MEMORANDUM

TO: Council and Board Members

FROM: Jane DiCosimo
Fishery Biologist

DATE: January 30, 2002

SUBJECT: Shark management

ACTION REQUIRED

(a) Status of Council amendment on sharks and skates.
(b) BOF proposal to allow spiny dogfish fishery in Cook Inlet.

BACKGROUND

(a) Status of Council amendment

A proposal requesting complementary federal action to a 1998 change in State management of sharks, skates, and rays in territorial waters of Alaska was initiated by the Alaska Board of Fisheries (Board). It was submitted by the Alaska Department of Fish and Game (ADF&G) to the Council during the July 1998 meeting of the Joint Committee of the Board/Council. Council staff recommends that the Council reschedule the original shark/skate analysis for final action in June or October 2002. Between 1999 and 2000, the Council had expanded the analysis to incorporate some larger issues related to other bycatch and non-target species upon advice from the staff, Groundfish Plan Teams, and Science and Statistical Committee. However, those larger issues will require a longer term solution. The original alternatives are as follows.

Alternative 1: No action.

Alternative 2: Separate sharks and/or skates from the "other species" category through the annual specifications process and enact federal regulations as specified by the Council.

Alternative 3: Amend the BSAI and GOA groundfish FMPs to separate sharks and/or skates from the "other groundfish" species category and defer management to the State of Alaska.

Alternative 4: Amend the BSAI and GOA groundfish FMPs to delete sharks and/or skates from the BSAI and GOA groundfish FMPs.

(b) Status of BOF proposal

The Board has been receiving industry proposals to reopen selected shark fisheries since its 1998 regulatory action to close the directed State commercial fishery for sharks and skates. ADFG comments on BOF Proposal 41 and public panel comments from the November 2001 Board meeting are presented in Attachment (b)(1). Board Proposal 41A (Attachment (b)(2)) was developed as a placeholder proposal for Board review at its March 2002 meeting while the Board consulted with the Council on reopening a hook and line fishery for spiny dogfish with a guideline harvest level of 500 mt in Cook Inlet.

The most comprehensive summary of sharks in the Gulf of Alaska was prepared by Ph.D. Candidate Ken Goldman, Virginia Institute of Marine Science, for the 2001 Ecosystems Consideration Chapter of the GOA Stock Assessment and Fishery Evaluation Report. An excerpt describing spiny dogfish biology is in Attachment (b)(3). Data from the commercial fisheries and efforts at assessing skates in the Gulf from Gaichas and DiCosimo (2001) are attached as Attachment (b)(4).

Spiny dogfish and four skate species in the Atlantic are overfished, and a precautionary approach to managing these species in Alaska is warranted. Trawl survey biomass estimates may be adequate for demersal species such as sleeper sharks and spiny dogfish. Longline surveys directed at halibut and sablefish may provide more insight into shark abundance in the BSAI and GOA. Spiny dogfish are found mostly in the GOA, and account for much of the aggregate shark biomass estimate there, but they are patchily distributed, resulting in potentially high variance in bottom trawl survey biomass estimates (similar to many rockfish species). Anecdotal information from the commercial industry reports large bycatches of spiny dogfish in the halibut and cod longline fisheries and salmon gillnet fishery, with expected (though unreported) high mortality rates.

The following is excerpted from the committee report prepared prior to the 1998 Board final action (Alaska Board of Fisheries 1998).

> "The committee reviewed available information regarding the life history and biology of sharks. Little information is available on Alaskan shark stocks. Available information for other shark stocks suggests that sharks are easily over-exploited and once over-fished take decades to recover. In the Atlantic Ocean, Dusky and Sandbar sharks have been over-fished and are considered depressed; in the Pacific Ocean, thresher and Pacific angel sharks have been over-fished and are considered depressed. These experiences suggest that a precautionary approach should be used to manage Alaskan shark fisheries.
>
> Experience in other areas has shown that shark fisheries, both commercial and recreational, can develop rapidly. . . The committee also discussed commercial shark fisheries. The committee recognized the potential for a rapidly developing directed commercial shark fishery to occur. Given this, the lack of biological information, and the current unknown current-"collateral kill" of sharks in other commercial fisheries, the committee recommends the Board closes the directed commercial fishery for sharks. To resolve the question as to the "collateral kill" of sharks, the committee recommends full reporting of sharks incidentally caught in other fisheries. The committee also realized that increased funds are necessary for this data collection. The committee suggests that the Board may wish to review these reporting requirements as part of a larger bycatch reporting issue. The Suggested Policy and Regulatory Changes for Development and Management of New and Recovering Commercial Fisheries in Alaska currently being developed may aid in this effort."

Caution is warranted in opening directed fisheries on long lived, slow growing, low reproducing species such as spiny dogfish. The proposed 500 mt harvest level for Cook Inlet should be examined in the context of the current statewide reported harvest. ADFG staff reports an approximate GHL to be 9-14 mt, based upon ADF&G trawl survey catches and a very low harvest rate.

PROPOSAL #41 - Establish a directed hook and line shark fishery and liberalize sport bag limits.

BACKGROUND:

- ADF&G submitted proposals (ACRs) in 1998 to provide for commercial shark fishing under a commissioner's permit and establish a statewide sport pelagic shark management plan.
- Proposals were amended by the BOF to close directed commercial shark fishing statewide and apply the sport plan to all sharks.
- Utilization and anti-finning regulatory language added in 2000.
- Shark harvest historically small. Little demand in sport fisheries for spiny dogfish.
- Reports of shark catch, especially spiny dogfish, may indicate high densities in localized areas.
- Department surveys, IPHC halibut longline surveys, and NMFS observer data suggest high annual and spatial variability in spiny dogfish abundance.
- Shark management in federal waters is currently being revised.
- Salmon sharks live to 25 years, mature between 6 and 10 years old. Females make up most of catch in the central Gulf of Alaska. Average length in the sport catch is 225 cm (89 in); most fish are 8-14 years old (n=166).
- Spiny dogfish live to 66 years, give birth to an average of 7 pups every 2 years. Age of sexual maturity estimates at between 20 and 35 years. Preliminary survey age data from PWS shows ages in the range 16-29 years (n=58).

DEPARTMENT CONCERNS

- Little new information available to support a directed fishery.
- Shark biomass unknown.
- Undocumented but reportedly high mortality on incidentally caught sharks.

Proposal #41 (continued).

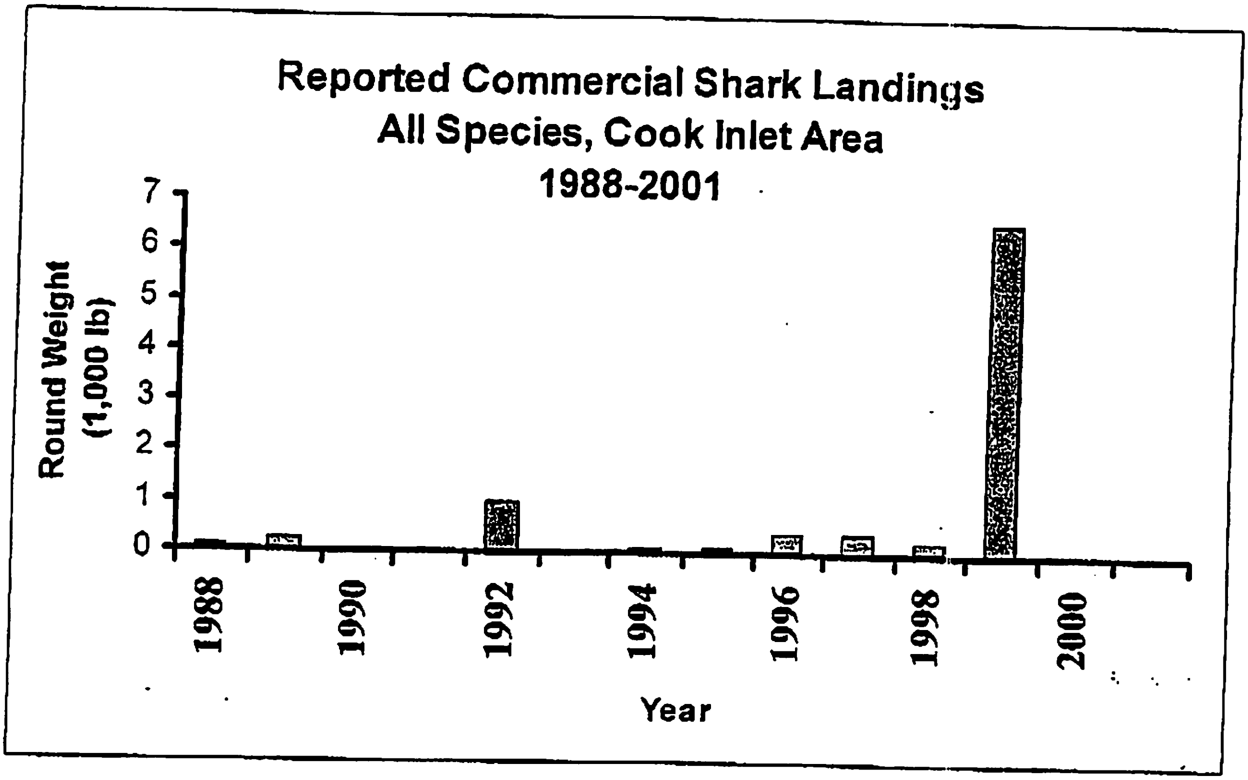

Figure 1. Shark landings reported by commercial fisheries in the Cook Inlet Area, 1988-2001.

