Fishery Management Report No. 08-63

Report to the Board of Fisheries, Miscellaneous Dive Fisheries

by

Marc Pritchett

and

Zachary Hoyt

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Alaska Department of Fish and Game Divisions of Sport Fish and Commercial Fisheries

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY MANAGEMENT REPORT NO. 08-63

REPORT TO THE BOARD OF FISHERIES, MISCELLANEOUS DIVE FISHERIES

By
Marc Pritchett
Alaska Department of Fish and Game, Division of Commercial Fisheries, Douglas
and
Zachary Hoyt
Alaska Department of Fish and Game, Division of Commercial Fisheries, Petersburg

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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The Fishery Management Reports series was established in 1989 by the Division of Sport Fish for the publication of an overview of management activities and goals in a specific geographic area, and became a joint divisional series in 2004 with the Division of Commercial Fisheries. Fishery Management Reports are intended for fishery and other technical professionals, as well as lay persons. Fishery Management Reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm. This publication has undergone regional peer review.

Marc Pritchett
Alaska Department of Fish and Game, Division of Commercial Fisheries,
Douglas Island Center Building, 802 3rd St., Douglas Alaska, 99824 USA

Zachary Hoyt
Alaska Department of Fish and Game, Division of Commercial Fisheries,
16 Sing Lee Alley, Petersburg Alaska, 99833-0667 USA

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ADF&G, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage AK 99518 (907)267-2375.

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ABSTRACT

The miscellaneous shellfish commercial fisheries in Registration Area A (Southeast Alaska) and Registration Area D (Yakutat) consist of abalone, geoduck clams, red sea urchins, and sea cucumbers. The Southern Southeast Regional Dive Fisheries Association (SARDFA) represents 583 diver permits that qualify for limited entry fisheries in Southeast Alaska. Miscellaneous shellfish commercial fisheries are conducted using management plans developed by the Alaska Board of Fisheries, Alaska Department of Fish and Game, and the commercial fishing industry.

Keywords: Abalone, Commercial Fisheries Entry Commission, Dive Fisheries, Geoduck Clams, Red Sea Urchins, Sea Cucumbers, SARDFA

INTRODUCTION

SOUTHEAST ALASKA DIVE FISHERIES

This report provides a general overview of the dive fisheries in Southeast Alaska and Yakutat. Southeast Alaska dive fisheries harvest three species of invertebrates: geoduck clams *Panopea abrupta*, California sea cucumbers *Parastichopus californicus*, and red sea urchins *Strongylocentrotus franciscanus*. All three fisheries occur primarily in southern Southeast Alaskan waters. The pinto abalone *Haliotis kamschatkana* fishery is currently closed to commercial harvest. A small experimental sea cucumber fishery was prosecuted during the 2007/08 season in the Yakutat area.

The Southeast Alaska/Yakutat area (Region I) consists of Alaska waters between Cape Suckling on the north and Dixon Entrance on the south. The region is divided into two registration areas: Area A, the Southeast Alaska area, extends from Dixon Entrance to Cape Fairweather and Area D, the Yakutat area, extends from Cape Fairweather to Cape Suckling. Southeast Alaska dive fisheries primarily occur in miscellaneous shellfish registration Area A. The Southeast Alaska area is divided into 16 regulatory districts (Districts 1 through 16) with each district divided into several statistical subdistricts for catch reporting. For management purposes, the Ketchikan area office is primarily concerned with fisheries that occur in Districts 1 to 4, the Petersburg and Wrangell area offices with Districts 5 to 10 (excluding Section 9-A), the Sitka area office with Section 9-A and District 13, and the Juneau area office with Districts 11 to 15.

Southeast dive fisheries are relatively recent entrants into the region's commercial fishing industry. The first commercial landings for abalone occurred in the mid 1960s, and red sea urchins, sea cucumbers, and geoduck clams in the early to mid 1980s. Initial participation in each fishery was often limited to just one or two divers and has developed to current effort levels. Currently, each fishery is a competitive limited entry fishery. Fish ticket information indicates 248 permits reported landings during the 2007/08 season including 179 sea cucumber, 59 geoduck clam, and 10 red sea urchin permits.

The exvessel value of the 2007/08 Southeast Alaska dive fisheries was estimated at approximately $5,966,544. This estimate is considered conservative as it is based on the price reported on fish tickets and does not include unreported price adjustments or situations where price information was not reported. The actual exvessel value will not be known until final processor reports are received and analyzed through the Commercial Fisheries Entry Commission (CFEC). The harvest of sea cucumbers was valued at $3,774,428 (63% of total 2007/08 dive fishery value), followed by geoduck clams at $1,954,582 (33%) and red sea urchins at $237,534 (4%).

COMMERCIAL FISHERIES ENTRY COMMISSION

Prior to July 1, 1996, entry into Southeast Alaska's dive fisheries were open access, requiring an interim-use permit by the CFEC for participation. Historically, most fisheries began slowly with little effort but interest grew relatively quickly as exvessel value increased, new markets opened, and fishers explored new ways to expand beyond the more traditional fisheries such as salmon or groundfish. Effort quickly soared to levels that made if difficult for the department to manage each fishery.

In 1996 the Alaska State Legislature established a four-year moratorium on interim-use permits for the Southeast dive fisheries. The legislation, HB 547, was incorporated into statue as AS 16.43.228. The moratorium specified a cap on the total number of interim-use permits in the Southeast Alaska abalone, geoduck, sea cucumber, and sea urchin fisheries. This legislation temporarily halted growth in the number of participants in these fisheries and provided specific eligibility criteria to be used in each fishery.

