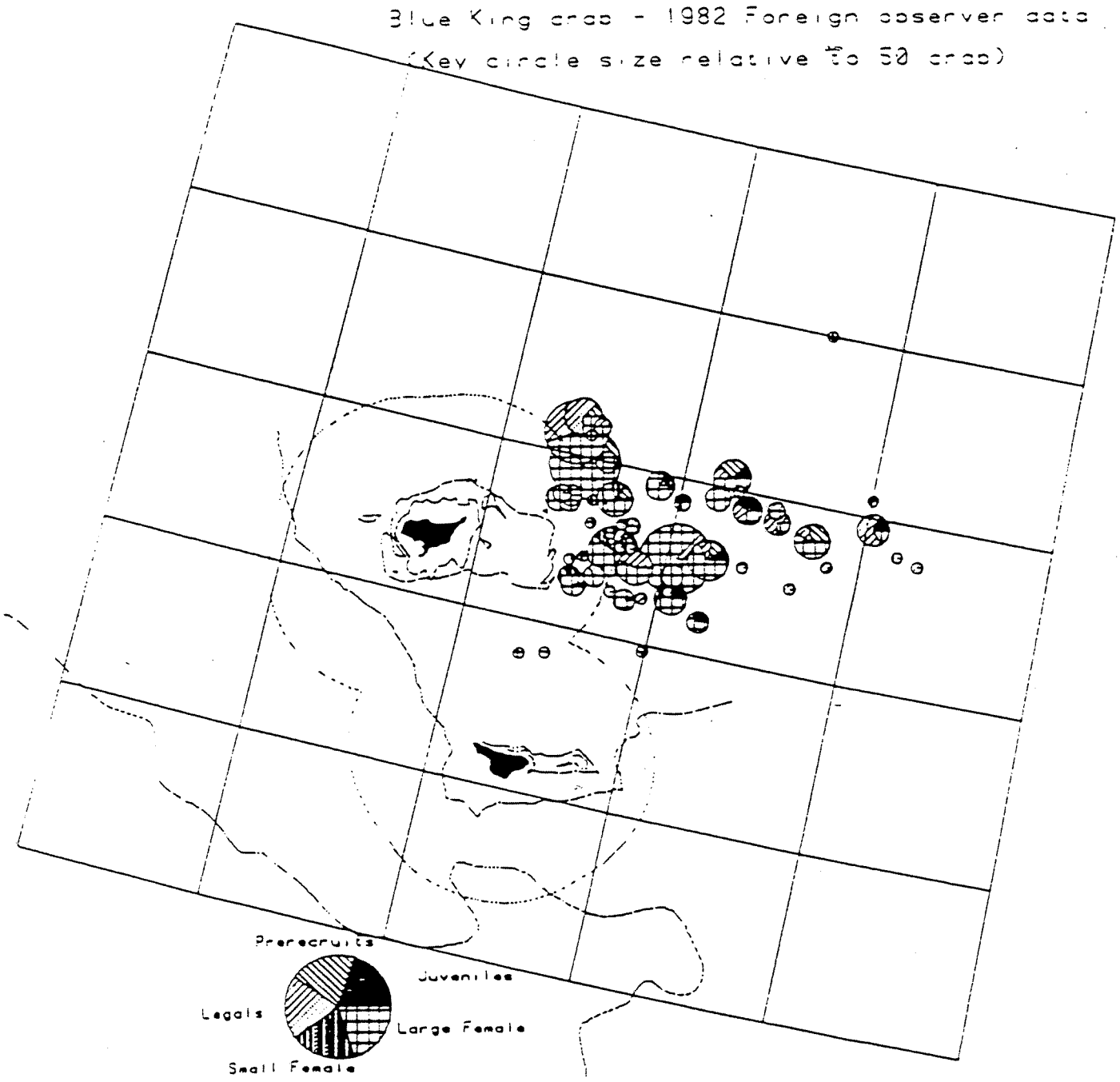


Figure B.2. Blue king crab bycatch in 1983 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

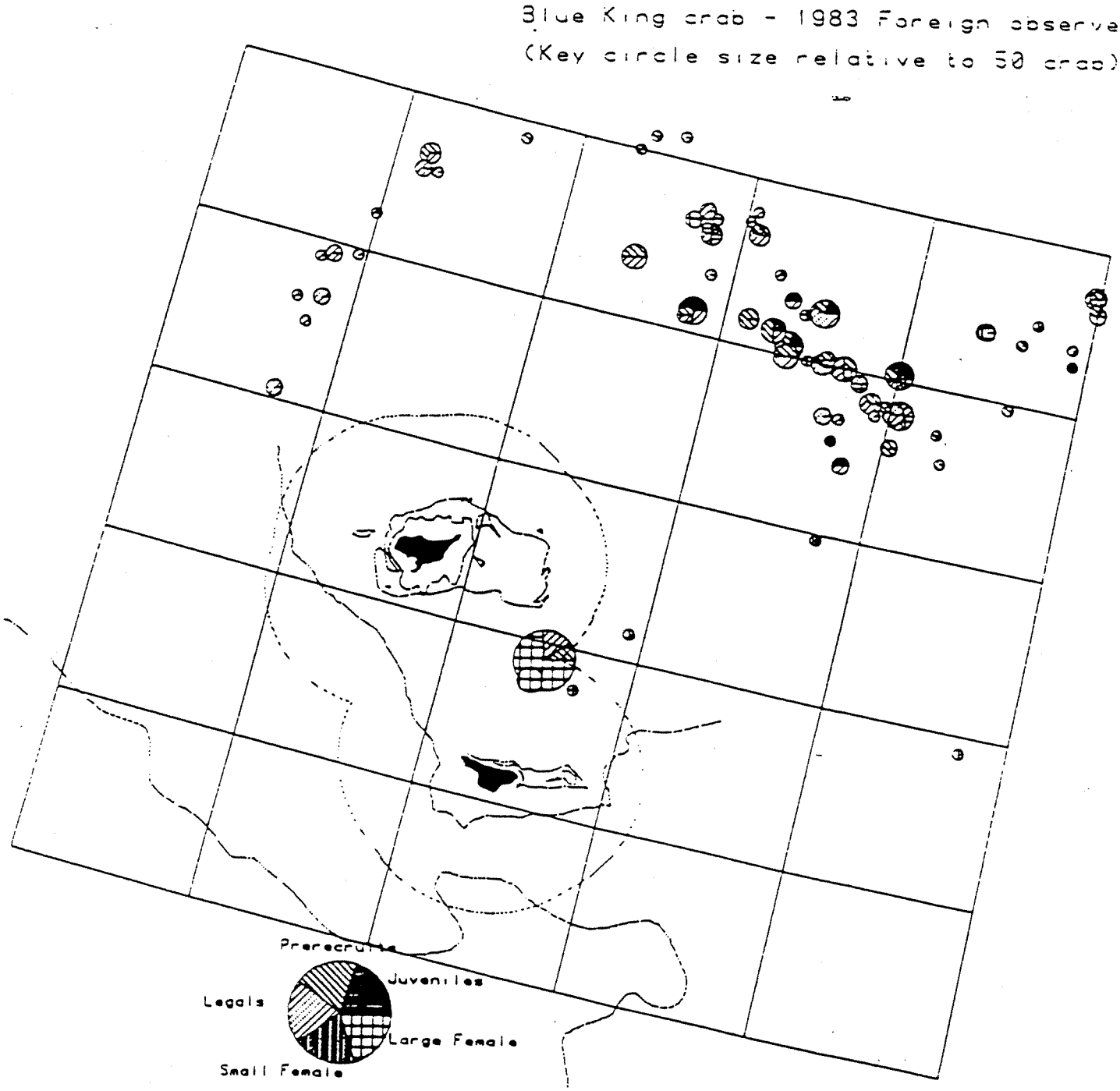


Figure B.3. Blue king crab bycatch in 1984 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

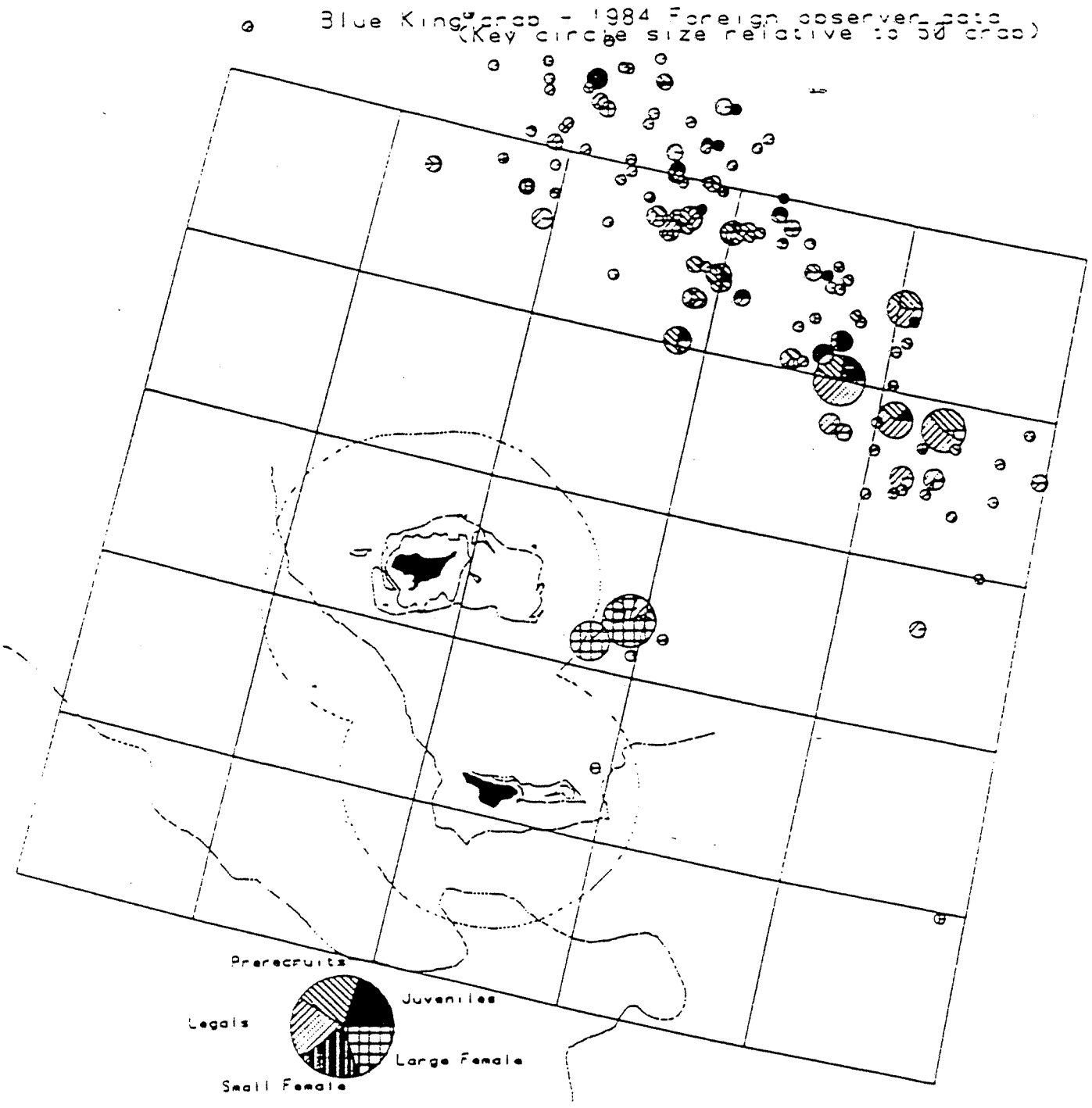


Figure B.4. Blue king crab bycatch in 1985 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