Proposal #41 (continued).

SPORT HARVEST INFORMATION

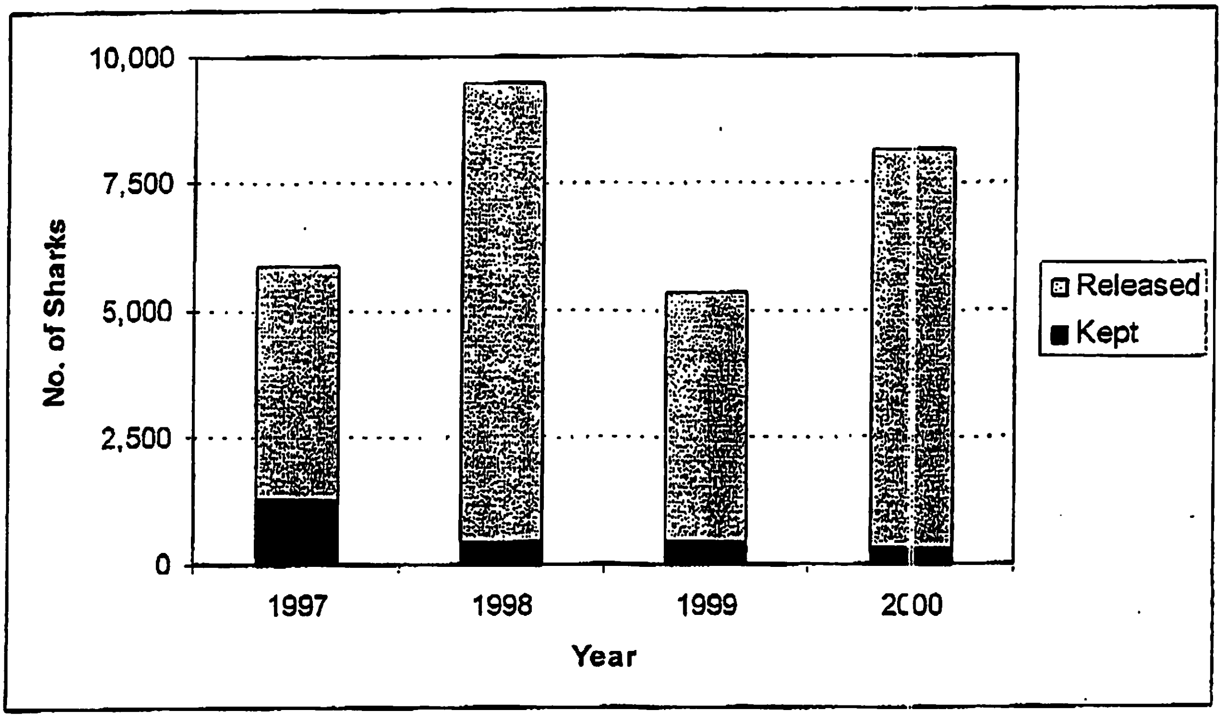

Figure 2. Estimated sport catch of sharks (all species) in the Cook Inlet-Resurrection Bay Regulatory Area, 1997-2000 (source is statewide harvest survey).

41C

Table 2. Harvest of spiny dogfish by anglers interviewed through on-site sampling at Deep Creek, Anchor Point, Homer, and Seward, 1998-2001.

Cook Inlet-ResBay Area wide	1998	1999	2000	2001	All Years
No. of anglers interviewed	7,648	10,292	10,117	9,558	37,615
No. of dogfish caught	746	239	1,313	2,810	5,108
Allowable harvest (assume 1 ea)	190	46	363	793	1,392
No. of dogfish kept	18	2	9	13	42
% of dogfish catch retained	2.4%	0.8%	0.7%	0.5%	0.8%
% of allowable harvest retained	9.5%	4.3%	2.5%	1.6%	3.0%

PROPOSAL 41. Page: 34 5 AAC 28.3XX COMMERCIAL SHARK FISHERY

WHAT WOULD THE PROPOSAL DO? The proposal would establish directed fisheries for sharks, permit retention and sale of sharks harvested incidentally to other directed fisheries, and liberalize existing bag limits for sport-harvested sharks.

WHAT ARE THE CURRENT REGULATIONS? Current commercial regulations prohibit directed fishing for sharks (5 AAC 28.084), allow sharks to be retained as bycatch up to allowable limits (20%), and require full utilization of sharks retained or sold. Additionally, 5 AAC 28.330 (b) allows retention of groundfish, including sharks, taken incidentally by drift or set gillnet gear during salmon or herring fisheries. Such retention would still be subject to bycatch limits. Sport fishing regulations include an annual limit of 2 sharks of any species and bag/possession limits of 1 per day and 1 in possession.

WHAT WOULD BE THE EFFECT IF THE PROPOSAL WERE ADOPTED? The proposal is very general and the proposed retention of sharks as bycatch is already permitted in regulation. Proposal adoption may enhance development of a commercial shark fishery. However, few sharks are currently retained as allowed under current regulations. Additionally, the extent to which liberalization of shark harvest regulations might facilitate rebuilding of salmon and marine mammal resources is unclear.

BACKGROUND: A 1997 board proposal to allow commercial shark fishing only under conditions of a department permit was amended and adopted as a statewide closure of the directed fishery. Prior to this closure, commercial efforts to target sharks in Cook Inlet were sporadic and yielded only limited harvests, primarily for salmon sharks. Although few sharks have been retained, fishermen report that the catch of sharks, especially spiny dogfish, can be quite high, approaching nuisance levels in some areas. For example, numerous fishermen explained shifting fishing areas due to the prevalence of sharks along the outer Kenai Peninsula. The catch of Pacific sleeper sharks has also increased in recent years. Fish ticket data focus on delivered catch and are notably limited when describing at-sea discards. However, the department conducted a longline survey for sablefish in Cook Inlet during 1999 and 2000 and in Prince William Sound during 1996-2001. Survey data suggest spiny dogfish were abnormally abundant in 1998, although the high relative abundance observed in 1998 appears to have been an anomaly. Survey catches of Pacific sleeper shark showed substantial variability but were <4% of all catches in Prince William Sound and <1% of catches along the outer Kenai Peninsula.

DEPARTMENT COMMENTS: The department does not support developing a directed commercial shark fishery because little new biological information has become available since the directed fishery was closed in 1998. Data that might be used to develop a management plan, such as stock structure, biomass and abundance levels, existing fishing mortality, and ecological linkages, are lacking. Because few sharks are currently retained as allowed under current regulations, interest in shark fisheries does not appear related to increased market demand, but instead to hook competition with target species. In the absence of a clear understanding of the complex relationships between different components of the marine ecosystem, particularly when some marine species are listed as threatened or endangered, the department will not support removal and wastage of specific ecosystem components.

PROPOSAL 41, 5 AAC 28.3XX COMMERCIAL SHARK FISHERY

Staff Reports: RC 2, tab 5.

Staff Comments: RC 3, Page 20; RC 8, Page 48-50.

AC Reports: RC 1,
Advisory Committee Comment Tab

Timely Public Comments:
Public Comment Tab

Record Comments: RC 19, RC 20

Narrative of Pro's and Con's:

Public panel members believed that a directed commercial fishery for salmon sharks would best occur in Prince William Sound. Reasons cited included the higher abundance in PWS and the desirability to service a high priced/low volume market. Some panel members believed that there was not sufficient salmon shark biological information available. There was no support expressed for a directed Pacific sleeper shark fishery. Deliberation materials demonstrated little demand in the sport fishery for spiny dogfish. At the end of this discussion, there was consensus that if any commercial fishery were to be established in lower Cook Inlet it should strictly limited be limited to spiny dogfish.