The effective date of the moratorium was July 1, 1996 and expired automatically on June 30, 2000. During the moratorium, the legislation directed the CFEC to consult with the Board of Fisheries (BOF), the Alaska Department of Fish and Game (ADF&G), and the participants in these fisheries about a permanent limited entry program. The legislation also directed the CFEC to determine the type of limited entry program that would be most appropriate for these fisheries. These fisheries would have returned to open access on the expiration date unless the CFEC limited these fisheries under the current limited entry law.

In September 1999, the CFEC proposed to adopt regulations for limiting entry into the geoduck and sea urchin dive fisheries. For these fisheries, CFEC proposed to establish the following:

1) The maximum numbers of permits to be issued for each fishery;
2) July 1, 1996 as the date for determining an applicant's qualifications for a Southeast Alaska geoduck or sea urchin dive entry permit;
3) Time periods for each fishery in which an individual must have participated in the fishery as an interim-use permit holder to be eligible to apply for an entry permit; and
4) Definitions for the proposed limitation of the geoduck and sea urchin dive fisheries.

The CFEC originally proposed a return to open access status for the sea cucumber and abalone dive fisheries at the end of the then current moratorium. Following a series of public comment periods and meetings, and after obtaining staff developed options for limiting entry, current dive fisheries became limited entry fisheries. Red urchins were finalized in November 2000 and sea cucumbers and geoducks in May 2001. The maximum number of limited entry permits originally authorized for each fishery was 104 for geoduck clams, 436 for sea cucumber, and 95 for red sea urchins. Currently there are a total of 583 permits for the Southeast Alaska dive fisheries: 111 for geoduck clams, 389 for sea cucumbers and 83 for red urchins. Abalone is currently an open access fishery (source: CFEC 2008).

SOUTHEAST ALASKA REGIONAL DIVE FISHERIES ASSOCIATION

State general funds have not been sufficient to fund the costs of management and research activities required for the dive fishery program. This funding gap has been filled through financial contributions by industry processors, local municipalities, federal funding, voluntary

diver assessments, and test fishing projects in which the resource was harvested and sold by the state. These were ad hoc attempts to keep the dive fisheries open. Industry divers throughout Southeast saw a need to establish an organization and provide for a funding mechanism to meet the funding gap and continue to expand the dive fisheries. Through municipality funding, industry divers hired a project coordinator to develop and promote state legislation addressing this need. The legislation, CSHB 198, passed unanimously in the House and Senate, was signed by the governor June 20, 1997 and became effective June 21, 1997. CSHB 198 allowed for the creation of the Southeast Alaska Regional Dive Fisheries Association (SARDFA), which is empowered to enact taxes on dive fishery landings to help pay for fishery development.

SARDFA is a non-profit, economic development corporation, whose voting members are all permit holders for the three Southeast dive fisheries (geoduck clams, sea cucumbers, and red sea urchins). SARDFA is managed by a board of directors which is elected by the membership. The board is composed of one member from each of five Southeast communities (Ketchikan, Prince of Wales Island, Sitka, Petersburg, and Wrangell), one member from out of state, one at-large director, one municipal director, and one processor director, for a total of nine directors.

SARDFA has created committees to focus on the individual needs of each dive fishery. Currently, the urchin, geoduck, and sea cucumber committees add another 47 voices to fishery management. This diversity helps to air concerns and allows for industry input. These committees are advisory to the SARDFA Board. The Board reviews and votes on committee recommendations and negotiates approved recommendations with ADF&G. The department is required by the State of Alaska to protect the integrity of the state's fisheries, therefore ADF&G managers will not approve any recommendations which they do not feel coincide with a sustainable fishery.

SARDFA's mission is to develop, expand, and enhance new and existing dive fisheries in Southeast Alaska in a sustainable and economically feasible manner. The first year of tax collected on the dive fisheries totaled $227,986. For the 2007/08 season total tax collected was $348,159.

ABALONE

BACKGROUND

The Alaskan abalone fishery targeted the pinto abalone *Haliotis kamschatkana*, which inhabits the rocks of the lower intertidal and subtidal surge zones of the outer coasts of Southeast Alaska. Commercially harvestable quantities of abalone occurred in parts of Districts 1, 2, 3, 4, 5, and 13. Life history information for this species in Alaska is very limited and relies on information from other North Pacific locations to understand the basic biology of this species. Tagging studies indicate it is a slow growing, long-lived species. Spawning occurs during the summer through early autumn. Size frequency information indicates that in at least some areas, a climax population may have existed prior to recent commercial exploitation. Recruitment levels appear to be low and sporadic and fecundity increases greatly with increasing shell length. Known predators include rockfish, starfish, octopus, sea otter, and man. Throughout the range of this and various other abalone species, exploitation has usually resulted in stock depletion and restrictive management (Sloan and Breen 1988, Woodby et al. 2000).

Abalone can be picked by hand from the shoreline during extreme low tides. However, until recently, most of the subsistence and personal use and the entire commercial fishery utilized

scuba or hookah umbilical diving gear and most of the harvest occurred subtidally. Current subsistence and personal use regulations prohibit the use of compressed gas systems (e.g. scuba or hookah).

FISHERY DEVELOPMENT AND HISTORY

The abalone fishery was marked by a boom in harvests and effort in the late 1970s and early 1980s followed by declining harvests and increasing effort (Table 1). The decline in harvest may be attributed to a combination of excessive fishing, predation by a growing sea otter population, and apparent low productivity of abalone stocks when heavily harvested. The increase in fishing effort was in part due to an increase in value from one dollar per pound in the early 1970s to more than ten dollars a pound during the last four seasons (1992/96).