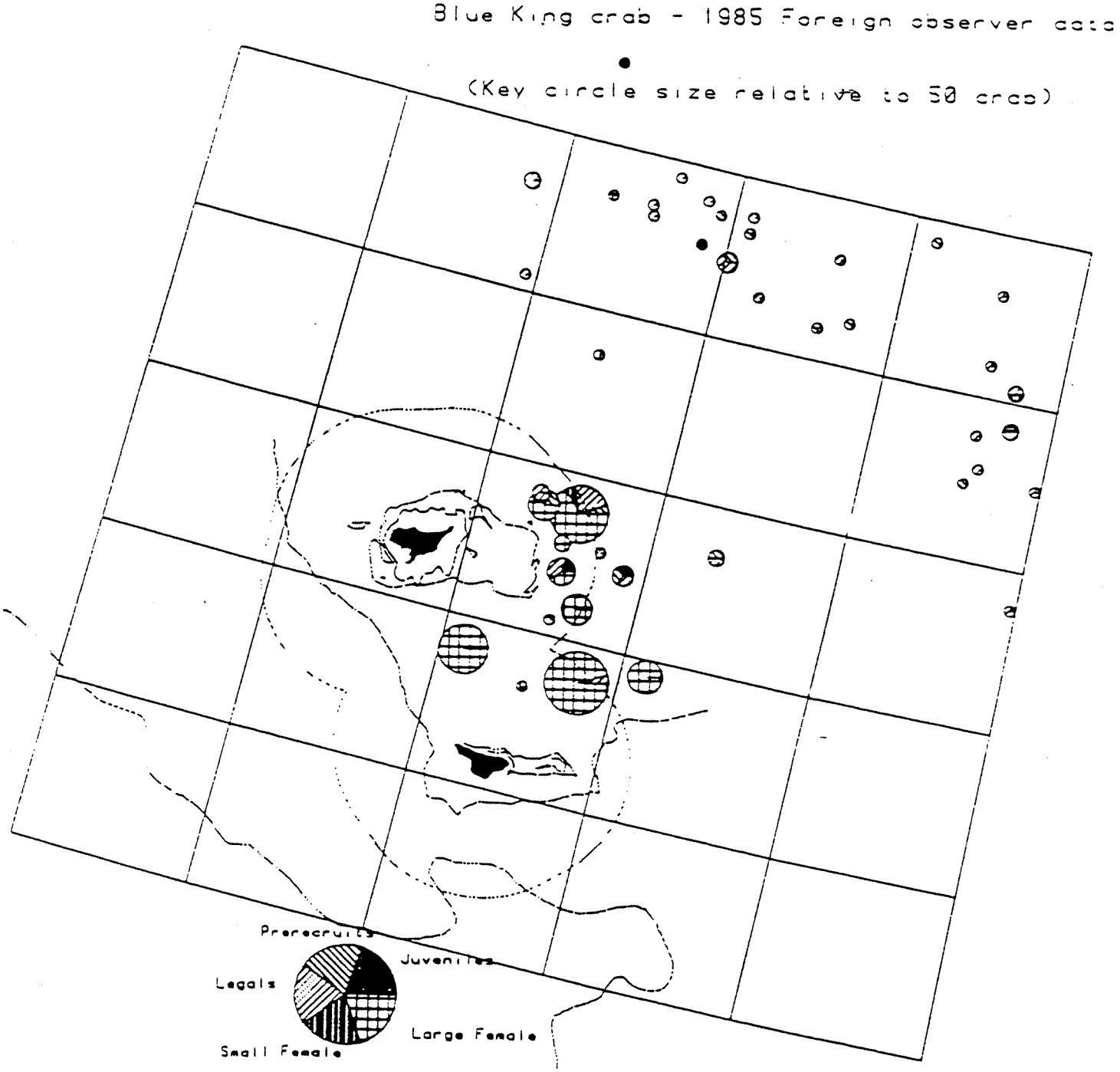


Figure B.5. Blue king crab bycatch in 1986 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

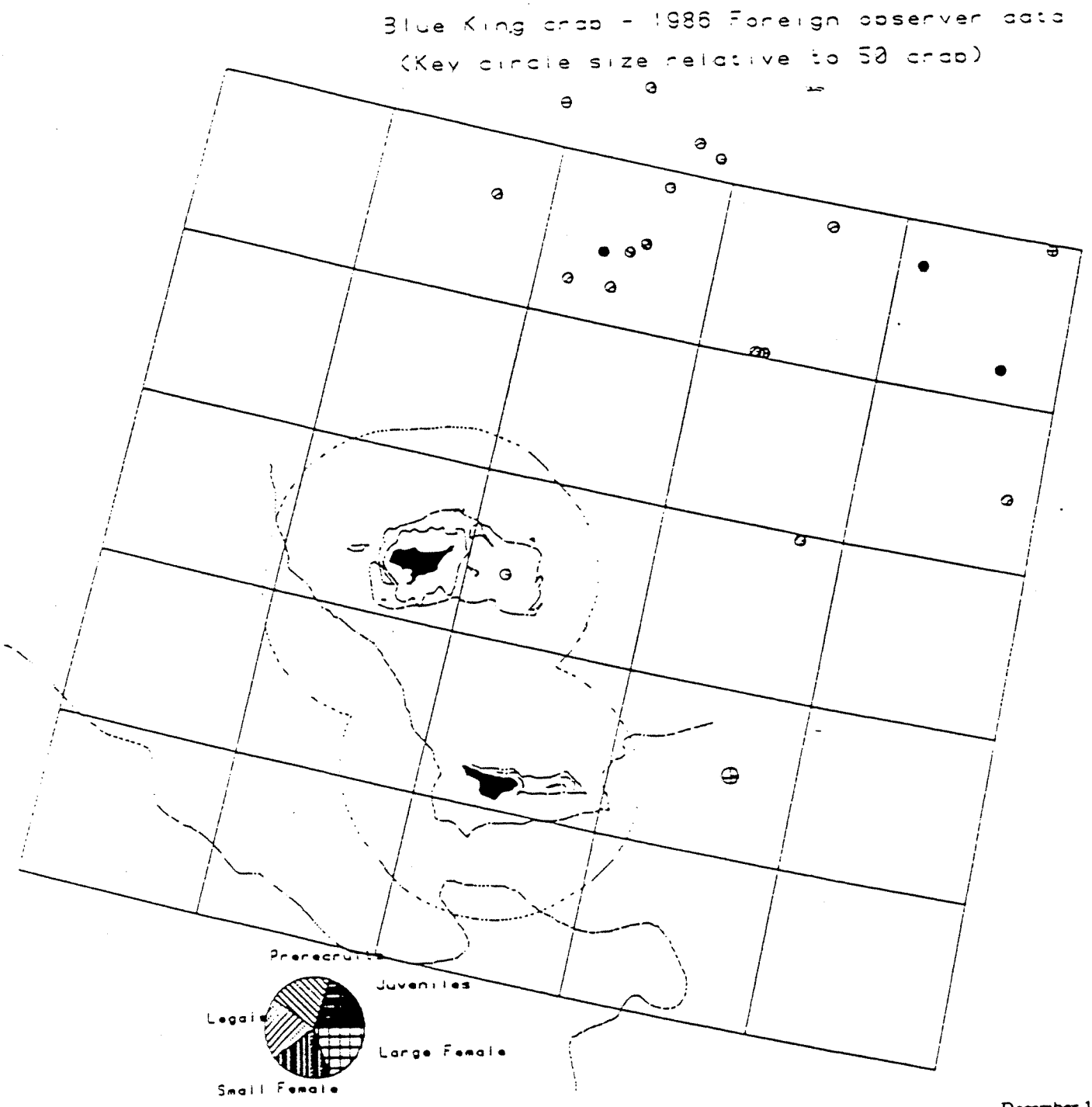


Figure B.6. Blue king crab bycatch in 1987 foreign observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

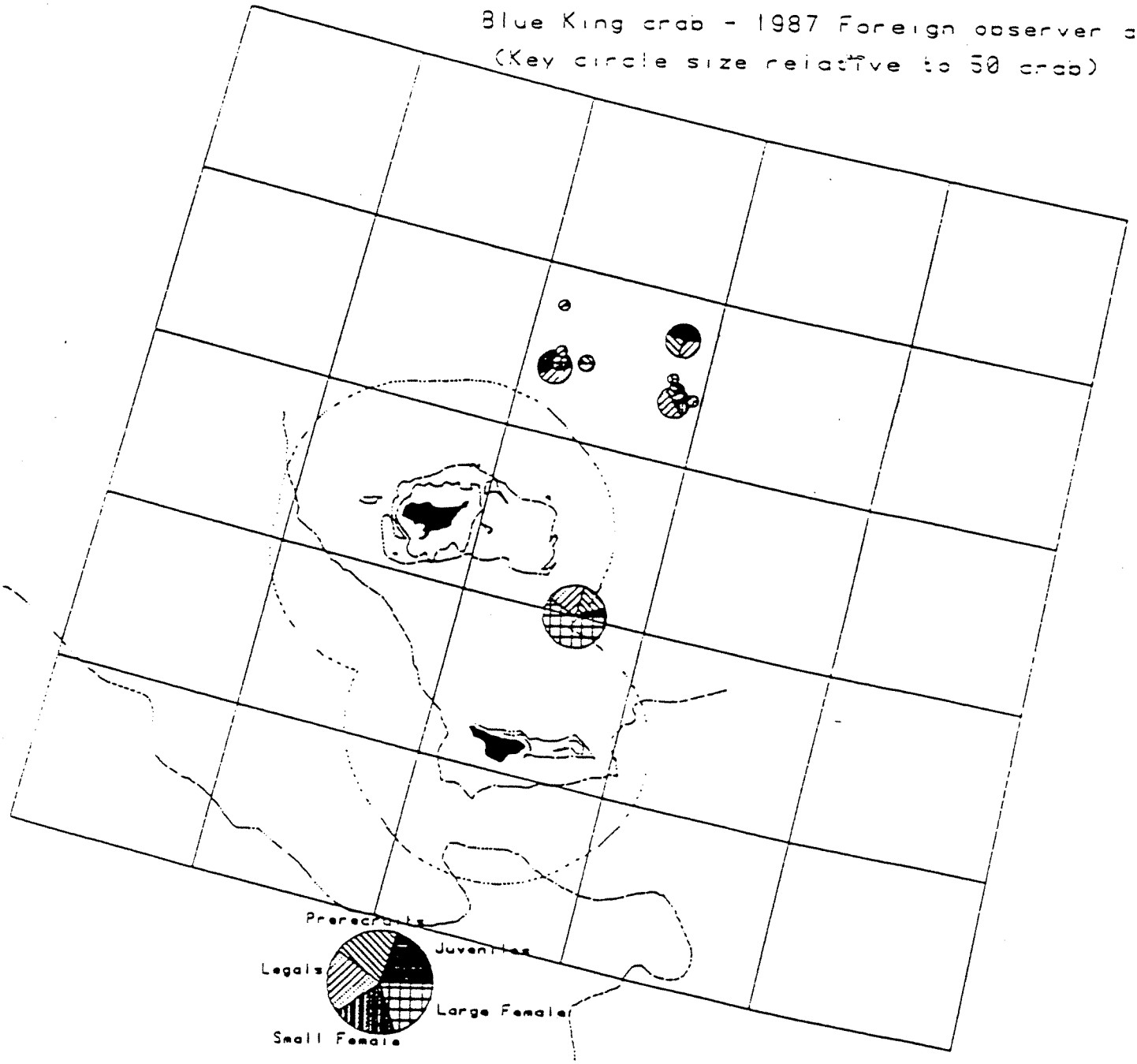


Figure B.7. Blue king crab bycatch in 1985 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

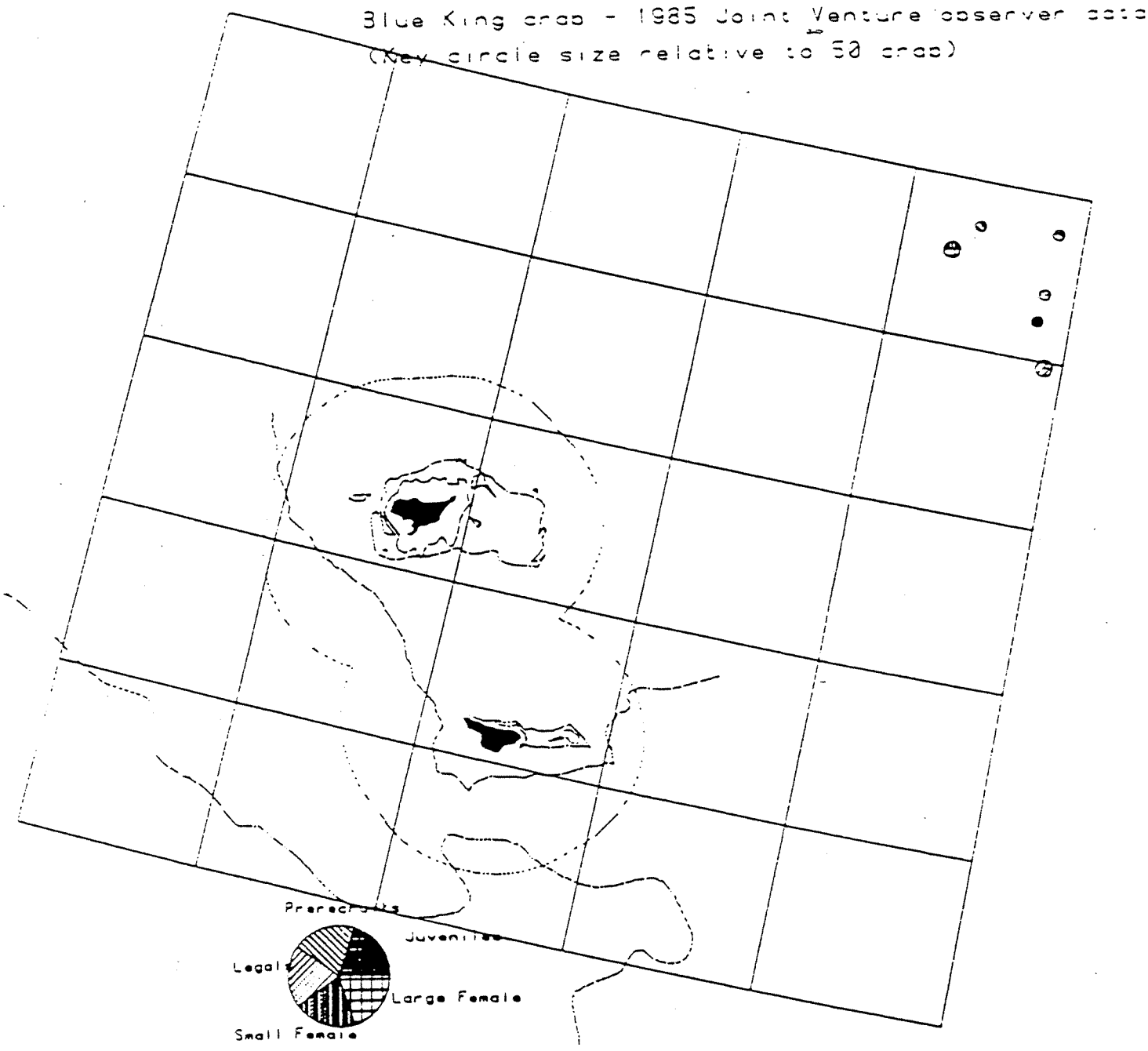


Figure B.8. Blue king crab bycatch in 1986 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