Some public panel members expressed support for a commercial spiny dogfish fishery due to the increased abundance and its place as a "higher trophic-level" predator impacting more commercially valuable species. There is a prevalent belief among the public panel participants that dogfish biomass is quite high and can sustain a low-level harvest. A desire was expressed for additional opportunities for commercial fishermen due to declines in other commercial fisheries and markets. Other public panel members expressed concern for a lack of dogfish data to justify a commercial fishery, the need for a conservation-based management plan with built-in protections for dogfish, and the potential for rockfish and halibut bycatch in a directed hook and line shark fishery. Fishery proponents supported the need for a fishery management plan.

Staff discussed inability to define stock biomass with only a few years of data. Staff also provided additional information on dogfish distribution and abundance that suggested the apparent increases were related more to shifts in distribution rather than a dramatic increase in stock abundance. Board committee indicated a desire for: information on a sustained, large-scale dogfish fishery; and the need for submission of an RC that detailed management plan components.

POSITIONS AND RECOMMENDATIONS

Public Panel Recommendation: No consensus.

PROPOSAL 41A – 5 AAC 28.3XX. COOK INLET AREA SHARK FISHERY MANAGEMENT PLAN. Establish a hook and line fishery for spiny dogfish shark, *Squalus acanthias.*

(a) Permit requirements: A miscellaneous groundfish permit, as specified in 5 AAC 28.379, is required in addition to a miscellaneous finfish CFEC interim use permit.

(b) Minimum acceptable biomass level is unknown at this time. This fishery will generate data needed as a component of an ABC model. Since this will be the only directed hook and line shark fishery in the state waters of the Gulf of Alaska and this species is highly mobile, the entire biomass of the area can be included as the basis of this guideline harvest level.

(c) Maximum allowable exploitation rate is unknown at this time. The guideline harvest level is intended to be conservative, based on the biology and observed density of the species.

(d) Guideline harvest level tentatively is set at 500 mt. This equates to 11 to 12 vans of product at a 42 percent meat recovery rate. This amount is estimated to be practical in creating processor interest for pursuing a viable market.

(e) Fishing seasons – year-round, which allows integration with bycatch of other hook and line fisheries within the same habitat type.

(f) Gear restrictions – Hand or mechanical jig and longline.

(g) Vessel restrictions – None.

(h) Reporting requirements – The miscellaneous groundfish permit may stipulate:
Logbooks – information required using same format as IPHC halibut logbook
All discards must be estimated and reported by species
Discards of dogfish must be recorded by sex and estimated size
Notification of the department upon initiation of a directed shark trip
No overboard crucifiers are allowed onboard vessel

(i) Potential user group conflicts – None.

(j) Ecosystem function of target and nontarget species – Dogfish are a top of the food chain predator. Their diet predominates with bony fish including juvenile salmon, herring, capelin, and additionally crustaceans, octopus, squid, et al. Dogfish migrate in large, densely-aggregated schools and have been observed feeding as a pack (origin of the name dogfish). The impact of the large increase in the dogfish population in the Cook Inlet area on forage base for other resident species is unknown. Salmon shark is a known predator of dogfish though not listed as a major component of its diet.

(k) Customary and traditional use patterns – None known at this time.

BOARD ACTION: Defer to March 2002 meeting, after consultation with NPFMC

Sharks and shark bycatch in Alaska State and Federal waters

Contributed by: Kenneth J. Goldman, Elasmobranch Ecology Program,Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062 e-mail: keng@vims.edu

Sharks species in Alaska waters

Sharks exhibit a life history strategy characterized by slow growth, late maturity, low fecundity and, therefore, extremely low intrinsic rates of population increase (Holden 1974 and 1977, Hoenig and Gruber 1990). This fact, in combination with heavy exploitation rates and a lack of management, has led to rapid stock declines and fishery failures worldwide (Compagno 1990, Hoff and Musick 1990, Castro et al. 1999). Successful conservation and management of salmon sharks in Alaska waters begins with knowledge of basic life history parameters such as growth rates, age at maturity and longevity.

A modest array of nine or ten shark species may occur in Alaska waters (Camhi 1999). The three most abundant species are spiny or piked dogfish (*Squalus acanthias*), Pacific sleeper (*Somniosus pacificus*) and salmon sharks (*Lamna ditropis*). Other species include blue (*Prionace glauca*), sixgill (*Hexanchus griseus*) and tope or soupfin sharks (*Galeorhinus galeus*).

Spiny dogfish

Spiny dogfish are possibly the most abundant shark species in the world and the only one that has supported a large and long-term fishery comparable to many teleost fishes (Compagno 1984, Bonfil 1999, Castro et al. 1999). They are cosmopolitan and widely distributed in the North Atlantic and Pacific, as well as around the southern tips of South America, Africa, Australia and New Zealand (Compagno 1984). In the North Pacific, they range from 30°N-65°N latitudeon the western side and from 23°N-65°N on the eastern side (Eschmeyer et al. 1983, Compagno 1984). Along the eastern North Pacific they are most abundant off Washington-and British Columbia (BC) where there has been an active fishery for over 126 years (Bonfil 1999). Maximum size in the eastern North Pacific is around 150 cm total length, and maximum weight is approximately 9kg (Hart 1973, Compagno 1984). They are typically found in waters ranging from 6°C to 15°C and have a depth distribution from shallow nearshore waters to a depth of 900m. They are highly gregarious, forming extremely large, localized (and yet highly mobile) schools that tend to be of uniform size and sex (Compagno 1984, Castro et al. 1999).

Usually coastal and demersal, spiny dogfish migrate north and south as well as nearshore and offshore. These movements are not fully understood, but appear to be tied to water temperature and prey availability. The stock structure of spiny dogfish in the eastern North Pacific is unknown. The current belief is that there is a coastal stock residing in the Strait of Georgia-Puget Sound area and an offshore stock that extends from Alaska to Baja California, Mexico (Ketchen 1986, Bonfil 1999). This hypothesis is based on short-term tag-recapture data and geographic differences in mercury levels found in tissues, however no population genetics study has been initiated to examine stock structure. Several long-term tag-recaptures of spiny dogfish from the eastern North Pacific have demonstrated long-ranging movements to central Baja California, Mexico and to Japan (Bonfil 1999, Compagno 1984), but the degree of trans-Pacific movements is probably insignificant (Ketchen 1986).

Spiny dogfish have an aplacental viviparous mode of reproduction. They possess the longest known gestation period of any vertebrate, with estimates ranging from 21 to 25 months (Castro et al. 1999). Size at parturition is 22 to 25cm total length. Litter sizes range from 1 to 20 with an average of 6 and a sex ratio of 1:1 (Compagno 1984, Weber and Fordham 1997, Castro et al. 1999). Mating occurs during the winter months (Ketchen 1972, Compagno 1984, Nammack et al. 1985, Saunders and McFarlane 1993). In several geographic areas, mature dogfish are often found in more inshore waters while immature individuals predominate in offshore waters.

Estimates of age and length at maturity and longevity vary considerably with geographic location (Nammack et al. 1985, McFarlane and Beamish 1987, Weber and Fordham 1997). Historic estimates of the age at 50% maturity for the eastern North Pacific range from 20 to 34 years. However, ages from the spines of oxytetracycline (OTC) injected animals provided validation of an age-length relationship and indicate that 50% sexual maturity occurs at 35.3 years of age (Beamish and McFarlane 1985, McFarlane and Beamish 1987). The same study also showed that longevity in the eastern North Pacific is between 80 and 100 years, and stated that several earlier published ages at maturity (and therefore longevity) were lower due to the rejection of difficult to read spines and the grouping of annuli that were very close together. This is one of the few shark species where validation using OTC has been completed, and it demonstrates the need to do so whenever possible (Cailliet 1990).

Spiny dogfish are opportunistic and adaptable in their feeding behavior. The majority of their diet is teleost fishes such as herring (and other clupeids), smelt (*Osmeridae*), hake (*Merluccius*), pollock and tomcod (Gadidae), sandlance (*Ammodytes*), flatfishes (*Pleuronectiformes*), lingcod (*ophiodon*) and salmon (*Oncorhynchus*). They also prey on mollusks, cephalopods and crabs (Hart 1973, Eschmeyer et al. 1983, Compagno 1984). Along the North American west coast spiny dogfish have shown a strong association with hake and with several other species of groundfish including sablefish (*Anoplopoma fimbria*), arrowtooth flounder (*Atheresthes stomias*), yellowtail rockfish (*Sebastes flavidus*) and walleye pollock (*Theragra chalcogramma*) (Bonfil 1999).