The marked increase in harvests and effort occurred in the 1978/79 season, when effort increased more than three-fold and harvests increased to 180,000 lb from a long-term average of about 6,000 lb. Harvests peaked at 378,685 lb the next season. This peak exceeded the quota of 250,000 lb adopted by the board in the spring of 1980 and the fishery was closed by emergency order for the first time.

High harvests continued through the 1981/82 season when almost 371,000 lb were landed, despite a reduction in the Guideline Harvest Range (GHR) to a maximum of 125,000 lb and a reduction in the fishing season. By the 1984/85 season, it was apparent that the resource might be in trouble when the lower end of the GHR was not reached despite 151 days of fishing.

The 1990/91 through 1995/96 seasons opened on October 1 and with the exception of District 13, which was managed separately and closed by emergency order, the length of the season for the rest of Southeast Alaska was set prior to the opening to avoid overharvest. A harvest of 68,400 lb during the 1990/91 season was the beginning of a second downward trend that was to continue through the remainder of the fishery.

As the 1994/95 season progressed, it became apparent that harvests were much lower than anticipated, and dramatically lower than historic levels. Fish ticket data indicated that 15,055 lb had been harvested during the eight-day opening. Despite requests from harvesters to reopen the fishery, the southern Southeast fishery was not reopened. The District 13 fishery was open from October 1 to 5, 1994 and October 12 to 14, 1994 for a total of eight days. A total of 7,824 lb of abalone were harvested from a Guideline Harvest Level (GHL) of 8,000 lb. Anecdotal information from harvesters indicated that good harvest areas were difficult to find. Harvest per unit effort for the fishery (lb diver^{-1} day^{-1}) declined to 64% of the 1993 level.

The 1995/96 southern southeast abalone fishery was open from October 1 to October 6, 1995 with an upper GHR of 10,000 lb. A total of 8,524 lb was taken by 44 divers with 48 landings in six days. The average price per pound was $8.99 giving the fishery an exvessel value of $74,074. Due to poor harvest rates and a concern by some harvesters that abalone populations were greatly reduced from historic levels, the fishery was not reopened despite not reaching the upper end of the GHR. The District 13 fishery extended from October 1 to October 5 and from October 15 to 16, 1995 with an upper GHR of 6,000 lb. Harvests of 3,833 lb and 1,995 lb occurred, respectively, during the two openings (5,828 lb total). A total of 56 divers made 73 landings with an approximate exvessel value of $52,452 in the District 13 fishery.

In response to a decrease in harvest rates observed during the 1990s, the apparent lack of abalone in many of the traditional harvest areas, and numerous comments from subsistence users and

commercial divers regarding the diminishing numbers of abalone, the fishery has been closed by emergency order since October 16, 1995 to protect the remaining, reduced population (Woodby et al. 2000). The emergency closure is consistent with 5 AAC 38.035. AREA CLOSURES. (b) which states "When the commissioner finds that continued fishing would jeopardize the health of a shellfish species described in this chapter in a registration area or portion of a registration area, the commissioner, by emergency order, shall close fishing for that shellfish species in the registration area or portion of the registration area." The closure applied to all of Southeast Alaska including both the Sitka area and southern Southeast fisheries. Anecdotal information from ADF&G staff and harvest divers suggest a continuing decline in abalone populations. This continued reduction may be in part to sea otter predation.

MANAGEMENT STRATEGY AND REGULATION DEVELOPMENT

Prior to the boom in harvest and effort in the late 1970s, abalone harvests were regulated primarily by response to local market conditions. Quotas, season limitations, and guideline harvest ranges were not imposed until 1980 after harvests began to soar.

The major fisheries were divided into District 13 (northern outer coast) and Districts 3, 4, and 5 (southern outer coast) fisheries. This division was established historically by early fishing and landing patterns that generally persisted throughout the fishery's history. Closed waters around Craig, Klawock, Ketchikan, Sitka, and Coronation Island were adopted to protect stocks used for subsistence and personal use from commercial exploitation.

Size limits have undergone several increases prior to reaching the present four-inch minimum. The size limit was raised from 3 inches to 4 inches for Districts 1 through 6 in 1968 and from 3 inches to 3½ inches for Districts 9 through 14 in 1976. A change for all districts to 3½ inches occurred in 1977. The board adopted an increase in minimum size to 3¾ inches in the spring of 1979. In November 1993, the board again increased the legal size limit to 4.0 inches due to concerns that abalone stocks were declining. The intent of the larger size limit was to reduce the harvest rate on mature abalone thereby increasing the potential for improved stock abundance.

Guideline harvest ranges and season length both decreased in several steps. In 1980 the harvest limit was set at 250,000 lb and the season was reduced from all year to September 1 through May 31. In the spring of 1981, the GHR was reduced 100,000 to 125,000 lbs, and the season was shortened to September 15 through May 15. In 1982 the board split the existing GHR, allocating 86,000 to 107,500 lb to the Ketchikan area and 14,000 to 17,500 lb to the Sitka area. In 1983 the board split the season into autumn and spring segments in each of which 50% of the allowable harvest was to be taken. The BOF restricted the 1985/1986 harvest to a range of 25,000 to 50,000 lb in the Ketchikan area and a maximum of 8,000 lb in the Sitka area. The District 13 season was reduced to November 1 to May 15 and all other areas were changed to October 1 to May 15. In 1986 the season was changed to October 1 through May 15 for all areas. The upper GHR was further reduced for the 1995/1996 season to 10,000 lb for southern Southeast and to 6,000 lb for the Sitka area. The reduction was due to a continued decline in abalone abundance in many areas, especially southern Southeast Alaska. These conservative GHRs were intended to provide a limited commercial fishery while increasing the potential for recruitment.