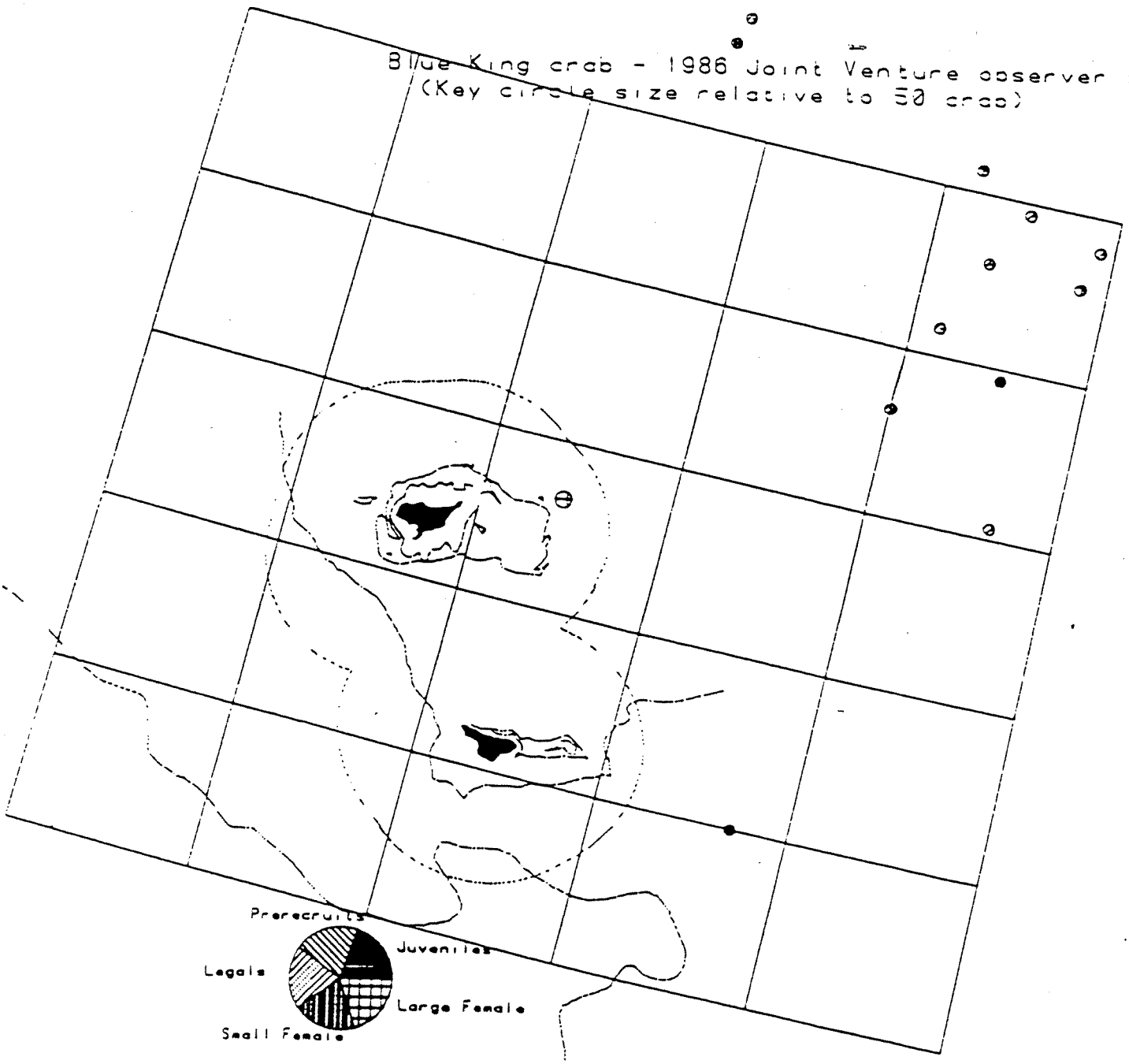


Figure B.9. Blue king crab bycatch in 1987 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

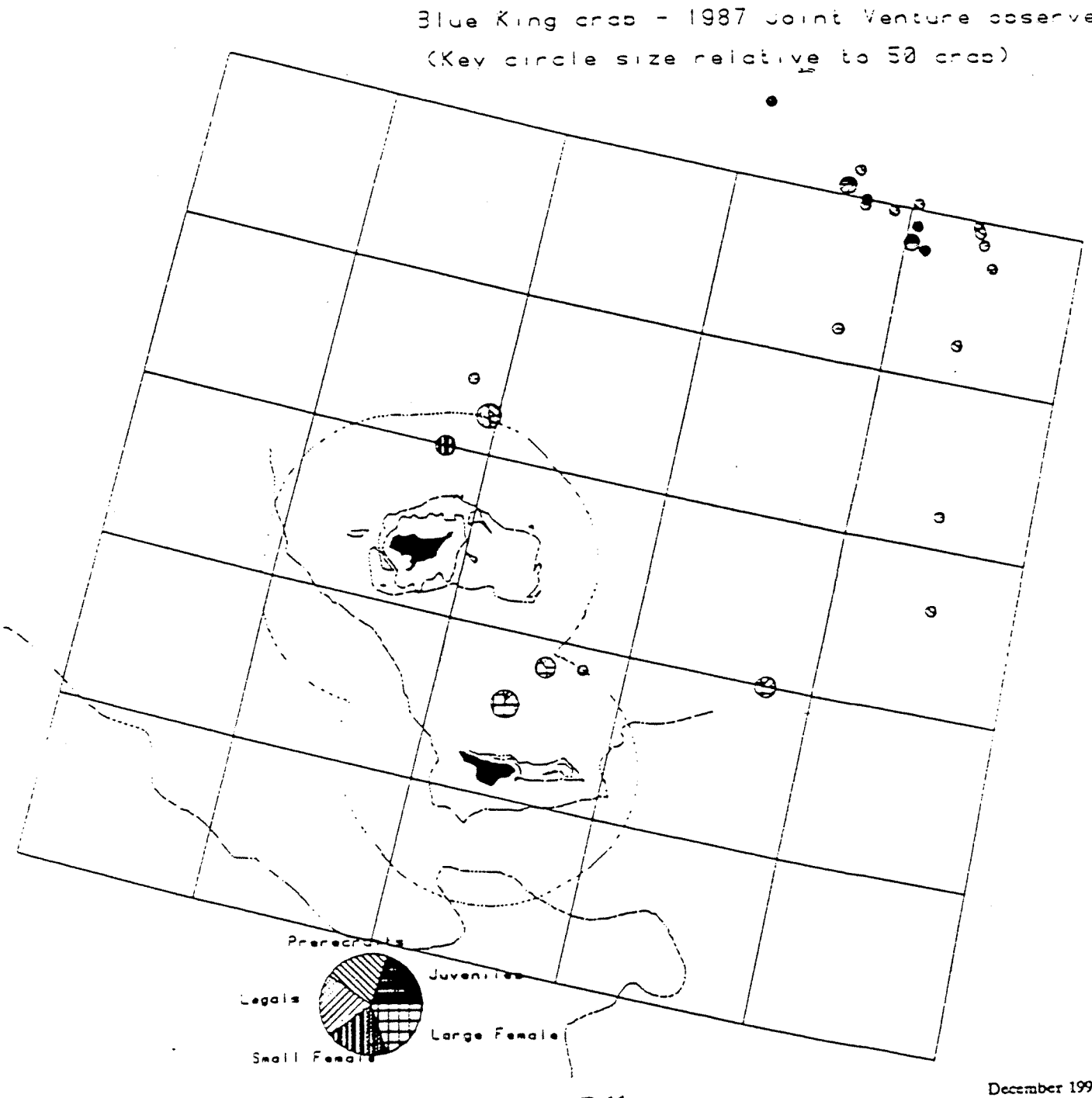


Figure B.10. Blue king crab bycatch in 1988 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

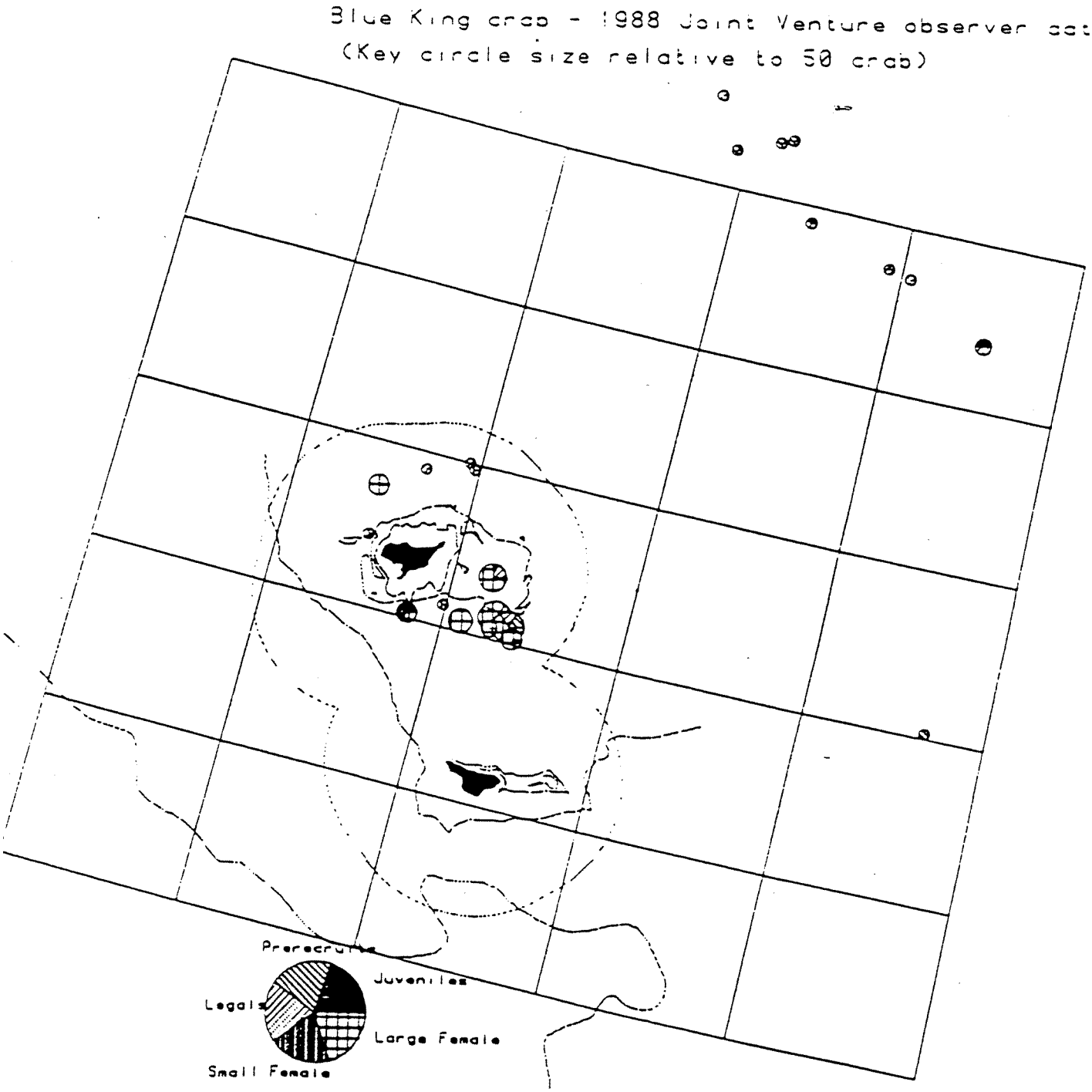


Figure B.11. Blue king crab bycatch in 1989 Joint Venture observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