Shark bycatch in the central Gulf of Alaska and Prince William Sound

Successful conservation and management of sharks in Alaska waters requires knowledge of their basic life history parameters such as growth rates, age at maturity and longevity, and an understanding of their demographics and movements. Most shark population studies have been implemented after or during heavy stock depletion (Hoff and Musick 1990, Compagno 1990). Hence, Alaska finds itself in a unique situation: having the ability to gain an understanding of the basic biology of its shark species and to provide information essential to guiding management and conservation before stock collapse. The commercial fishing potential of these species can also be examined.

There are currently no directed commercial fisheries for sharks in Alaska state or federal waters. The state prohibited directed commercial fishing for sharks in 1998 and set limits for the modest sport fishery that currently exists (2 sharks per person per year, 1 on any given day). This made Alaska the first state ever to implement precautionary management before allowing a commercial fishery or large sport fishery to develop (Camhi 1999). Additionally, the North Pacific Fishery Management Council (NPFMC) is in the process of developing a management program for sharks (and skates) in Alaska's federal waters (an EA/RIR has been drafted). Despite these management efforts, shark landings in Alaska's fisheries are nearly as high as the combined shark landings for California, Oregon and Washington (Camhi 1999). The bycatch of elasmobranchs appears to be very high in Alaska's groundfish and other fisheries, and the majority (up to 90%) of this bycatch is discarded (Fritz 1998, Camhi 1999). Much of the catch and landing data for sharks in Alaska is not useful for assessing relative abundance because species are lumped into a single category of "shark". However, in recent years the National Marine Fisheries Service

(NMFS) Groundfish Observer Program, the International Pacific Halibut Commission (IPHC) and the Alaska Department of Fish and Game (ADF&G) have begun to document their shark catch by species making preliminary estimates of relative abundance possible. The NMFS Observer database contains estimated weights (in tons) for species, while the IPHC and ADF&G databases contain data on shark bycatch from fishery-independent halibut and sablefish surveys respectively.

Sources of bycatch data

This report uses fisheries dependent and independent shark bycatch data collected by the agencies listed above. It includes 11 years of commercial fisheries catch data from the NMFS Groundfish Observer Program, 8 years of data from the IPHC halibut survey and 5 years of data from ADF&G sablefish survey. Assessing the abundance of shark species (particularly using short-term data series) is best done with a cautious and conservative approach. This allows the most productive use of the available data and is of particular importance with the data used herein. A brief description of each agency's data set used herein and their collection methods follows.

The NMFS data are currently being summarized by NMFS (and here) as two data series (1990-1996 and 1997-2000) because of differences in how data were assigned to a groundfish target fishery, which determines how observed catch is scaled up to estimate total catch (catches presented herein represent total bycatch). Gear used by target fisheries includes longlines, pots, pelagic and bottom trawls. Catch is summed across gear types in this report, however it should be noted that bottom trawls and longlines were responsible for the majority of sleeper shark and spiny dogfish bycatch while pelagic trawls caught most of the salmon sharks. The 1990-1996 data were assigned to a target fishery based on total catch weight of allocated species in individual hauls, while 97-00 observer data were assigned to a target fishery based on the retained catch weight of allocated species for an entire week on an individual vessel, gear type and area combination. The latter method is how the Regional NMFS Office assigns target species and is believed to be more accurate. Therefore, these data sets are cautiously comparable; one potential problem being that mismatches in target fisheries may result in inappropriate estimates (S. Gaichas pers. comm.). Additionally, trends in catch may not necessarily reflect trends in CPUE, however, these data are worth examining in their current form. Effort is currently being estimated for the various target fisheries, gear types and areas, so that CPUE can be calculated, allowing a better look at shark bycatch and relative abundance. It is important to remember that differences in catch can be driven by numerous factors including changes in target fishery effort within and across statistical areas, gear types used in different target fisheries and areas, and the catchability of different gear types and vessels.

The IPHC conducts an annual standard station halibut longline survey (6 skates per set, 100 hooks per skate). The 8 years of bycatch data are summarized herein as 2 data sets (1993-1996 and 1997-2000). Comparison problems stem from changes in the method of data collection and a drastic change in the identification of sharks to species vs. non-species specific identification (lumped into a "shark" or "unidentified shark" category). Between 1993 and 1996, every hook was observed as they came from the water while from 1997 to 2000 (and currently) 20 hooks per skate were sub-sampled (120 hooks per skate) in a non-random manner. Observations were usually made on the first 20 hooks from each skate, however, other times the 20-hook sub-sample began at a haphazard point in a skate. Even under the (likely valid) assumption that the catchability is equal for all hooks on a skate, it is questionable whether these methods are comparable. For example, the non-random sub-sampling method does not allow a variance to be calculated, and attempts to do so would almost certainly underestimate the true variance. The IPHC is currently conducting field studies and statistical analyses to examine this question (H. Gilroy pers. comm.). The geographical area surveyed also expanded around this time. In addition to the change in their sampling method, 18.5% of the sharks caught between 1993 and 1996 were categorized as "unidentified shark" compared to only 0.4% between 1997 and 2000. Therefore, catch per unit effort (CPUE) calculations for the 1993 to 1996 data set underestimate the real CPUE for those surveys. As with the NMFS data set, the IPHC data are cautiously comparable.

The ADF&G sablefish longline survey, conducted in Prince William Sound (PWS), has been documenting shark bycatch since 1996. While the survey methods have not changed (~675 hooks per set), the areas sampled within PWS are not the same for every year of the survey. Therefore, these data cannot be analyzed in a single time series. In 1996, only the northwest area of the sound was surveyed. In 1997 and 1999, the northwest and southwest areas of the sound were surveyed, while in 1998 and 2000 the northwest and eastern areas of PWS were surveyed. Therefore, there are only two sets of directly comparable data in this series (1997 to 1999, and 1998 to 2000). However, these data will soon be further 'broken down' so that relative abundance in the northwest area of PWS can be analyzed.

Seven shark species appear in the bycatch data, however catch of blue (*Prionace glauca*), sixgill (*Hexanchus griseus*), soupfin (*Galeorhinus galeus*) and brown catsharks (*Apristurus brunneus*) are nominal. As such, this report will focus on the spiny dogfish (*Squalus acanthias*), the Pacific sleeper shark (*Somniosus pacificus*) and the salmon shark (*Lamna ditropis*).

Spiny dogfish

Recent summaries of fisheries survey data (including the IPHC and ADF&G data shown here) have been reported to indicate that a dramatic increase in spiny dogfish abundance in the GOA and PWS has occurred since the early 1990's, and anecdotal information has been stated to support this claim (Hulbert 2000). However, no statements were made about the nature of these data, the changes in methodology that occurred through the years of sampling, addition of sampling areas or the discrepancy in the number of unidentified sharks reported in one data set vs. another. These are all critical factors to consider in attempting to accurately access shark abundance in Alaska. It is important to note a clear distinction between density and stock abundance. Fluctuations in the density of spiny dogfish in particular areas does not necessarily mean that the stock abundance is increasing or decreasing at a rapid rate, as exemplified by the population off of British Columbia, Canada, (Bonfil 1999).

<u>NMFS GOA Area 630</u>

The NMFS Observer data from 1990 to 1996 are shown in Figure 1a. The data from Area 630 had a maximum catch of 322t (tons) in 1993, a minimum catch of 103t in 1995 and the average catch over these years was 195t. The catch varies widely during this time. This degree of fluctuation in catch is not uncommon for a mobile species with a patchy distribution and offers little information on changes in spiny dogfish abundance.

The 1997 to 2000 data series had a maximum catch of 266t in 1997, a minimum of 148t in 2000, and the average catch over these years was 211t (Figure1b). The catch slightly decreased each subsequent year in the series. If viewed as one continuous time series, and effort is assumed to be relatively constant, the declining catch suggests a decrease in spiny dogfish abundance since 1996. However, the mean catch for both data series is very close (195t between 1990-1996 and 211t between 1997-2000), which may indicate that spiny dogfish have a relatively stable abundance in NMFS Area 630.