FISHERY OUTLOOK

The department believes that the current population is far below its historic level because of overfishing and predation by sea otters. This low level does not likely promote significant

recruitment and the department is unsure when, or if, the population will rebuild to a level needed to allow a commercial fishery. A fishery will not be opened until a management plan is developed that addresses the issues and information identified in 5 AAC 39.210, Management Plan for High Impact Emerging Fisheries. As part of that process ADF&G would require a plan for determining productivity and abundance of abalone, and a harvest strategy that would ensure a sustained fishery.

These elements would be difficult to achieve and the department would be very concerned about local and serial depletion under either an open access or limited entry fishery. The department believes that it is highly unlikely stocks will recover sufficiently to allow commercial fishing to resume.

SEA CUCUMBER

BACKGROUND

The commercial species of sea cucumber harvested in Southeast Alaska is the California sea cucumber *Parastichopus californicus*. It is a common species distributed from Mexico to Southeast Alaska and has been observed at least as far west and north as the Alaska Peninsula, Aleutian Islands, and Bering Sea where there is a small experimental fishery. It occupies a broad range of subtidal habitats from nearshore shallows to over 100 fathoms. The sea cucumber's primary food is detritus which it ingests along with significant amounts of fine substrate. Its ecological function seems to include recycling detrital material into nutrients for the primary producers in the marine food chain (Lambert 1997, O'Clair and O'Clair 1998). *P. californicus* appears to favor locations with moderate current, avoiding mud bottoms and areas subject to inundation by freshwater or glacial runoff. The abundance of sea cucumbers in Southeast Alaska is greatest in the southern and western portions in protected bays and inlets.

FISHERY DEVELOPMENT AND HISTORY

The first experimental fishing permits for sea cucumbers were requested in 1981. One or two permits were issued each year between 1981 and 1986, with only one vessel reporting landings during this period. The first fisheries were based in Ketchikan and, over the years, evolution of management strategies resulted in a partition of most of the statistical subdistricts into one of three seasonal rotations. The initial fishery had no established season; harvests are reported in Table 2. on an October to September basis for consistency with current seasons.

Most of the vessels pioneering this fishery were small skiffs of limited range and capability operating in the vicinity of either Ketchikan or Sitka, mostly as a day fishery. Larger vessels with two divers and a crewman with living quarters and the capability of transporting product and divers during typical fall and winter weather conditions are now the norm. Harvest is conducted by scuba or hookah diving gear usually at depths of 30 to 60 feet. The number of hours each diver can work each day depends on the maximum working depths and may be as little as three or four hours. Harvest consists of collecting sea cucumbers in large mesh bags and transporting the filled bags to the tendering vessel.

Processing is currently conducted in a two-step process. The freshly caught animal is eviscerated on the fishing grounds where a knife is used to make an inch long puncture in the body wall of the animal. Drained sea cucumbers are then placed in totes and transported to the processing facility where they are either processed immediately or held for up to two days in a refrigerator.

Sea cucumbers were purchased by the bucket in early years but are now sold exclusively by drained weight. Holding times for the eviscerated, densely packed sea cucumbers are limited by their rapid decomposition even when refrigerated.

Processing at the plant consists of separating the muscle bundles from the skin with a scraper or knife. The major products from this fishery are the longitudinal and transverse muscle bundles or meat, and the skins. Skin processing involves cooking or boiling the skins to a specific texture and drying the product. The dried skins are a preferred item in upscale oriental cuisine. Sea cucumbers harvested in Southeast Alaska have been processed in Craig, Juneau, Ketchikan, Petersburg, Sitka, British Columbia and the state of Washington.

Effort increased in the fishery to a maximum of 424 divers during the 1995/96 season. This high number can be attributed to increased prices during the previous season and concerns that the fishery was to be limited by the CFEC. Beginning July 1, 1996 the CFEC imposed a moratorium into Southeast dive fisheries that limited the number of divers able to participate in the sea cucumber fishery to 472. The CFEC moratorium ended July 1, 2000 with a maximum of 436 limited entry permits authorized for the sea cucumber fishery. Currently there are 389 permits in the Southeast Alaska sea cucumber fishery. The GHL has exceeded one million pounds (drained weight) for more than a decade (Table 2).

During the 2006, 2007, and 2008 survey seasons, with SARDFA input and funding, ADF&G surveyed nine and added six new areas to the sea cucumber commercial harvest. Additionally, two previously surveyed and opened sea cucumber areas were expanded. The total GHL increase for these three seasons for all newly opened and expanded areas was approximately 350,100 lb. For the 2006/07 season two new and two expanded areas added 186,100 lb to the commercial harvest with three new areas adding 149,800 lb in 2007/08, and one new area adding 14,200 lb in 2008/09.

Yakutat Bay was surveyed during the 2005 season with an estimated biomass of 225,006 lb and a 31,200 lb GHL. This fishery did not fall within the limited entry jurisdiction in Southeast Alaska and was an open access fishery. During its September 14, 2005 meeting, the SARDFA Sea Cucumber Committee agreed to not pursue a Yakutat sea cucumber fishery. There was little interest until the 2007/08 season when the area was open to commercial harvest. Six divers participated making 34 landings and harvesting 31,353 lb.