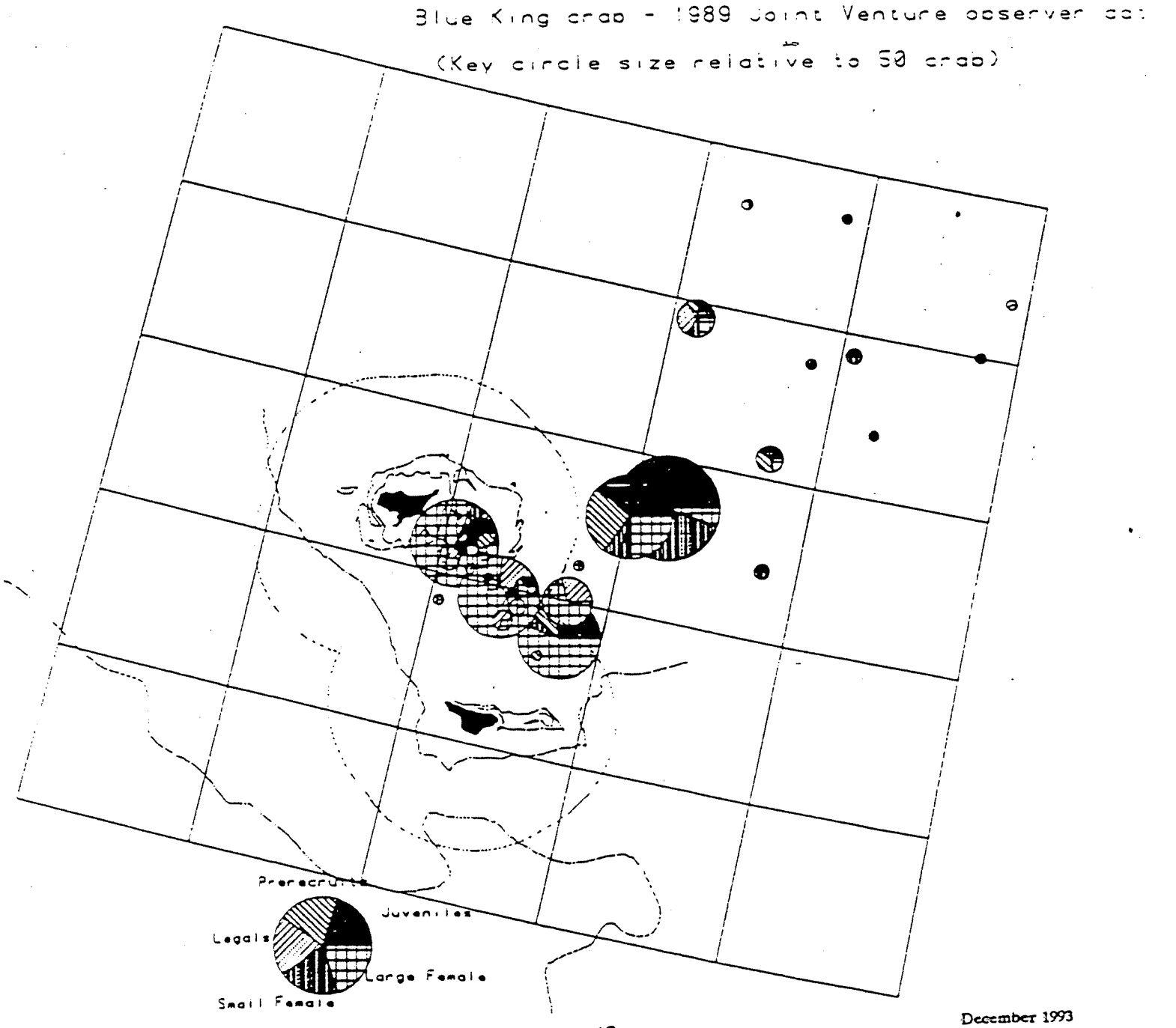


Figure B.12. Blue king crab bycatch in 1989 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

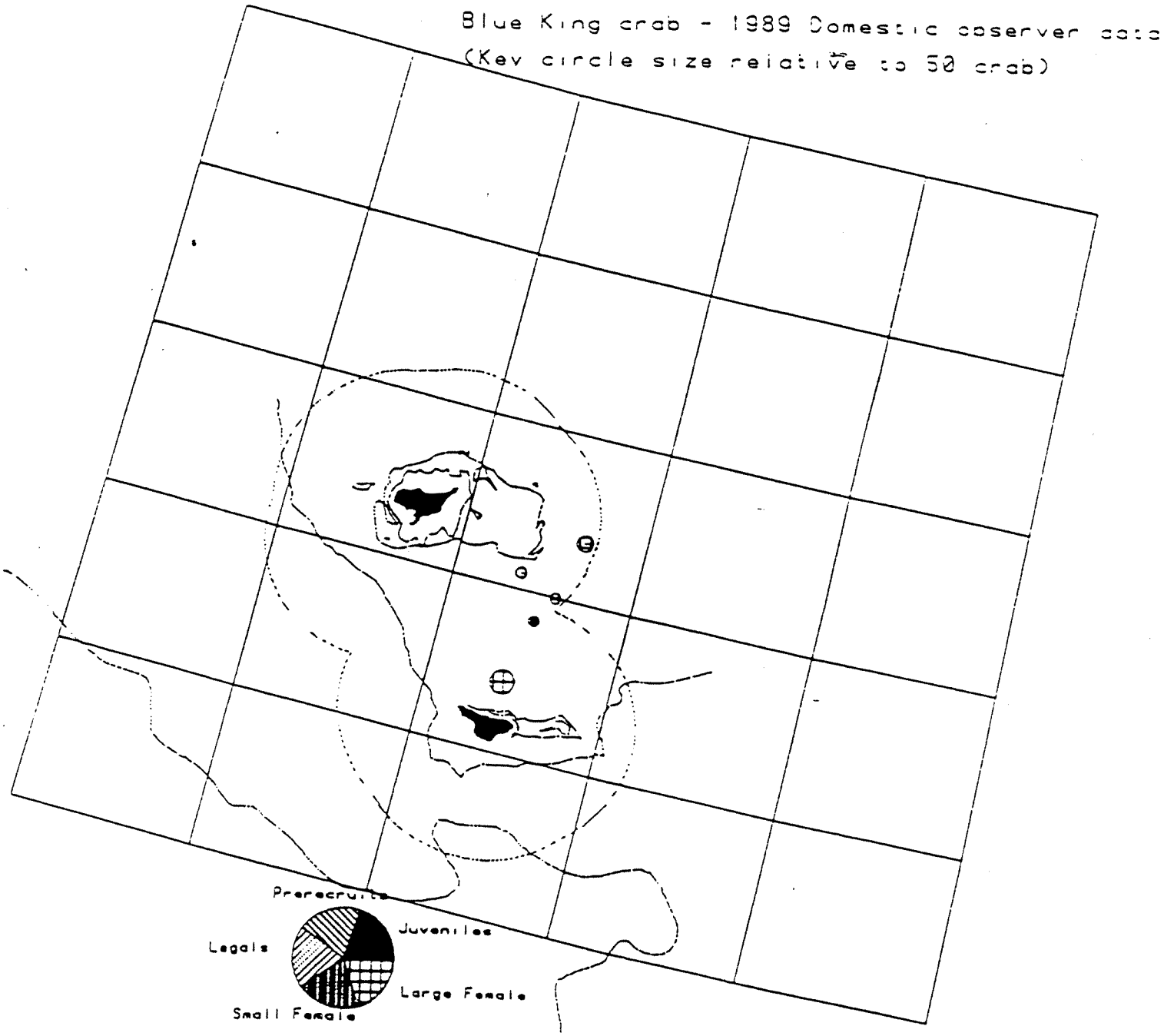


Figure B.13. Blue king crab bycatch in 1991 domestic observed trawl fisheries in the Bering Sea. Only hauls for which species identification was made. Size of circle is relative to number of crab. Size of key legend circle = 50 crab.