NMFS GOA Area 640

Area 640 had a considerably smaller amount of catch than Area 630 (Figure 1). Between 1990 and 1996 the maximum catch was 23t in 1996, the minimum catch was 1.8t in 1992 and the average catch over these years was 8.5t (Figure 1a). There was an extremely small increase during this time. From 1997 through 2000, the Area had a maximum catch of 576t in 1998, a minimum catch of 38.8t in 1999 and the average catch over those years was 185.3t (Figure 1b). The peak catch in 1998 was also a high catch year for the majority of surveys and survey areas in all data sets. (If 1998 is excluded, the mean catch becomes 55.6t yr^{-1}). Potential causes for this large increase are briefly touched on later, but determining what might cause such an increase would require lengthy investigation. The high variability in catches prevents any conclusion from being reached regarding changes in relative abundance of spiny dogfish in Area 640 between 1997 and 2000. If the two data sets are assumed to be comparable and are viewed as one continuous time series then it would appear that there has been a nominal increase in spiny dogfish bycatch in Area 640 since 1990.

NMFS GOA Area 650

Area 650 had similar catch amounts to Area 640, showing fairly consistent levels of catch (Figure 1). Between 1990 and 1996 the maximum catch was 33.6t in 1994, the minimum catch was 5.6t in 1993 and the average catch over those years was 20.3t (Figure 1a). From 1997 through 2000, the Area had a maximum catch of 334.7t in 1997, a minimum catch of 26.1t in 1998 and the average catch over those years was 140.7t (Figure 1b). This was one of the few Areas in which 1998 did not have the highest catch amount, but (in fact) the smallest amount of catch. The fluctuations from 1997 through 2000 do not appear to indicate any significant increase in spiny dogfish in Area 650 during these years. If the two data sets are viewed as one continuous time series, it would appear that Area 650 has had a small increase in the abundance of spiny dogfish since 1990. Two things that stand out from the data from these three Areas are that Area 630 consistently has the highest catch of spiny dogfish and that there is a decrease in spiny dogfish catch moving across the GOA from Area 630 to 650. The eastern GOA is closed to trawling making longlines the dominant gear used, so the low catch observed here (and possibly Area 640) could be an artifact of allowable gear types.

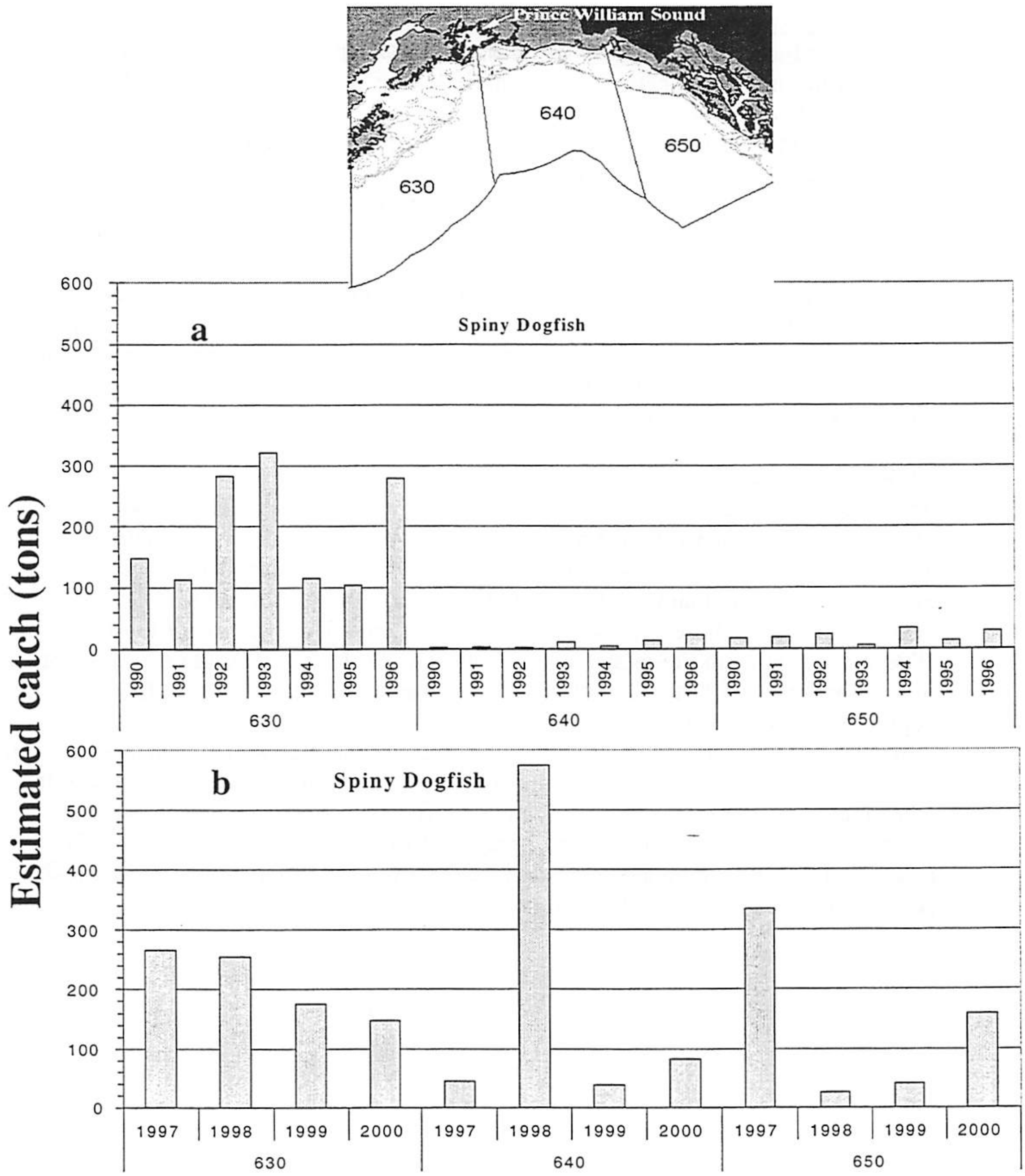

Figure 1. Spiny dogfish bycatch in the central GOA (from the NMFS Observer Program).

IPHC Statistical Areas 240, 250 and 260

These three IPHC statistical Areas encompass roughly ½ of NMFS Area 630 (note – all other IPHC Areas within NMFS 630 had shark bycatch that is not presented in this report). Between 1992 and 1996, the CPUE in these Areas ranged between 0.8 and 11.8 sharks per 100 hooks (catch per unit effort hereafter will always mean the "number of sharks per 100 hooks") (Figure 2a). The CPUE was nominally different across these Areas during these years. Between 1997 and 2000, CPUE ranged from 5.3 to 23.9 (the peak year being 1998 – Figure 2b). The CPUE decreased by almost half in Area 240 during this time, but was fairly constant in Areas 250 and 260. Overall these three Areas show a relatively constant CPUE from 1997 through 2000 (Figure 2b). If the two data sets (93-96 and 97-00) are viewed as one continuous time series, it could be suggested that spiny dogfish abundance has about doubled in these Areas since 1993. However caution should be used in making this assessment because of the substantial discrepancy between data sets in the number of unidentified sharks and the changes in data collection methods previously mentioned. The discrepancy in the number of unidentified sharks in the early data series means that CPUE in these years underestimates the actual CPUE (by how much is under investigation).

IPHC Statistical Areas 185 to 230

Survey Areas 185, 190, 200, 210, 220 and 230 did not appear in this author's copy of the IPHC 1993 to 1996 data set. Data from these Areas (for 1996) will be obtained and included in the overall analysis soon, however, comparisons will not be made here. (In 1996-97, the survey expanded to cover new Areas from the Hinchinbrook entrance to Cape Spencer). However, IPHC Areas 210, 220 and 230 cover virtually the same area as NMFS Area 640 and IPHC Areas 185, 190 and 200 are encompassed by NMFS Area 650. As previously stated, trends in catch may not necessarily reflect trends in CPUE, but it is worth examination. Similarities in trends would not necessarily mean agreement between them and dissimilar trends would not necessarily mean disagreement. The nature of the data (fisheries dependent and independent) and other factors involving sampling design and gear types would need to be considered in detail prior to making any conclusions. Catch per unit effort estimates for the NMFS data are being calculated in order to better compare all data.