MANAGEMENT STRATEGY AND REGULATION DEVELOPMENT

The fishery expanded rapidly in the late 1980s, and in 1989 the fishery exceeded the ability of ADF&G to manage by the interim-use permit system. The department closed the fishery in May 1990 and reopened it in October 1990 following development of the Southeast Alaska Sea Cucumber Commercial Fisheries Management Plan (5 AAC 38.140). This plan seeks to protect subsistence opportunities and provides for sustained commercial fishing harvests. To protect subsistence opportunities, the cucumber management plan established 16 areas closed to commercial fishing (5 AAC 38.140 (k)). There are also provisions to prevent the use of diving gear in the subsistence (5 AAC 02.020 (1)) and personal use (5 AAC 77.010 (l)(3)) fisheries in those areas. Annual commercial fishery guideline harvest levels are 6.4% of the lower bound confidence interval of the total sea cucumber biomass taken on a three-year rotational basis (i.e. 19.2% once every three years). Rotational fisheries have the advantage of lowering overall departmental assessment survey and management costs.

Initially the Sea Cucumber Management Plan provided for a season that began October 1 in 1990 with two 48-hour openings per week. The season was changed to a November opening in 1993, and in order to extend the season, weekly fishing periods were reduced to seven daylight hours on Mondays in November, plus an additional four daylight hours on Tuesdays from December through March. The Sea Cucumber Management Plan was amended by the board for the 1997 season and provided for an October 1 opening date with weekly fishing periods of seven daylight hours on Mondays in October, plus an additional four daylight hours on Tuesdays from November through March. There are also provisions for limiting the numbers of divers per vessel to two, providing fishing period trip limits of 2,000 lb per person, and limiting gear to scuba, surface-supplied systems, or snorkels. During the January 2000 board session the open weekly fishing period was amended providing for a Monday, 8:00 a.m. to 3:00 p.m. and Tuesday 8:00 a.m. to 12:00 p.m. opening in October (i.e. opening an additional half-day in October). The board also allowed the use of enhanced air nitrox of ≤40% oxygen with the balance consisting of nitrogen.

The time series of stock assessment data was used to evaluate sea cucumber population response to harvest under the current management plan. Preliminary analysis reveals highly diverse responses among management units. Although changes in mean density, mean weight, and biomass are apparent in many areas, variability makes detection of statistically significant differences difficult. In general, more areas open to commercial harvest have decreased in mean density, increased in mean weight, and decreased in biomass. In several surveyed areas which are closed to commercial harvest, decreases have been observed in density, weight, and biomass, indicating that populations respond to environmental variables in addition to exploitation.

2007/08 SEA CUCUMBER COMMERCIAL HARVEST SEASON

The 2007/08 season opened by regulation on Monday, October 1, 2007 with a GHL of 1,384,300 lb of sea cucumbers. A total of 179 permit holders reported landings with a fish ticket exvessel value of $3,774,428 (Table 2).

2008/09 OUTLOOK

Biomass estimates made during the summer of 2008 indicated a harvestable surplus of 1,122,100 lb of sea cucumbers was available for the 2008/09 season. Three new areas were surveyed for the first time during the 2008 survey season. The GHL for two of these areas was insufficient to allow management of an open competitive fishery. One new area, Subdistricts 107-40 and 45, was opened for a GHL of 14,200 lb (Figure 1). The 2008/09 sea cucumber fishery opened by regulation at 0800, October 6, 2008.

There were dramatic decreases in several areas when compared to previous openings during the 2005/06 and 2002/03 seasons. It might be assumed that decreases in Districts 3 (e.g. 103-90, 103-40) may be due to sea otter predation but this assumption would not explain the decreases for some areas in District 1 (e.g. 101-29) or District 7 (e.g. 107-10, 107-20, and 107-30 and -35) where sea otters have not been observed. Given adequate resources, the department will review these differences prior to the 2009 survey season.

GEODUCK CLAM

BACKGROUND

Geoduck clam *Panopea abrupta* beds have a patchy habitat specific distribution in the central and southern portions of Southeast Alaska, primarily in protected waters near the outside coast. Highest densities are found in fine to course sand substrates with minimal surge energy. Highest densities of geoducks within Southeast, Alaska have been observed in the large island groups just west of Craig, including shoreline adjacent to Suemez Island, Baker Island, Lulu Island and Noyes Island. Studies conducted in Washington State, British Columbia and in Southeast Alaska indicate this clam can live to be over 100 years old (Bureau et al. 2003). Southeast Alaska is the extreme northern limit of the geographic range of this species and recruitment is sporadic or very low seasonally. Sporadic recruitment, low growth rates, and high maximum age makes this species susceptible to overharvest.

A troubling problem is the tendency for geoduck clams to bioaccumulate undesirable microorganisms or compounds. In particular, high levels of paralytic shellfish poisoning (PSP) have been found in geoducks in Southeast Alaska, most strongly associated with the viscera. The mantle and necks are the usual body parts consumed and PSP concentrations are lower in these parts. Though this situation permits the sale of processed clams with viscera removed, exvessel value for processed clams is significantly less than that for whole, live product.