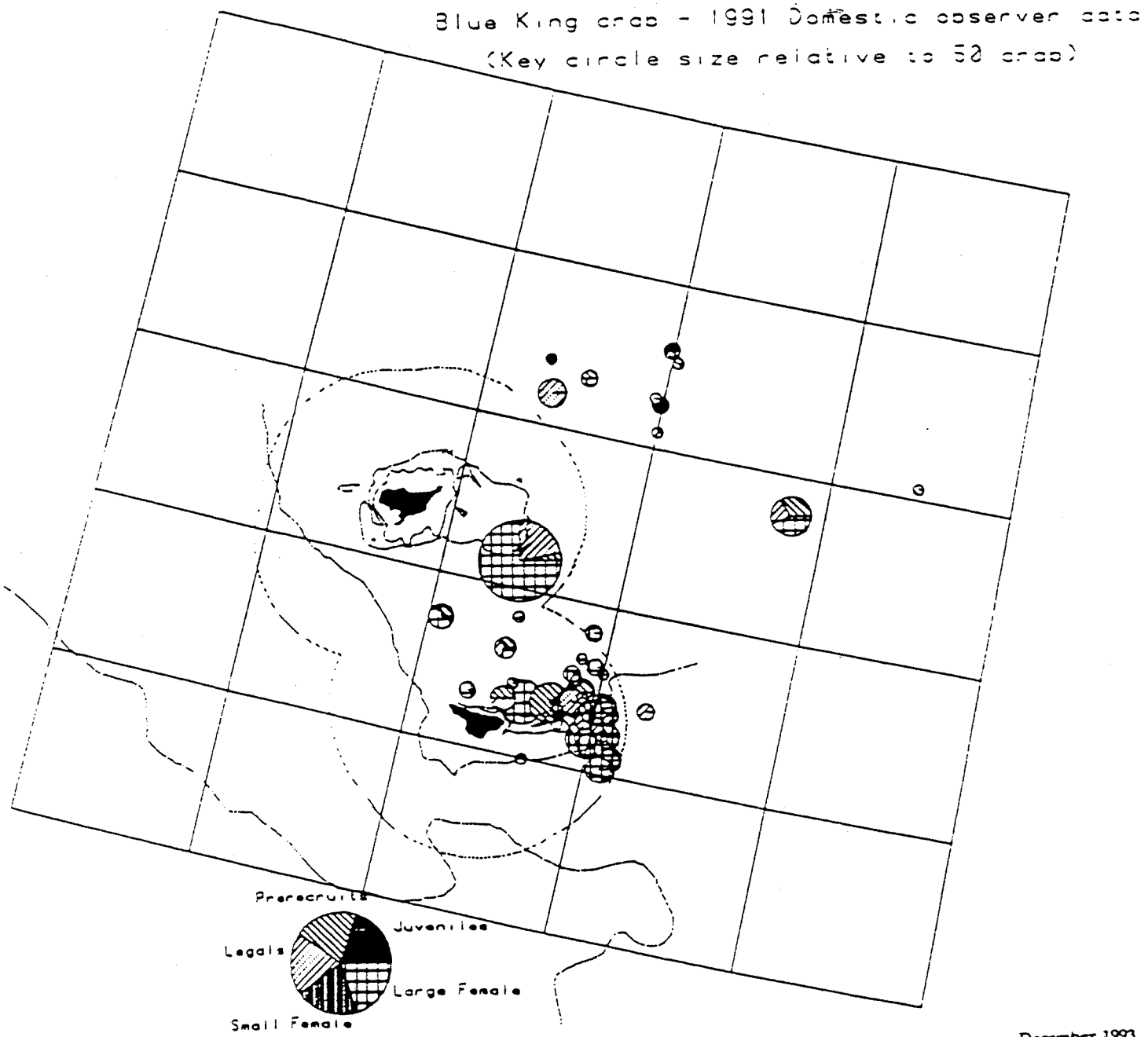
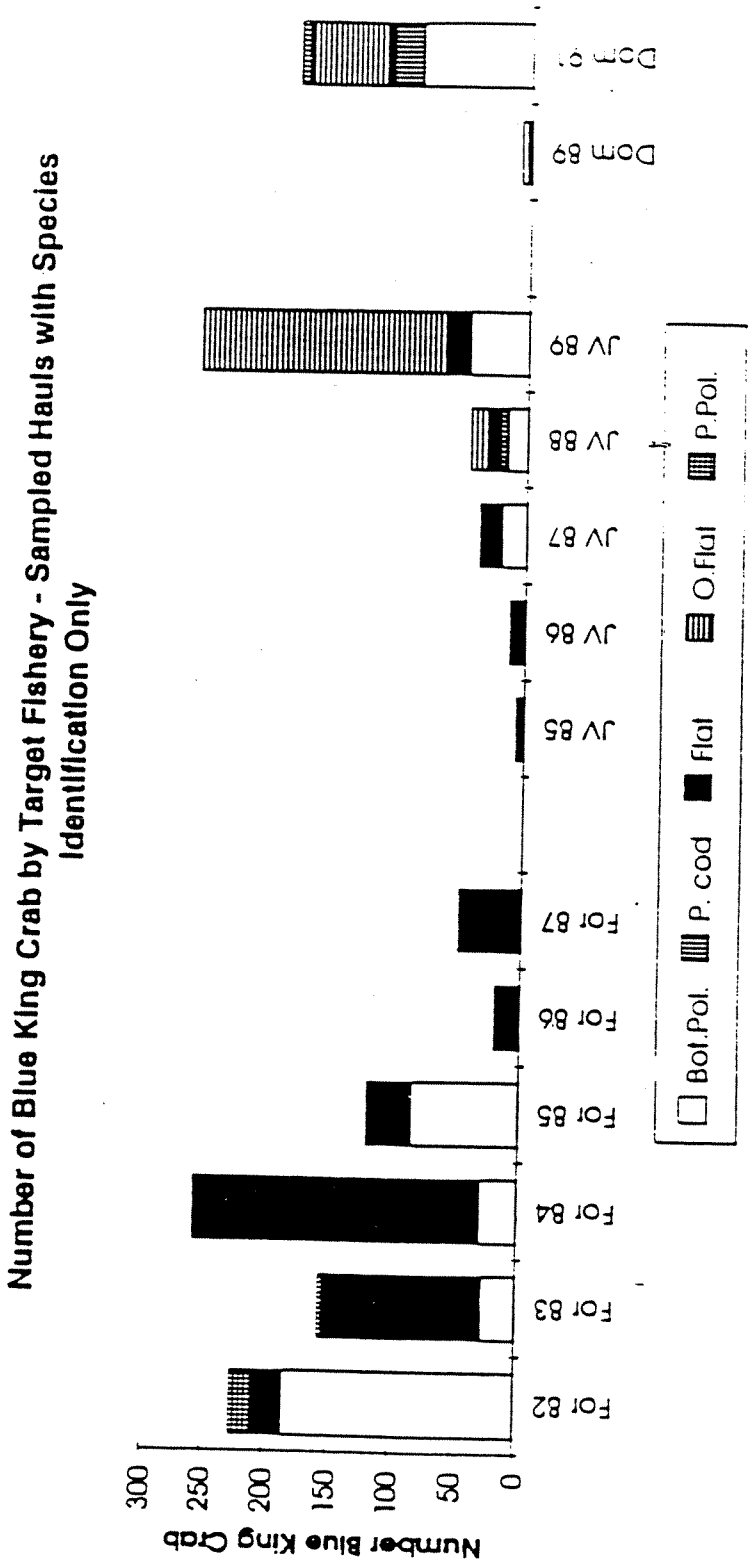
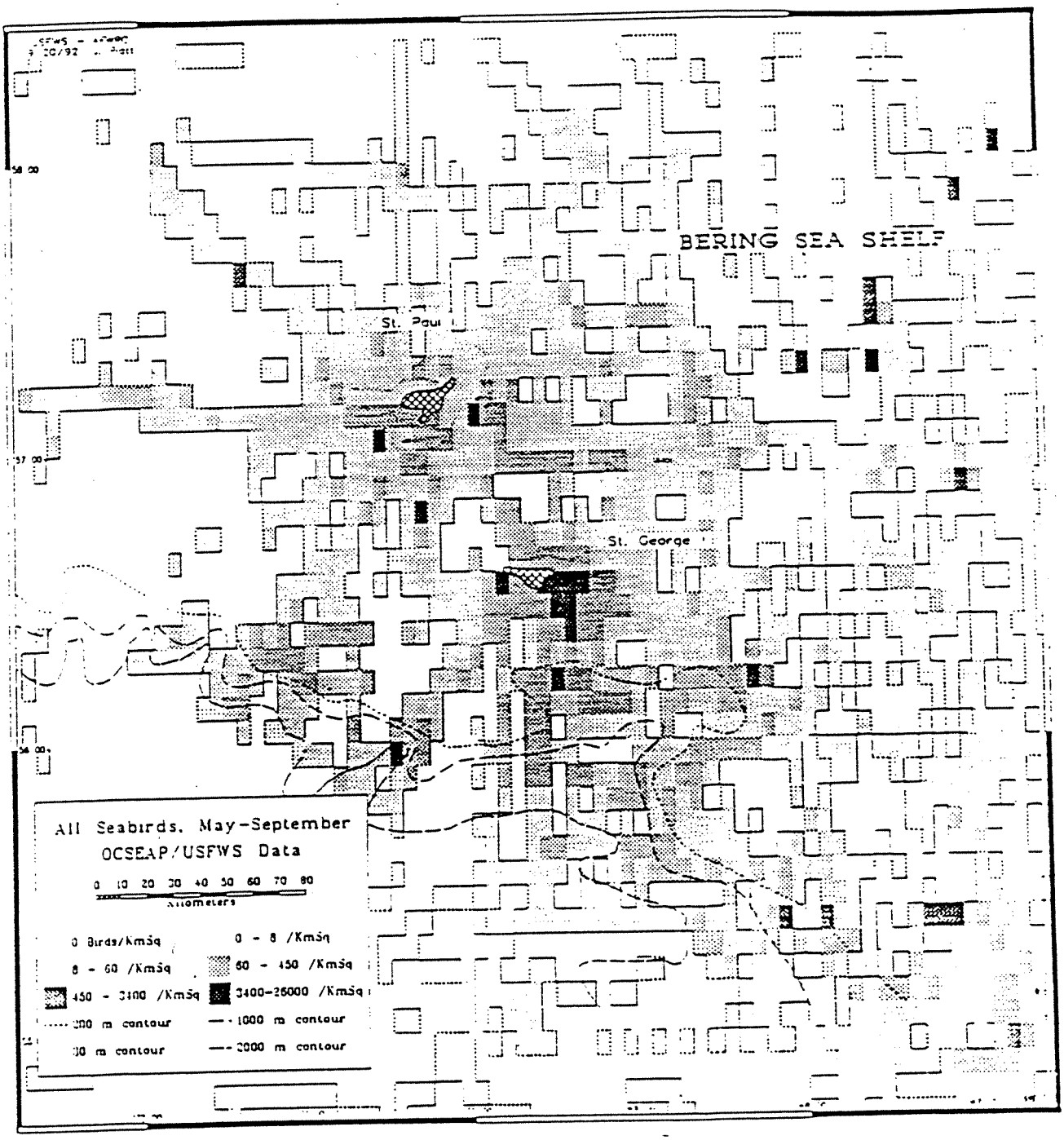
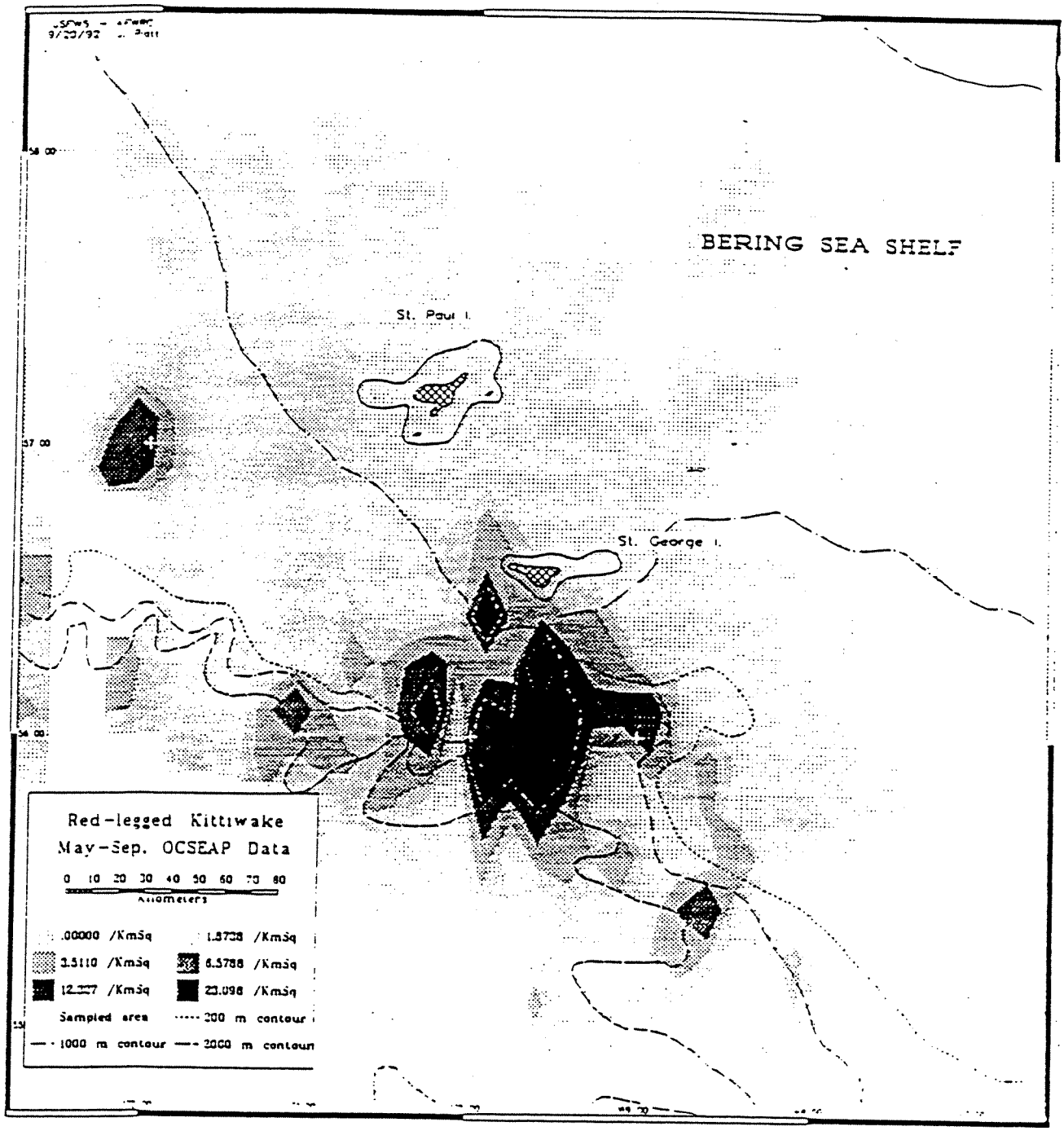


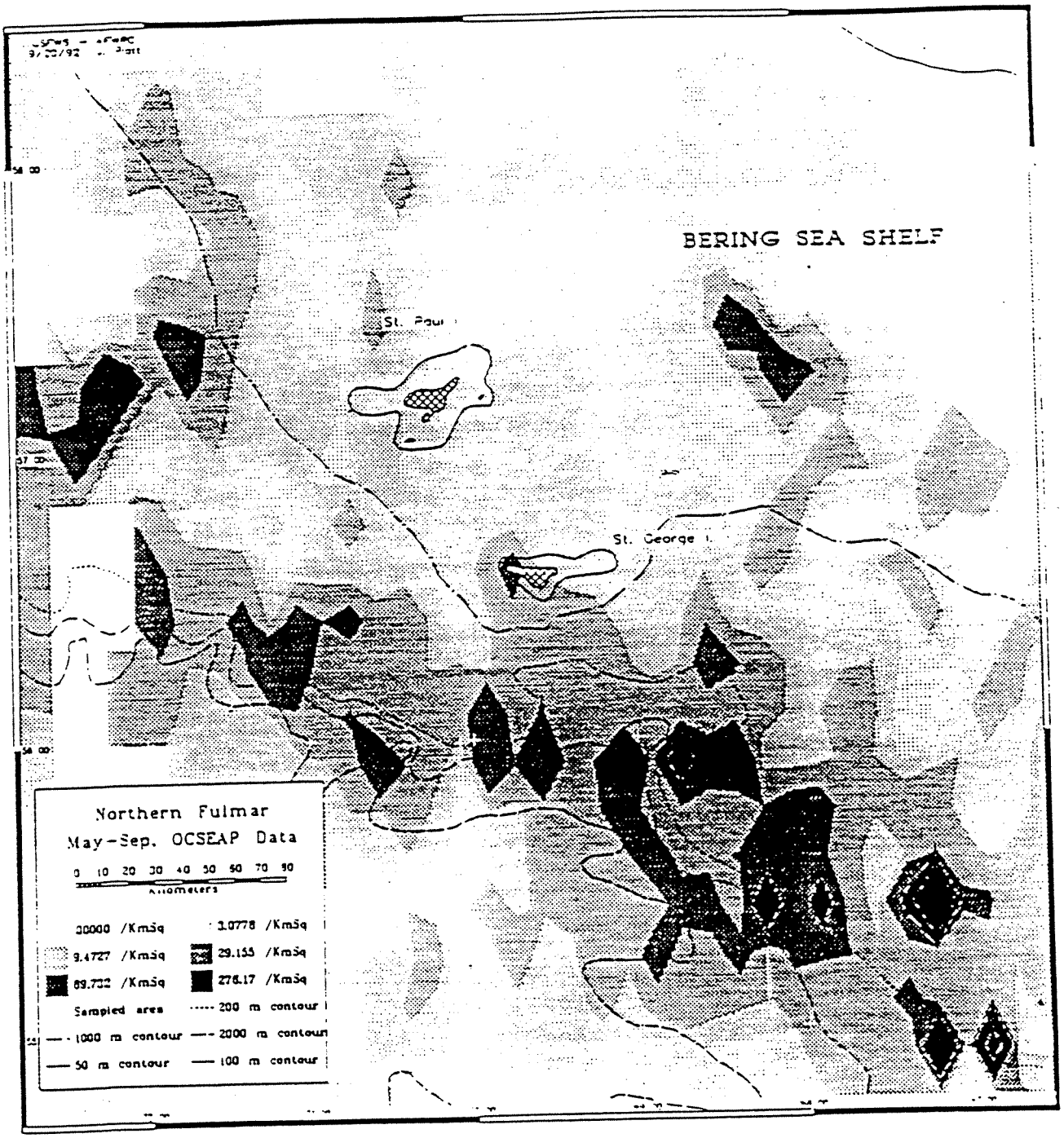
Figure B.14. Number of blue king crab identified by observers from each year and target fishery.