The CPUE for Areas 185 through 230 (from 1997 to 2000) ranged from 7.8 to 37.5 sharks per 100 hooks (Figure 2b). Area 185 shows almost a doubling in CPUE in 4 years, beginning in 1998 (which was not the peak year). The other Areas also showed relatively large increases in CPUE for 1998 and then dropped again in 1999 and appear to have randomly fluctuated up and down over the rest of the period. Aside from 1998, there appears to be a variable yet level amount of spiny dogfish bycatch on the IPHC survey in Areas 185 through 230. All years included, it may be that a combination of the patchy distribution of spiny dogfish, their gregarious mobile behavior and their associations to several prey species are playing significant roles in a given year's catch. The abundance and distribution of those prey species relative to the dogfish abundance and distribution needs thorough investigation.

Areas 190 through 230 had a consistently higher CPUE than Areas 185, 240, 250 and 260 and may indicate a slight increase in abundance moving east across the GOA (to Area 185). This is somewhat in contrast to the NMFS data that shows an increase in bycatch moving west across the GOA (Figure 1). However, the NMFS Observer Program data do reflect the IPHC data in that no consistent increase in spiny dogfish abundance appears to have taken place in the central GOA over time.

ADF&G and IPHC PWS Areas

As stated earlier, ADF&G has been documenting their shark bycatch in PWS since 1996 (Figure 3a). In 1996, only the northwest Area of the sound was surveyed. In 1997 and 1999, the northwest and southwest Areas of the sound were surveyed, while in 1998 and 2000 the northwest and eastern Areas of PWS were surveyed. Therefore, there are only two sets of directly comparable data in this series (1997 and 1999, and 1998 and 2000). This survey shows a decrease in spiny dogfish CPUE for both directly comparable Areas. Again we see that 1998 was a "banner year" for spiny dogfish on this survey. This, as well as any possible meaning of the relative drop from 1998 to 2000 for the northwest and eastern portions of PWS should not be over-analyzed. It is extremely difficult to conclude anything about the high CPUE for 1998 at this point in time. The IPHC data for PWS shows an overall higher CPUE than those from ADF&G, but aside from IPHC station 4138 (in 1998) the CPUE was never higher than 4.2 in any area surveyed and appears relatively small and similar in each comparable Area (Figure 3b).

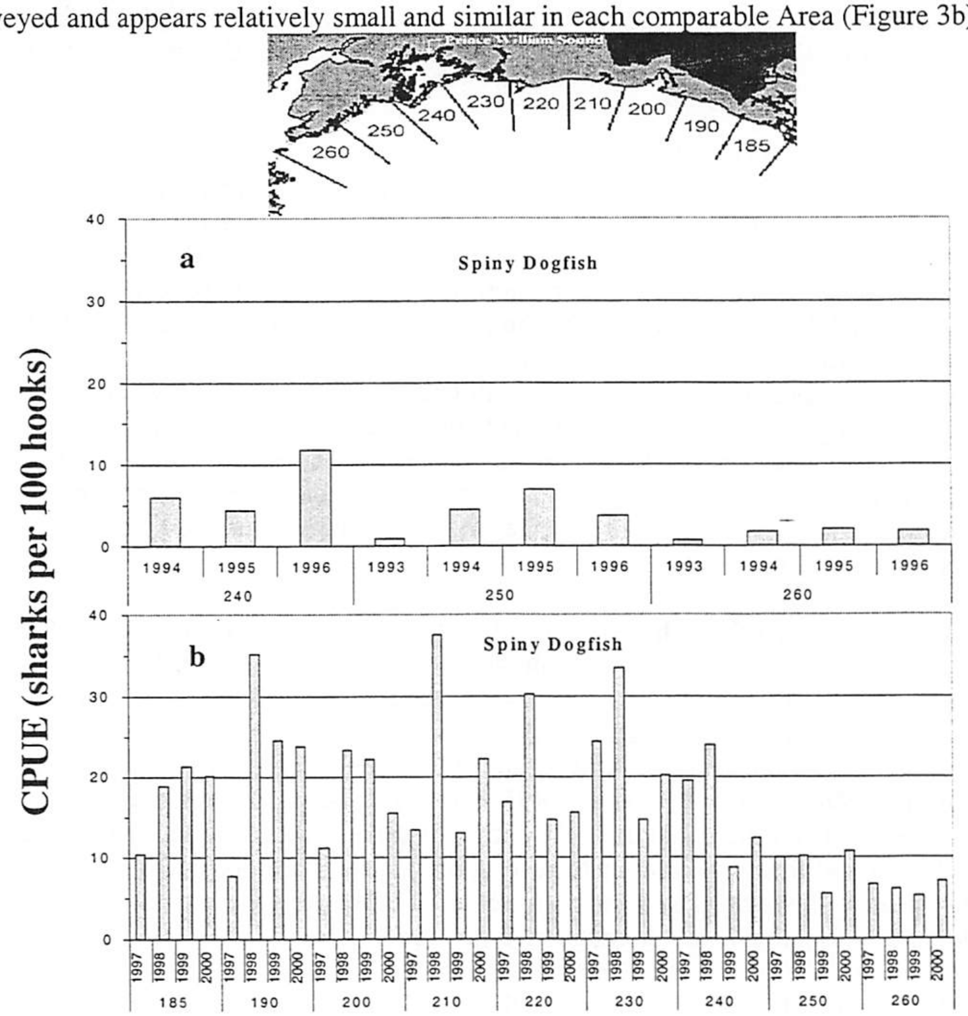

Figure 2. Spiny dogfish bycatch in the central GOA (from the IPHC).

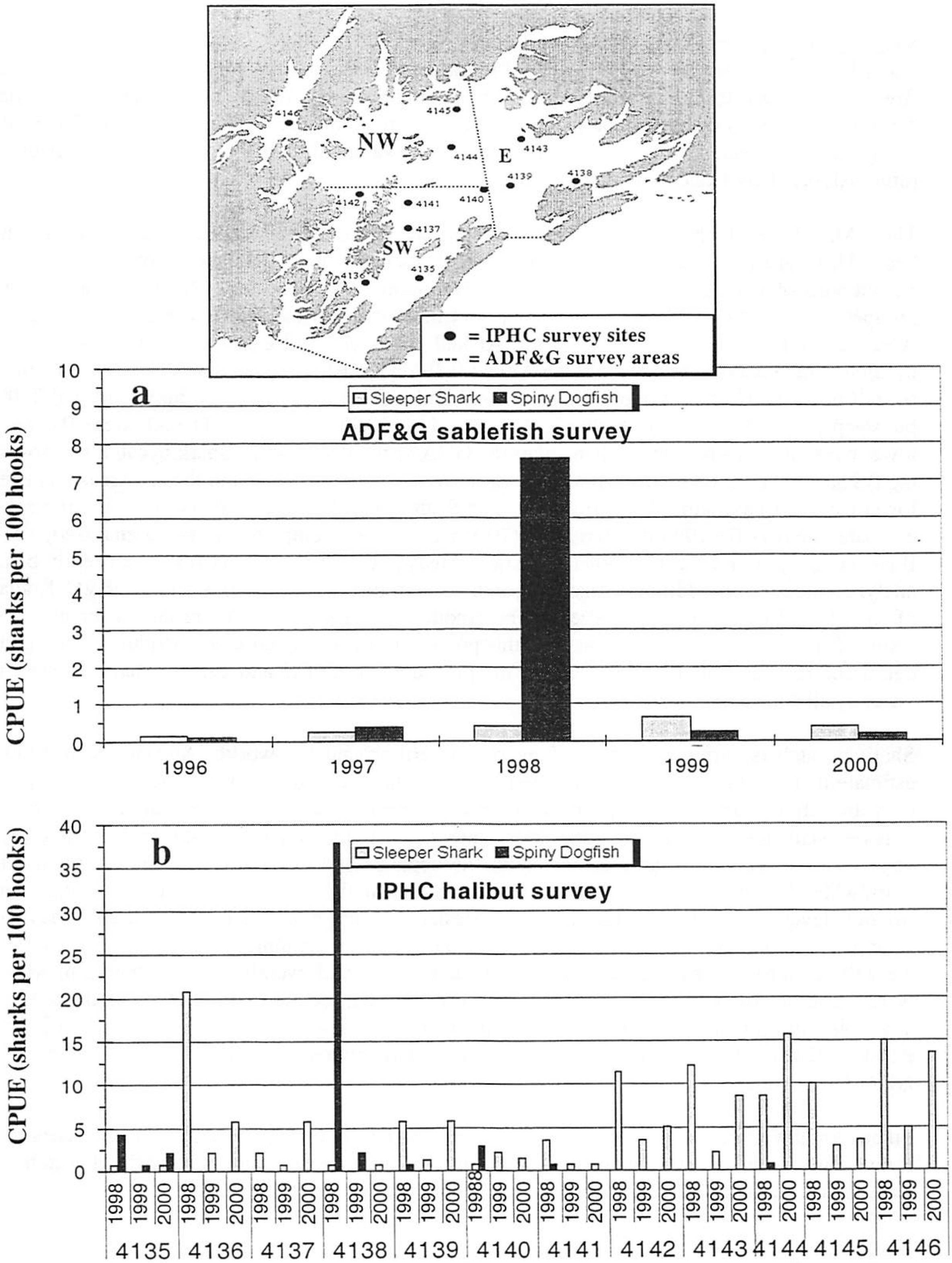

Figure 3. Spiny dogfish and sleeper shark bycatch from PWS. a) ADF&G data b)IPHC data.