In order to protect consumers, the state requires that each individual fishery be sampled and clams tested by the Alaska Department of Environmental Conservation (ADEC). The sample, which represents clams within a commercial fishing area, must fall under a PSP criteria of 80 ug 100^{-1} grams of tissue prior to the opening of a fishery by the Department of Fish and Game. In addition, water quality for commercial beds is tested for human pathogenic microorganisms and certified safe by the ADEC. Time required for transport and testing of samples, and the relatively short shelf life of the fresh product, require a close working relationship between fishery managers and industry to successfully market the product. The current PSP protocol was adopted prior to the 2003/04 season. With PSP data collected since the inception of this program, ADEC modified the PSP testing protocol prior to the 2006/07 season. These modifications allow an additional day of harvest and fewer test samples prior to allowing the harvest and marketing of live product. These changes will reduce cost to industry and increase marketing opportunities.

FISHERY DEVELOPMENT AND HISTORY

Starting in 1978 with the Noyes Island survey, state grants were used to find and qualitatively assess commercial beds in the Ketchikan, Craig, Petersburg, Wrangell, and Sitka areas. A number of potential commercial beds were located near Ketchikan, Craig, and Sitka. Procedures for testing and certifying the product for human consumption were established by the ADEC. Population assessment surveys were conducted on three beds around Noyes Island near Craig, a harvestable biomass estimated, and the ADEC completed sanitation surveys on these areas. Two processors conducted the required modifications to their facilities and procedures to handle batch processing, lot testing, and product quarantine and were certified to process geoducks. In late 1985 the first permit was issued for the commercial harvest of geoduck clams. During the 1985/86 season 143,868 lb of the 300,000 lb, five-year quota (Table 3) were harvested by eight divers in the Noyes Island area. During the 1986/87 season, only 28,191 lb were harvested by only three divers. The decline was mainly due to poor marketing conditions and high operational

costs. Increased interest in this fishery began after the department completed a population estimate on the west side of Gravina Island in 1987. Biorka Island, near Sitka, was included in the geoduck fishery during the 1989/90 season, Kah Shakes was included in the 1990/91 season, and the Goddard area entered the fishery during the 1998/99 season. The largest growth in the geoduck fishery has occurred during 2004/05 through 2008/09 seasons due in part to survey funding from Nearshore federal grant money, cooperation from SARDFA reconnaissance, and a logbook program allowing the identification and mapping of new unmapped geoduck beds both within existing fishing areas and new areas being surveyed. As of the 2008 department survey season, a total of 37 distinct commercial fisheries have been identified and surveyed in Southeast Alaska. It is anticipated that additional new undiscovered beds will be surveyed over the next couple of years as funds are available.

The 1991/92 geoduck fishery saw an increased interest in participation and harvest by divers from Washington State. Prior to the 1991/92 season non-resident participation was minimal. Exvessel value and the number of divers began to increase with the 1992/93 season. Participation fluctuated in the late 1990s due to decreasing exvessel value with sales of processed product. However, the changes in PSP testing protocol by ADEC prior to the 2003/04 season, which allowed for over 90% percent of the harvested product to be sold live, generated increased effort in the fishery. During the last three seasons 100% of the harvest has been sold as live product. The exvessel value of the fishery for the 2007/08 season was estimated at $2.0 million.

MANAGEMENT STRATEGY AND REGULATION DEVELOPMENT

The objective of geoduck fishery management is to allow only a very low exploitation rate because the species is long-lived and recruitment is sporadic and low both spatially and temporally. Harvests are by permit only and have generally been allowed only from October through May 31, to avoid the summer spawning and recruitment period and to minimize PSP toxin levels.

Harvests are restricted to beds for which biomass estimates are available. Only four areas had been surveyed prior to 1997: Symonds Bay on Biorka Island in the Sitka Management Area, West Gravina Island (Vallenar Bay, South Vallenar Point, Middle Gravina and Nehentna Bay), Kah Shakes (Kirk Point/Bullhead Cove), and northern Noyes Island (Ulitka Bay, Little Steamboat Bay, and Steamboat Bay) in the Ketchikan Management Area. The GHL for each area is estimated as 2% of the lower bound confidence interval of the harvestable adult population. Following reassessment dive surveys during the summer of 1997, it became apparent that the abundance of geoducks in areas currently being fished was much lower than expected and the distribution of geoduck clams more limited than previous surveys had indicated. These preliminary results suggested that previous GHLs established for the geoduck clam fishery may not be sustainable. As a result, the department delayed the opening, originally scheduled for October 1, 1997, until further analysis and review of the survey results were completed.

The department held public meetings to discuss possible management options for the fishery including a season opening date. Representatives of the CFEC, Fish and Wildlife Protection (FWP), and the ADEC attended. An opening date and daily open hours were agreed on as well as a GHL for each area. Generally, the 2% per year harvest rate was maintained for all areas but the number of years an area would remain fallow was increased to four years in Symonds Bay and 13 to 16 years on west Gravina Island, with Steamboat Bay and Kah Shakes remaining on a two-year rotation. This expanded rotational cycle in Symonds Bay and west Gravina Island allowed

for a viable fishery and provided an opportunity for industry self assessment; potentially providing funds for future reconnaissance and assessment surveys.

As a result of the meeting held prior to the 1997/98 season, the Southeast Alaska Geoduck Task Force was formed. On January 7, 1998 the task force voted to assess themselves $0.25 on the pound for the February 1998 commercial opening. Through a cooperative agreement between ADF&G and SARDFA, portions of funds generated through the voluntary self-assessment were used to estimate the geoduck clam biomass in Port Alice (summer 1998), and Turn Point, Cone Bay, and Nakat Inlet (Cape Fox and Lord/Sitklan Islands, summer 1999). Port Alice was scheduled to open during the 1998/99 season but ADEC water quality sampling was not available in time for the general opening on November 15, 1998 and this area was therefore not opened. Without ADEC approval for Port Alice for the 1998/99 season, the general industry consensus during the October 14, 1998 Geoduck Task Force meeting was to delay opening Port Alice until the 1999/2000 season.