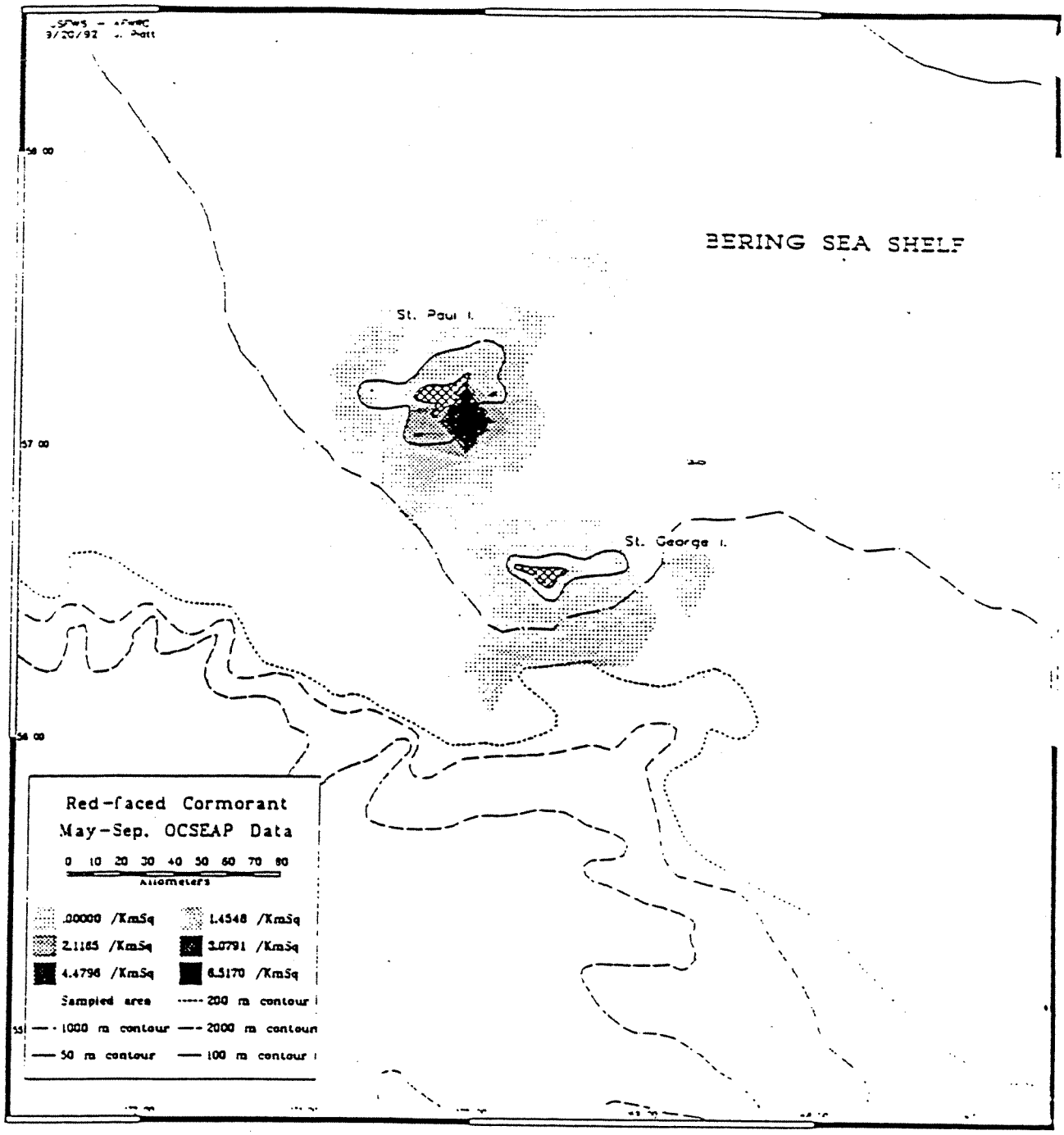


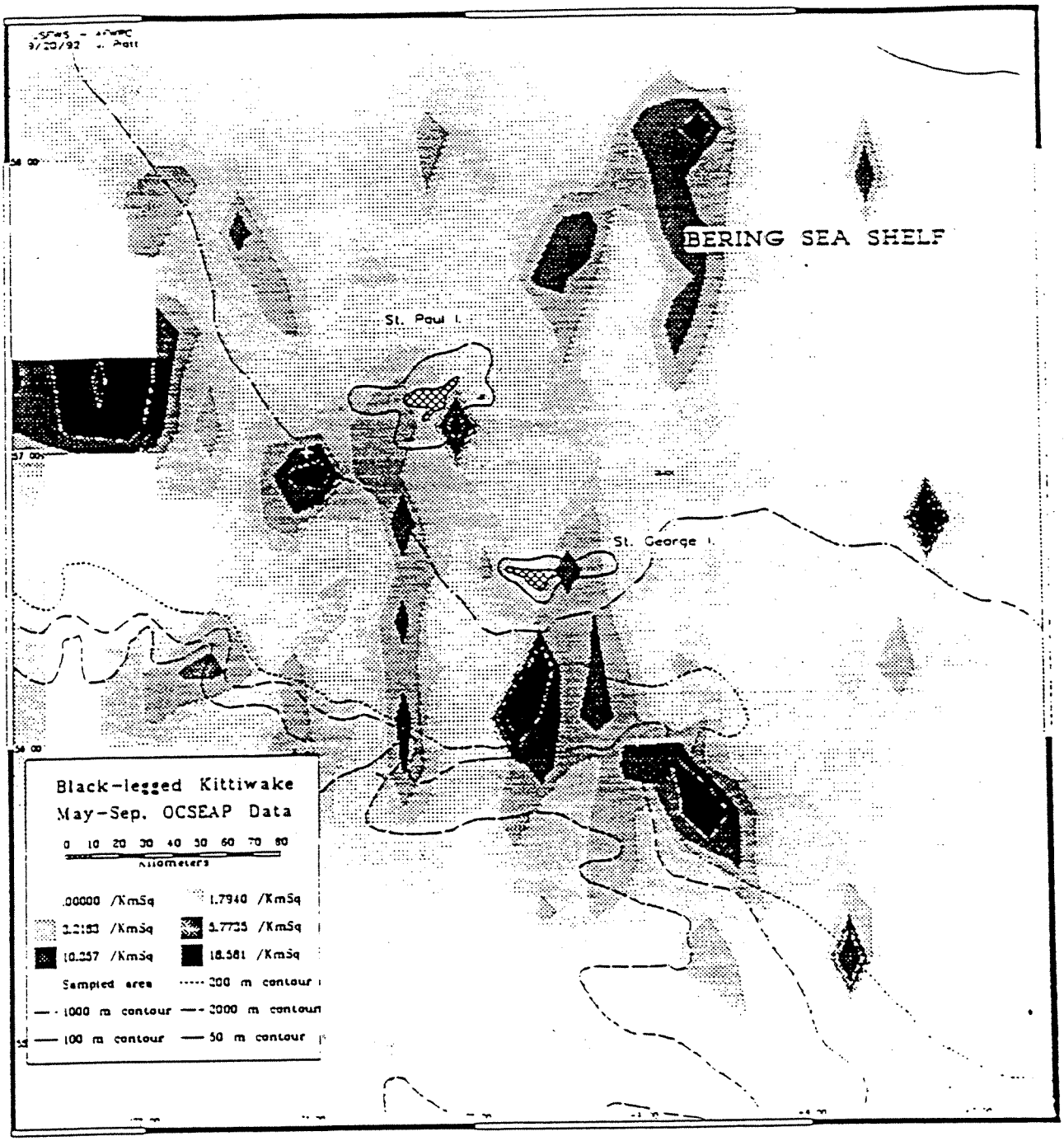
Appendix C. Location of seabird foraging areas near the Pribilof Islands. Provided by the U.S. Fish and Wildlife Service.

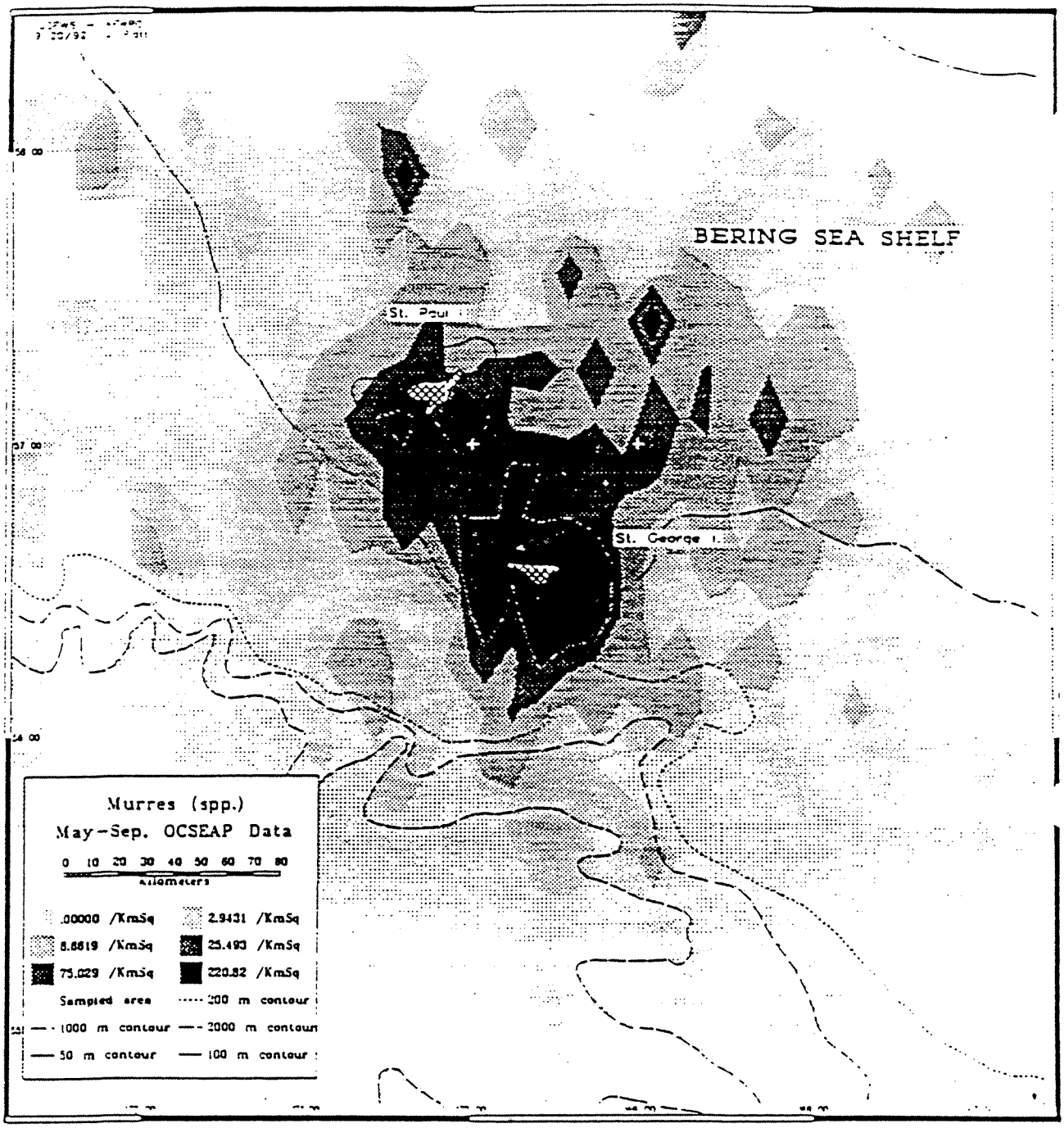

BERING SEA SHELF
St. Paul
St. George
All Seabirds, May-September
OCSEAP/USFWS Data
0 10 20 30 40 50 60 70 80
Kilometers
0 Birds/Km2q
0 - 8 /Km2q
8 - 60 /Km2q
60 - 450 /Km2q
450 - 3400 /Km2q
3400-26000 /Km2q
200 m contour
1000 m contour
2000 m contour