Shark bycatch in other Areas not included in this report

Shark bycatch data from NMFS Observer Program and IPHC halibut survey for other Statistical Areas of the GOA, the Aleutian Islands and the Bering Sea are currently being analyzed. A brief mention of some of those data is appropriate to include here. Data (from ADF&G) on commercial and recreational bycatch in Alaska State waters are being acquired for inclusion in future Alaska shark bycatch reports.

The NMFS Groundfish Observer Program covers the entire GOA, Aleutian Islands and Bering Sea. There are two additional Areas that NMFS includes in their coverage of the GOA that extend west of Area 630 ending at 170°W. Continuing west from there, NMFS Areas become grouped into an Aleutian Island (AI) group and there is a Bering Sea (BS) series of Statistical Areas as well. From 1997 to 2000, the AI and BS Areas had extremely low spiny dogfish bycatch, with a maximum of 8.6t in the AI and 0.49t in the BS. Sleeper shark bycatch was lower overall in the GOA than in the BS during 1997 and 1998 (the BS Area averaging around 300t), but sleeper shark bycatch was higher in the GOA during 1999 and 2000. The AI Areas showed a lower bycatch of sleeper sharks than either the GOA or the BS. Salmon shark bycatch was low in the BS and AI Areas. The BS had a maximum catch of 29.5t in 1999, and the AI Areas had even lower catches (maximum of 3.5t in 2000). The Seattle NMFS office is also calculating the catch estimate numbers for 1998 through 2000 (2000 numbers are complete and being analyzed). The IPHC shark bycatch data from other Statistical Areas in the GOA, AI and BS are currently being analyzed along with additional shark bycatch data from both the NMFS and ADF&G Kodiak offices. It is difficult to assess whether the amount of shark bycatch represents a threat to the status of shark stocks in Alaska waters at this point in time. It is even more difficult to attempt to determine the cause of the 1998 'spike' in spiny dogfish CPUE and catches that was seen in virtually all data sets.

Shark bycatch is currently a topic of major concern around the world. Stevens et al. (2000) estimate that around 50% of the estimated global catch of chondrichthyan fishes (sharks, skates, rays and chimaeras) is taken as bycatch that is unmanaged and does not appear in official fisheries statistics. As a result, species of skate, sawfish and some deep-sea dogfish have been virtually extirpated from large areas. With the depleted status of numerous shark populations worldwide (Compagno 1990), it is all the more crucial that any approach to assessing shark bycatch levels and relative abundance in Alaska be carried out using the strictest possible scientific criteria. As further analysis of these data and the sampling of shark bycatch continue we will begin to better understand the relative abundance and overall status of sharks in Alaska waters, and determine if the current levels of shark bycatch are too high. Careful analysis of the available data and knowledge of life history parameters, demographics and movements will allow Alaska's fishery managers to better understand the biology and overall ecology of sharks in the GOA, PWS, BS and AI.

I thank Sarah Gaichas, Bill Bechtol, Scott Meyer, Charlie Trowbridge, Heather Gilroy, Aaron Ranta, Paul Anderson, Jim Blackburn, Pat Livingston and Jane DiCosimo for sharing bycatch data, their time on the phone, numerous e-mails and comments on this draft.

References

Anderson, S.A. and K.J. Goldman. 2001. Temperature measurements from salmon sharks, *Lamna ditropis*, in Alaskan waters. Copeia 2001(3):794-796.

Beamish, R.J. and G.A. McFarlane. 1985. Annulus development on the second dorsal spine of the spiny dogfish (*Squalus acanthias*) and its validity for age determination. Can. J. Fish. Aquat. Sci. 42:1799-1805.

Blagoderov, A.I. 1994. Seasonal distribution and some notes on the biology of salmon shark (Lamna ditropis) in the northwestern Pacific Ocean. Journal of Ichthyology 34(2), 115-121. Originally published in, and translated from, Voprosy Ikhtiologii.

Brodeur, R.D. 1988. Zoogeography and trophic ecology of the dominant epipelagic fishes in the northern Pacific. In: The biology of the subarctic Pacific. Proceedings of the Japan-United States of America seminar on the biology of micronekton of the subarctic Pacific (eds. T. Nemoto and W.G. Percy). Bulletin of Ocean Research Institute, University of Tokyo, No. 26 (Part II), 1-27.

Bonfil, R. 1999. The dogfish (*Squlaus acanthias*) fishery of British Columbia, Canada, and its management. Chpt. 21, p 608-655. *In*: Case studies of the management of elasmobranch fisheries. FAO Fisheries Tech. Paper No. 387 part 2. R. Shotton ed. FAO Rome.

Cailliet, G.M. 1990. Elasmobranch age determination and verification; an updated review. pp. 157-165. In: H.L. Pratt Jr., S.H. Gruber and T. Taniuchi (eds.) Elasmobranchs as Living Resources: Advances in the Biology, Ecology, Systematics and the Status of the Fisheries. NOAA Tech. Rep. NMFS 90.

Camhi, M. 1999. Sharks on the line II: An analysis of Pacific state shark fisheries. National Audubon Society Publication. October 1999, 114 pp.

Carey, F.G., Casey J.G., Pratt H.L., Urquhart D. and McCosker J.E. 1985). Temperature, heat production, and heat exchange in lamnid sharks. Southern California Academy of Sciences, Memoirs 9, 92-108.

Castro, J.I., C.M. Woodley and R. L. Brudek. 1999. A preliminary evaluation of the status of shark species. FOA Fisheries Tech. Paper No. 380. FAO Rome, 72p.

Castro, J. 1983. The sharks of North American waters. Texas A&M Univ. Press.

Compagno, L.J.V. 1990. Shark exploitation and conservation. In 'Elasmobranchs as living resources: Advances in the biology, ecology, systematics, and the status of the fisheries'. H.L. Pratt Jr., S.H. Gruber, and T. Taniuchi Eds. NOAA Technical Report No. NMFS 90, pp. 391-414.

Compagno, L.J.V. 1984. FAO species catalogue. Vol. 4. Sharks of the World. An annotated and illustrated catalogue of shark species known to date. Part 1. Hexanchiformes to Lamniformes. FAO Fisheries Synopsis, (125)4, Pt.1, 249 pp.

Eschmeyer, W.N., E.S Herald and H. Hammann. Peterson Field Guides; Pacific Coast Fishes. Houghton Mifflin Co., Boston, MA.

Farquhar, G.B. 1963. Sharks of the Family Lamnidae. Technical Report of the US Naval Oceanographic Office (TR-157). 22 pp.

Fritz, L. 1998. Squid and other species. *In*: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/Aleutian Islands region, p 544-551. North Pacific Fishery Management Council, Anchorage, AK.

Gilmore, R.G. 1993. Reproductive biology of lamnoid sharks. Environmental Biology of Fishes 38, 95-114.

Goldman, K.J. and J.A. Musick. In press. Biology of the Salmon Shark, *Lamna ditropis*. In: Sharks of the Open Ocean. E.K. Pikitch and M. Camhi eds. Blackwell Scientific.

Goldman, K.J. and B. Human. In press. Salmon shark, Lamna ditropis. In: Fowler, S.L., M. Camhi, G. Burgess, S. Fordham and J. Musick. In press. Sharks, rays and chimaeras: the status of the chondrichthyan fishes. IUCN/SSG Shark Specialist Group. IUCN, Gland, Switzerland, and Cambridge, UK.

Gorbatenko, K.M. and Cheblukova L.V. 1990. Environment conditions and fish species composition in the epipelagic zone of the Okhotsk Sea suring summer. Journal of Ichthyology 30, 89-100. Originally published in, and translated from, Voprosy Ikhtiologii 30, 21-30.