A cooperative agreement was also entered into between the ADF&G and the Sitka Harvest Divers Association (SHDA). Using funds provided by the SHDA, ADF&G conducted a survey of the geoduck clam populations on the west coast of Baranof Island and nearby islands in portions of Subdistricts 113-31 and 113-41. This area has since become know as the Goddard area due to the proximity of the Goddard Hot Springs and includes three present day fisheries (Biorka/Legma Islands, Taigud/Kolosh Islands, Elovoi/Golf/Gornoi Islands, Figure 2).

Reconnaissance surveys within Sea Otter Sound (Port Alice/Cone Bay, Turn Point), Nakat Inlet (Cape Fox, Lord/Sitklan Island), and the Goddard area were conducted by SARDFA and SHDA prior to population assessment surveys by the department. The purpose of the reconnaissance surveys was for industry to identify the most likely sites capable of supporting commercial geoduck fisheries. This data was then given to the department for biomass assessment surveys. The department has also received Federal Nearshore Funds[1] that have been used through industry contracts to complete reconnaissance surveys for potential commercial beds in a substantial portion of Southeast Alaska during the spring of 2001, 2002, and 2003. Funds provided by SARDFA, state appropriations and Federal Nearshore grants were available for additional reconnaissance surveys during the spring and summer of 2005, 2006, 2007 and 2008. Five existing fisheries had additional reconnaissance work done at industry request to better define existing beds and find beds which were not identified during original reconnaissance work. The 2005 reconnaissance work was conducted in Cone Island North, Cone Island South/Paloma Pass, Port Real Marina, Portillo Channel, and Bucareli Bay fisheries. Cone Island North and Cone Island South/Paloma Pass were surveyed by the department during the 2005 survey season. The results from these surveys included increased precision of the survey and an increase in biomass with subsequent increase of GHL. Since 1998, new fisheries have been defined by industry reconnaissance and subsequently surveyed by the department (Table 4) almost yearly with a current total of 38 defined commercial harvest areas.

Prior to the January 2000 Board of Fisheries meeting, regulations (5 AAC 38.110.) referred to the general harvest of clams; requiring a permit that specifies the species, method of fishing, area of operation, and harvest levels. There were no regulations that specifically addressed the

[1] The reconnaissance and biomass surveys were funded, in part, by grants NA06FN0385 and NA16FN1560 from the National Oceanic and Atmospheric Administration (NOAA). The views expressed are those of the authors and do not necessarily reflect the views of NOAA or any of its sub-agencies.

Southeast Alaska geoduck clam fishery. The department, in cooperation with the SARDFA Geoduck Committee, developed regulations and a management plan for the Southeast Alaska commercial fishery. The Alaska Board of Fisheries formally adopted the geoduck management plan (5 AAC 38.142) during their regular meeting in January 2000, which was in place beginning with the 2000/01 commercial fishery. The core elements are:

1. There are no size limits for geoducks and all geoducks harvested must be retained.
2. Annual guideline harvest levels must be established for an area before it is open to commercial harvest. The GHL must be based on biomass estimates where biomass surveys have been conducted within the previous 12 years.
3. Commercial harvest gear is limited to dive gear while using a hand-held, manually operated, water jet device.

Previous to the 2003/04 season, the department opened commercial geoduck fisheries in Southeast Alaska with little or no preliminary knowledge of current PSP levels. The ADEC also did not have a live shipment program in place for geoducks that was based on preliminary fishery testing previous to the 2003/04 season. Geoducks were harvested and then tested for a live market in "lots". Due to requests by SARDFA for changes to ADEC's program, ADEC held a geoduck conference in Anchorage on August 5 and 6, 2002. A result of this conference was the implementation of an enhanced live shipment program for geoducks. This required changes in ADF&G fishery management in order to target live geoduck sales. This program was enacted prior to the 2003/04 fishery. During the 2003/04 through 2006/07 seasons a significant amount of PSP data was collected by ADEC and changes to the testing protocol were adopted. Further, upwards of 90% of the GHL was shipped live, significantly increasing the value of the fishery.

The fluid openings (i.e. openings based on geoducks passing ADEC PSP testing) necessitates relatively short notice for announcing openings. As openings for specific areas may be delayed, then opened on short notice, permit holders are required to closely monitor PSP test results which are posted on ADEC's and SARDFA's web sites. Divers may not be 'in position' to take advantage of a short-noticed opening (i.e. divers may be involved in other fisheries/activities and not be able to participate given short notice). This may prohibit a diver from harvesting lower valued product for the processed market, but may leave the product for a higher valued live market. There is no guarantee that an area will ever pass PSP testing before the end of a season which means the product may eventually be harvested for the processed market. By managing the fishery based on PSP results, the fishery may be extended over a longer period. Though the objective of the management plan is to realize a higher valued fishery, the department was concerned that allocative issues may occur that would need to be addressed by the board.

During the January 2003 Board of Fisheries meeting the geoduck management plan was amended with the establishment of a control site (Port Mayoral) within Subdistrict 103-50. The Board also amended regulations that the department "may" consider PSP levels in geoduck management (5 AAC 38.142 (a)).

During the February 2006 Board of Fisheries meeting the geoduck management plan was amended to allow the department to require a harvest logbook from commercial divers. A second geoduck clam control site was also established within Subdistrict 101-27 (Blank Inlet).