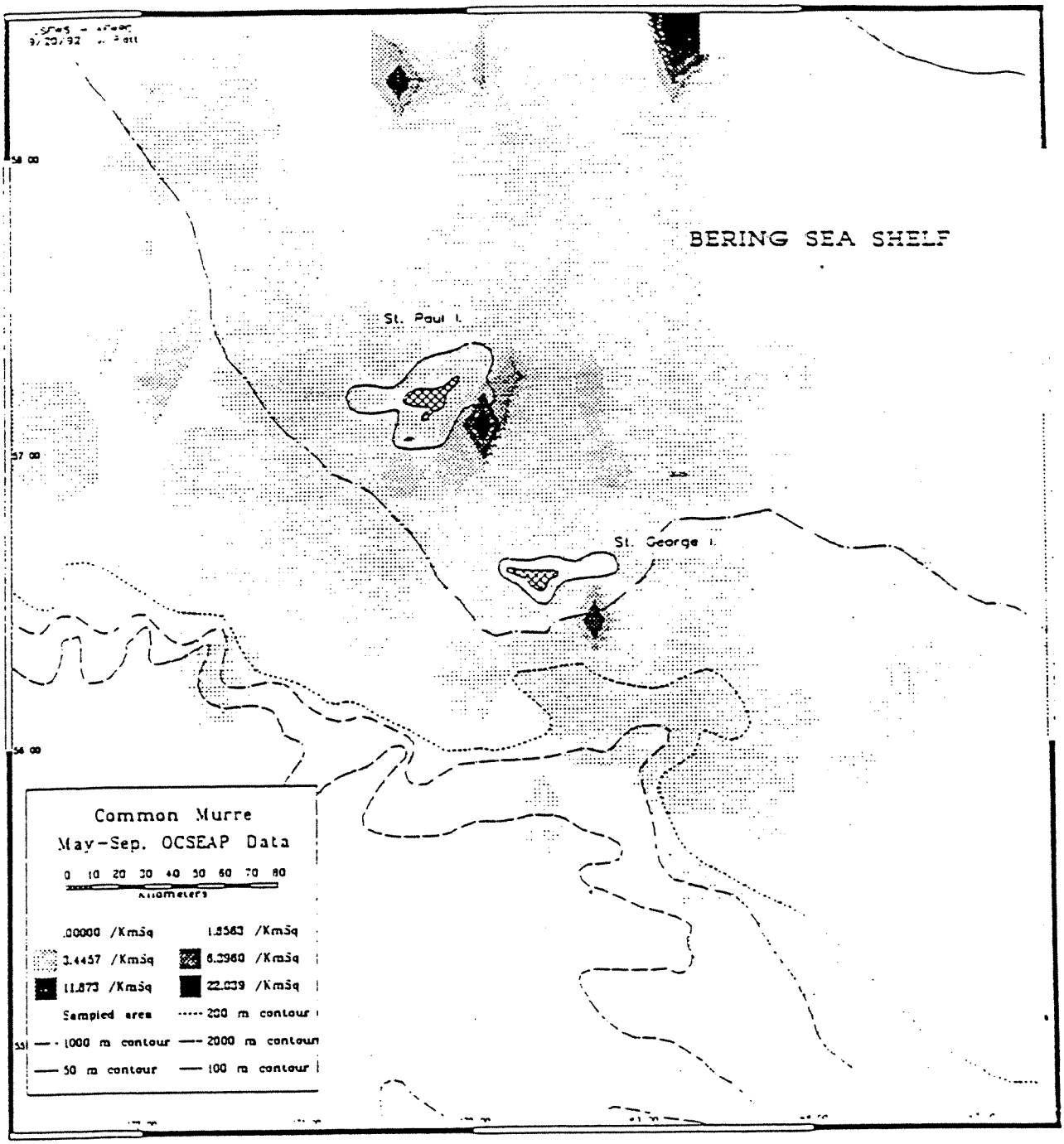

BERING SEA SHELF
St. Paul I.
St. George I.
Red-legged Kittiwake
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.8728 /KmSq
3.5110 /KmSq
6.5788 /KmSq
12.327 /KmSq
23.098 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour

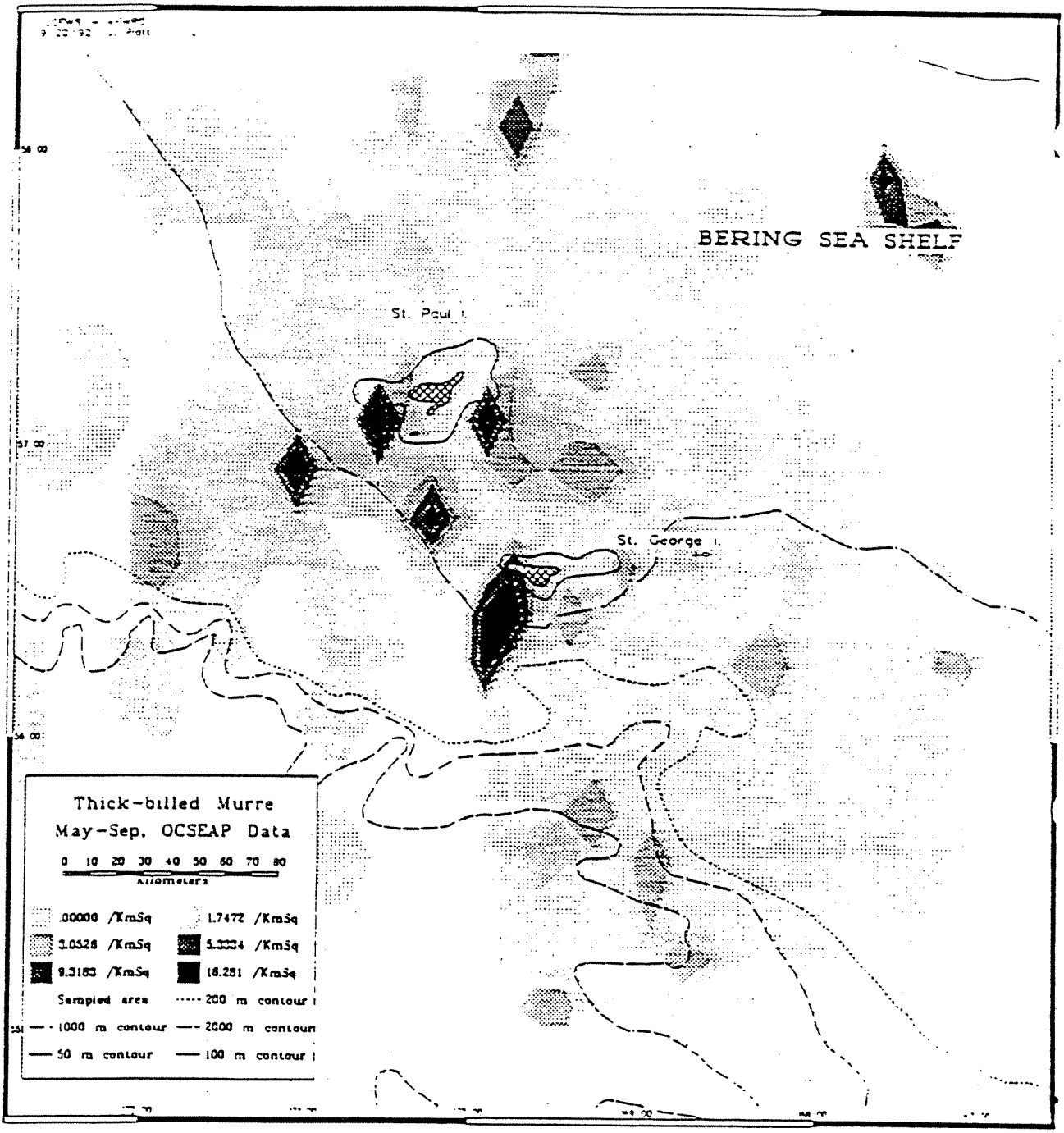

BERING SEA SHELF
St. Paul
St. George I.
Northern Fulmar
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
30000 /KmSq
9.4727 /KmSq
69.732 /KmSq
3.0778 /KmSq
29.155 /KmSq
278.17 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour

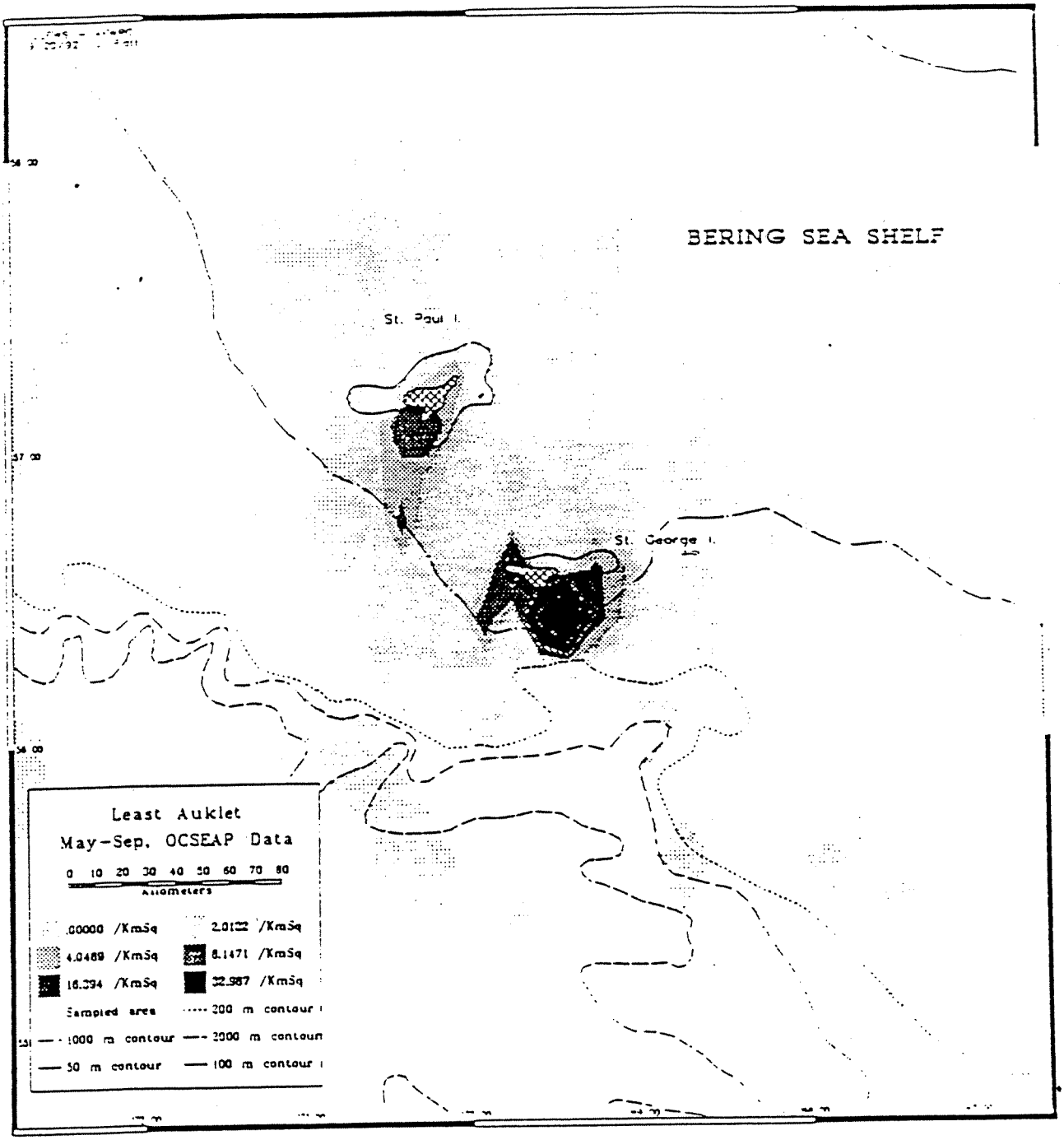

BERING SEA SHELF
St. Paul I.
St. George I.
Red-faced Cormorant
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.4548 /KmSq
2.1165 /KmSq
3.0791 /KmSq
4.4796 /KmSq
6.5170 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour

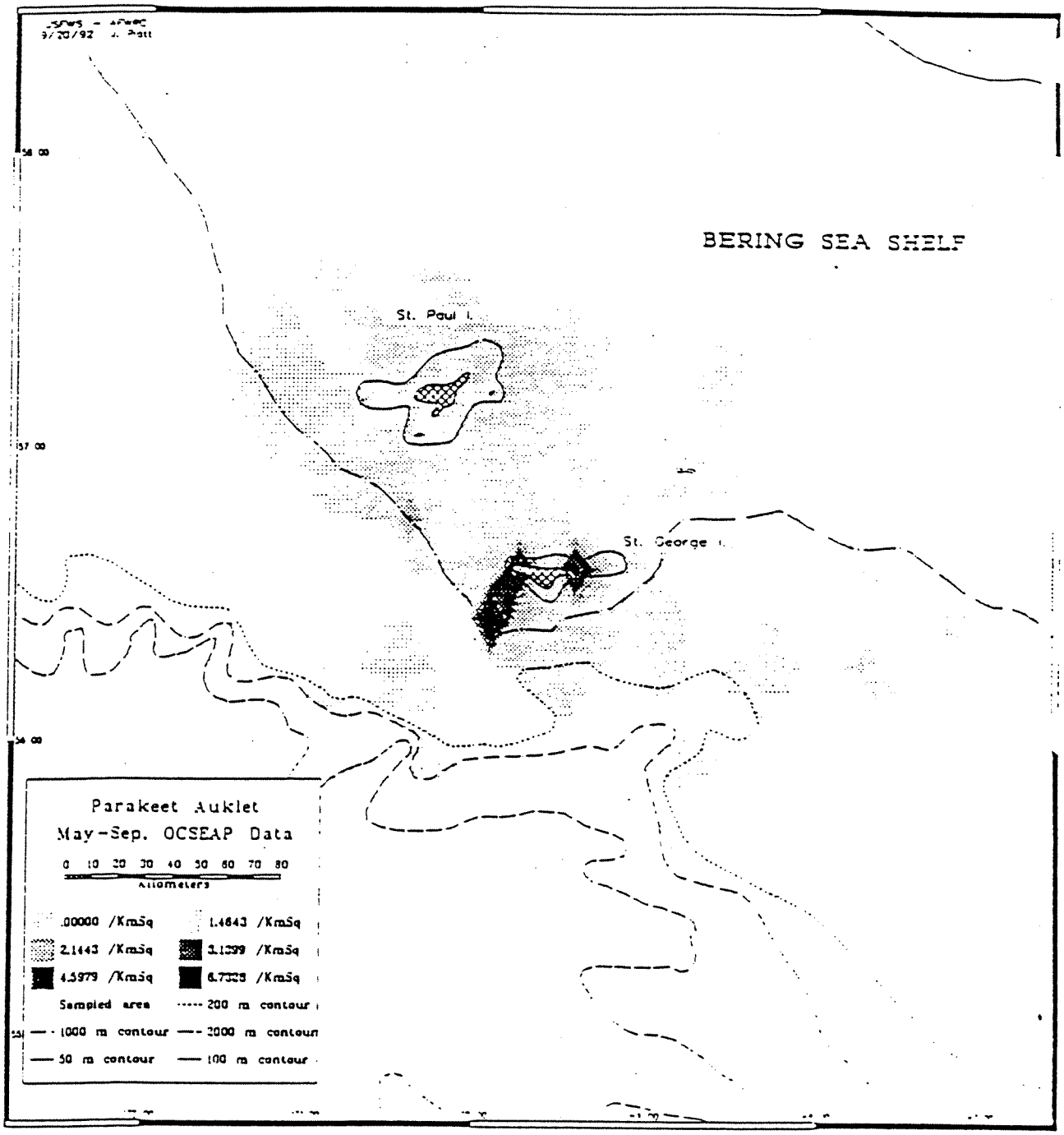

BERING SEA SHELF
St. Paul I.
St. George I.
Black-legged Kittiwake
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.7940 /KmSq
3.7735 /KmSq
18.581 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
100 m contour
50 m contour

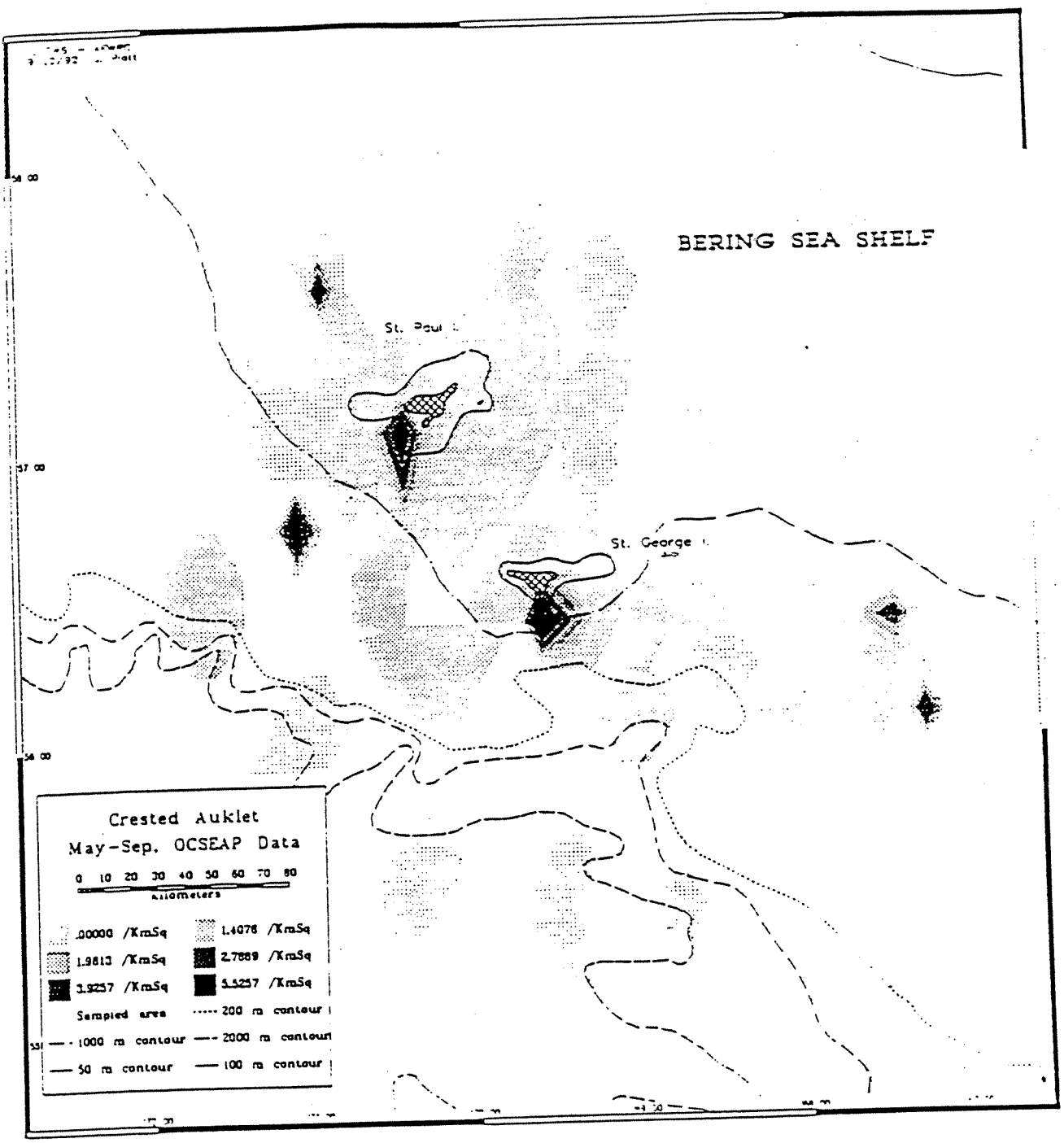

BERING SEA SHELF
St. Paul I.
St. George I.
Murres (spp.)
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
2.9431 /KmSq
8.8819 /KmSq
25.493 /KmSq
75.029 /KmSq
220.82 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour

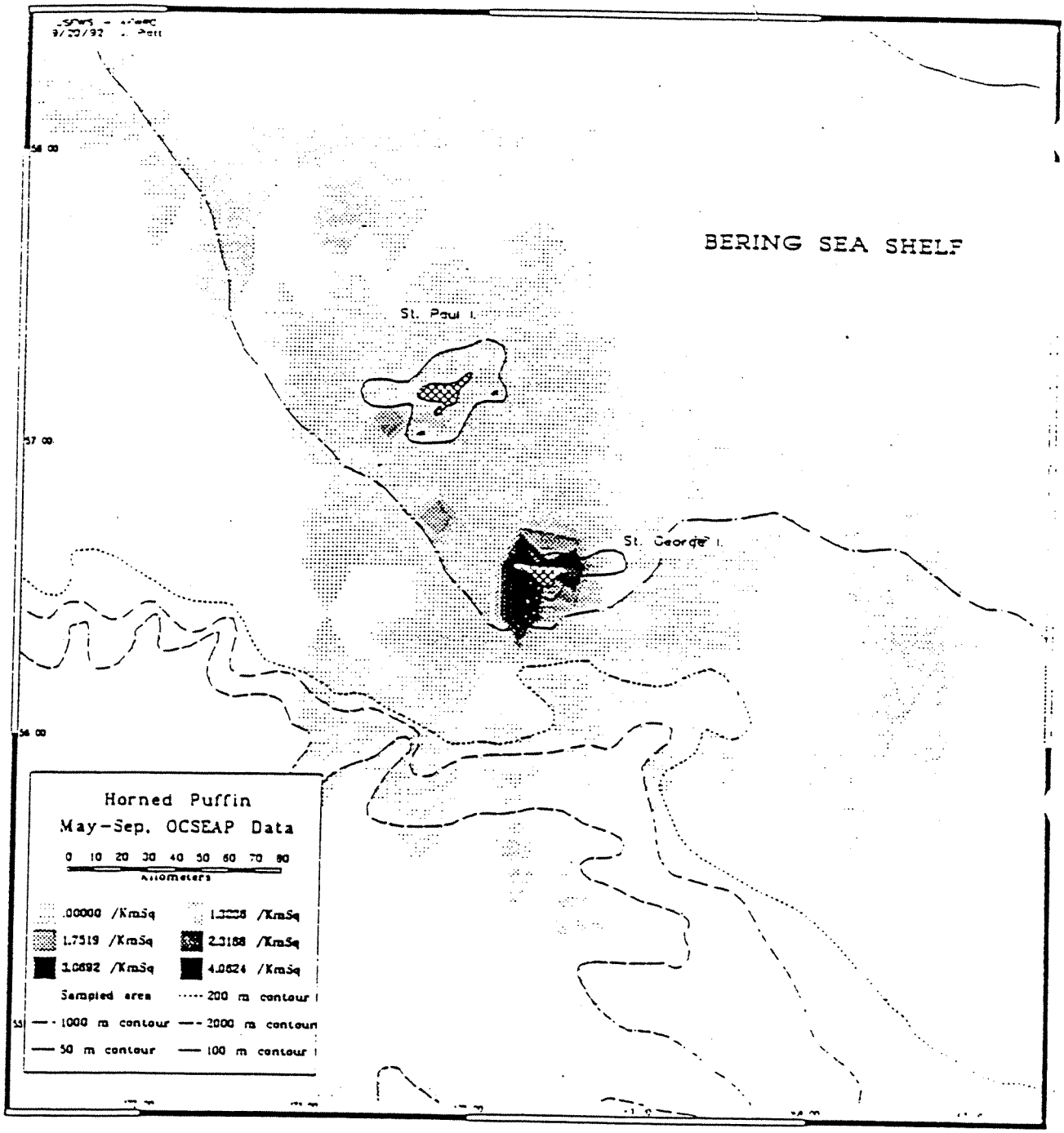

BERING SEA SHELF
St. Paul I.
St. George I.
Common Murre
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /Km2q
1.8563 /Km2q
3.4457 /Km2q
6.2960 /Km2q
11.873 /Km2q
22.039 /Km2q
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour


BERING SEA SHELF
St. Paul I.
St. George I.
Thick-billed Murre
May-Sep, OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.7472 /KmSq
3.0528 /KmSq
5.3334 /KmSq
9.3183 /KmSq
16.281 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour


BERING SEA SHELF
St. Paul I.
St. George I.
Least Auklet
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
2.0122 /KmSq
4.0489 /KmSq
8.1471 /KmSq
16.294 /KmSq
32.987 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour


9/20/92 J. Piatt
BERING SEA SHELF
St. Paul I.
St. George I.
Parakeet Auklet
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.4643 /KmSq
2.1443 /KmSq
3.1299 /KmSq
4.5979 /KmSq
6.7328 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour


BERING SEA SHELF
St. Paul
St. George
Crested Auklet
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.4078 /KmSq
1.9813 /KmSq
2.7889 /KmSq
3.9257 /KmSq
5.5257 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour


BERING SEA SHELF
St. Paul I.
St. George I.
Horned Puffin
May-Sep. OCSEAP Data
0 10 20 30 40 50 60 70 80
Kilometers
.00000 /KmSq
1.3228 /KmSq
1.7519 /KmSq
2.3188 /KmSq
3.0692 /KmSq
4.0624 /KmSq
Sampled area
200 m contour
1000 m contour
2000 m contour
50 m contour
100 m contour