Hart, J.L. 1973. Pacific fishes of Canada. Bulletin, Fisheries Research Board of Canada 180, 36-37.

Hoenig, J.M., and S.H. Gruber. 1990. Life-history patterns in elasmobranchs: Implications for fisheries management. In 'Elasmobranchs as living resources: Advances in the biology, ecology, systematics, and the status of the fisheries'. H.L. Pratt Jr., S.H. Gruber, and T. Taniuchi Eds. NOAA Technical Report No NMFS 90, pp. 1-16.

Hoff, T.B. and J.A. Musick. 1990. Western North Atlantic shark-fishery management problems and informational requirements. In 'Elasmobranchs as living resources: Advances in the biology, ecology, systematics, and the status of the fisheries'. H.L. Pratt Jr., S.H. Gruber, and T. Taniuchi Eds. NOAA Technical Report No NMFS 90, pp. 455-472.

Holden, M.J. 1974. Problems in the rational exploitation of elasmobranch populations and some suggested solutions. In 'Sea fisheries research' (F.R. Harden-Jones, ed.), pp. 117-137. John Wiley and Sons, New York.

Holden, M.J. 1977. Elasmobranchs. In 'Fish population dynamics' (J.A. Gulland, ed.). John Wiley and Sons, New York.

Hulbert, L. 2000. Alaska Shark Assessment Program. *In*: Ecosystems Considerations Report for 2001. Pat Livingston, ed.. North Pacific Fishery Management Council, 605 W. 4th Ave., Suite 306, Anchorage, AK 99501-2252.

Iino, R. 1939. Migration of salmon sharks. Suisan Kenkyu-shi 34, 171-173. In Japanese.

Ketchen, K.S. 1986. The spiny dogfish (*Squalus acanthias*) in the Northeast Pacific and a history of its utilization. Can. Spec. Pu. Fish. Aquat. Sci. 88. 78p.

Ketchen, K.S. 1972. Size at maturity, fecundity, and embryonic growth of the spiny dogfish (*Squalus acanthias*) in British Columbia waters. J. Fish. Res. Bd. Canada. 29:1717-1723.

Kosugi, H. and H. Tsuchisaki. 1950. On the longline fishing of salmon sharks in the Japan Sea off Hokkaido. Hokusuisi Geppo, 17(1):14-20. In Japanese.

Lowe, C.G. and K.J. Goldman. 2001. Thermal and bioenergetics of elasmobranchs: bridging the gap. In: T.C. Tricas and S.H. Gruber (eds.) The Behavior and Sensory Biology of Sharks and Rays: State of the Art and Future Direction. American Elasmobranch Society Symposium, Special Volume in Honor of Dr. D.R. Nelson. Env. Biol. Fish. 60:251-266.

McFarlane, G.A. and R.J. Beamish. 1987. Validation of the dorsal spine method of age determination for spiny dogfish. p 287-300 *In*: The age and growth of fish. R.C. Summerfelt and G.E. Hall, eds. Iowa State Univ. Press.

Nagasawa, K. 1998. Predation by salmon sharks (Lamna ditropis) on Pacific salmon (Oncorhynchus spp.) in the North Pacific Ocean. Bulletin of the North Pacific Anadromous Fish Commission, No. 1, 419-433.

Nakano, H. and Nagasawa K. 1996. Distribution of pelagic elasmobranchs caught by salmon research gillnets in the North Pacific. Fisheries Science 62(5), 860-865.

Nakano, H. and Nagasawa K. 1994. Distribution of the salmon shark (Lamna ditropis) in the North Pacific Ocean and Bering Sea. Salmon Report Series, No. 37, 226-237. National Research Institute of Far Seas Fisheries, Shimizu Japan.

Nammack, M.F., J.A. Musick and J.A. Colvocoresses. 1985. Life history of spiny dogfish off the Northeastern United States. Trans. Am. Fish. Soc. 114:367-376.

Okada, S. and Kobayashi K. 1968. Colored illustrations of pelagic and bottom fishes in the Bering Sea. Japan Fisheries Research Consortium Association, Tokyo. 179 pp. In Japanese.

Orlov, A.M. 1999. Capture of an especially large sleeper shark *Somniosus pacificus*, (Squalidae) with some notes on its ecology in the northwest Pacific. J. Ichthyol.39(7):548-553. Translated from Russian, Originally in Voprosy Ikhtiologii 39(4): 558-563.

Orlov, A.M. and S.I. Moiseev. 1998. New data on the biology of the Pacific sleeper shark, *Somniosus pacificus*, in the northwestern Pacific Ocean. *In*: Fish Performance Studies: Symposium proceedings, AFS physiology section.

Paust, B. and R. Smith. 1989. Salmon shark manual: The development of a commercial salmon shark, *Lamna ditropis*, fishery in the North Pacific. Alaska Sea Grant Report 86-01, University of Alaska Sea Grant Program, 392 p.

Sano, O. 1962. The investigation of salmon sharks as a predator on salmon in the North Pacific, 1960. Bulletin of the Hokkaido Regional Fisheries Research Laboratory, Fisheries Agency, No. 22, 68-82. In Japanese

Sano, O. 1960. The investigation of salmon sharks as a predator on salmon in the North Pacific, 1959. Bulletin of the Hokkaido Regional Fisheries Research Laboratory, Fisheries Agency, No. 24, 148-162. In Japanese

Saunders, M.W. and G.A. McFarlane. 1993. Age and length at maturity of the female spiny dogfish, Squalus acanthias, in the Strait of Georgia, British Columbia, Canada. Env. Biol. Fish. 38:49-57.

Smith R.L., & D. Rhodes. 1983. Body temperature of the salmon shark, Lamna ditropis. J. Mar. Biol. Assoc. U.K. 63:243-244.

Stevens, J.D., R. Bonfil, N.K. Dulvy and P.A. Walker. 2000. The effects of fishing on sharks, rays, and chimaeras (chondyrichthyans), and implications for marine ecosystems. ICES J. of Mar. Sci. 57:476-494.

Strasburg, D.W. 1958. Distribution, abundance, and habits of pelagic sharks in the central Pacific Ocean. U.S. Fish. Bull. 58:335-361.

Tanaka, S. 1980. Biological investigation of *Lamna ditropis* in the north-western waters of the North Pacific. In: Report of investigation on sharks as a new marine resource (1979). Published by: Japan Marine Fishery Resource Research Center, Tokyo [English abstract, translation by Nakaya].

Urquhart, D.L. 1981. The North Pacific salmon shark. Sea Frontiers 27(6):361-363.

Weber, M.L. and S.V. Fordham. 1997. Managing shark fisheries: opportunities for international conservation. TRAFFIC International and the Center for Marine Conservation.

Yang, M-S. and B.N. Page. 1999. Diet of Pacific sleeper shark, *Somniosus pacificus*, in the Gulf of Alaska, U.S> Fish. Bull. 97:406-409.

Attachment (b)(4)

Table 1. Estimated total catch (mt) of sharks by FMP area, 1997-2000.

		BSAI				GOA			
Category	Species group	1997	1998	1999	2000	1997	1998	1999	2000
	dogfish	4.1	6.4	5.0	8.9	657.5	864.9	313.6	397.6
	salmonshk	6.8	18.0	30.0	23.3	123.8	71.0	131.6	37.8
	sleepershk	304.1	336.0	318.7	490.4	135.9	74.0	557.7	608.2
	shark	52.8	136.1	176.4	67.6	123.5	1379.9	33.0	73.6
	TOTAL	367.8	496.5	530.1	590.2	1040.7	2389.8	1035.9	1117.2

Table 2. Biomass (mt) estimates (AFSC trawl surveys) of Gulf of Alaska sharks.

Year	Sharks
1984	18,156
1987	24,049
1990	33,063
1993	50,025
1996	52,883
1999	51,355
avg all	38,255
avg 90s	46,832
most recent	51,355

Table 3. Potential GOA ABC and OFL by species group for sharks (reprinted from 1999 GOA SAFE Report Appendix D).

			Sharks (mt)
Tier 5		M	0.09
average all survey biomass			38,255
	F=.75M	ABC	2,582
	F=M	OFL	3,443
average 1990's biomass			46,832
	F=.75M	ABC	3,161
	F=M	OFL	4,215
most recent biomass estimate			51,355
	F=.75M	ABC	3,466
	F=M	OFL	4,622
model estimated current biomass			34,214
	F=.75M	ABC	2,309
	F=M	OFL	3,079