2007/2008 GEODUCK COMMERCIAL HARVEST SEASON

The 2007/08 season GHL was 517,500 lb (Table 3). A total of 59 divers harvested 610,807 lb. The fishery was open from October 4, 2007 until April 2, 2008. This was the largest GHL since the geoduck fishing began in Southeast Alaska and all product landed entered the live market. Exvessel value averaged \$3.20 lb^{-1} for a estimated exvessel value of \$1,954,582. Harvest for live product was allowed up to three days a week and areas had to pass only one PSP sample before a fishery could be certified to ship live product.

2008/2009 OUTLOOK

A total of 868,700 lb of whole geoduck clams will be available for harvest during the 2008/09 season (Figure 2 and Table 3). Anecdotal conversations with processors and divers indicate a potential of approximately \$4.00 lb^{-1} delivering to the live market during the 2008/09 season.

Prefishery testing was scheduled to begin during the first week of October 2008. Once an area passes a single PSP test, the department will issue a news release opening that area for up to three days in the Ketchikan management area and up to seven days in the Sitka management area. These changes are a result of analysis of PSP data collected during each of the previous three seasons by ADEC. With SARDFA consultation for the purpose of slowing down the fishery and maximizing market condition, the ADF&G will only open harvest for one day a week until approximately December 1, 2008. Weekly openings after this date will likely be open for two days a week with actual weekly opening being decided inseason.

Daily open periods will initially be from 9:00 a.m. to 3:00 p.m. but may change, depending on the number of divers anticipated in an individual area and the GHL for that area. If an area does not pass PSP testing by the last week of April the department may open all remaining areas for commercial harvest of processed product.

RED SEA URCHIN

BACKGROUND

Two commercial species, red sea urchins *Strongylocentrotus franciscanus* and green sea urchins *S. droebachiensis*, are common in Southeast Alaska. The red sea urchin occurs primarily on rocky shorelines of the outside coast with largest concentrations in southern Southeast Alaska. Green sea urchins are most common in protected waters of Southeast Alaska in a wider variety of habitats. The red sea urchin population is kept at very low levels by sea otters in many areas of the outside coasts, including, the Barrier Islands, Baker Island, Chichagof Island, Dall Island, Kuiu Island, Lulu Island, Maurelle Islands, Noyes island, Sumez Island, southern Prince of Wales Island, and nearby areas. The only commercial fishery for urchins in recent years in Southeast Alaska has been for red sea urchins. Urchins are harvested for their gonads, commonly called roe or uni, with no distinction made between males or females. The product is most valuable fresh and is marketed primarily in Japan.

FISHERY DEVELOPMENT AND HISTORY

Harvests of red sea urchins in Southeast Alaska began in 1981 near Ketchikan, primarily around Gravina Island. Both red and green sea urchins were harvested, with the vast majority of the

harvest comprised of red urchins. Participation and harvest built through the mid-1980s (Table 5), expanding to include Districts 1, 2, 3, and 4. Harvest grew to 890,092 lb in 1986/87 and then tapered off due to difficulties in marketing. In 1988, harvests were restricted to District 1, Gravina Island, District 3 and the West Coast of Prince of Wales Island due to lack of staff time and budget support the fishery.

Interest in establishing a commercial urchin fishery in Southeast Alaska resurged in 1990 due to the success of urchin fisheries in California, Washington, and British Columbia. This interest was directed towards the Sitka area; however, lacking basic stock information, further commercial harvest was postponed until completion of a test fishery in late 1990 and early 1991 to estimate population size and to gather size frequency data. A limited commercial fishery opened in southern Sitka Sound in January 1991 with a harvest of 174,233 lb before it was closed in April. Subsequent fisheries were opened in 1992 and 1993, and then closed indefinitely due to extreme predation by sea otters. It is estimated that 16,000,000 sea urchins were consumed by sea otters in a 15 month period from December 1, 1992 to February 24, 1993 (Davidson et al. 1993). All other areas of Southeast Alaska remained closed pending development of a management plan, stock assessments, harvest quotas, and a means of monitoring and managing the fishery.

ADF&G initiated a test fishery in District 1 near Ketchikan in the spring 1995 as a method to pay for population assessment surveys. The test fishing contract was awarded to Ocean Fresh Seafoods of Fort Bragg, California, the sole bidder. Under the contract, Ocean Fresh paid the department $139,567 in exchange for the opportunity to harvest 3,000,000 lb of red sea urchins. The test fishery spanned 14 months from March 1995 through April 1996, and harvested 2,965,607 lb of red sea urchins (Table 5). Monthly roe recovery averaged between 5.5% and 12.2%. The average price per pound ranged from $0.29 to $0.81. The test fishery provided considerable employment and revenues to Southeast Alaska, with an estimated exvessel value of approximately $1,402,837 for dive harvesters.

Fully developed red sea urchin fisheries have occurred ever since the 1996/97 fishing season. The overall quota has ranged between 4.4 and 6.8 million pounds, however, selected areas have seen reductions in biomass, likely due to sea otter predation. Most areas in Southeast Alaska supporting red sea urchin populations are threatened by the rapidly sea otter population. The numbers of participating divers and landings have decreased during recent years.

MANAGEMENT STRATEGY AND REGULATION DEVELOPMENT

Prior to 1996 permits to fish for sea urchins were given under authority of 5 AAC 38.062. In 1984, the first year with significant landings of red urchins, there was a size limit of 3 to 5 inches test diameter to protect small urchins for recruitment, to provide large urchins as a protective spine canopy for small urchins, and to give processors the desired size urchin. An interim management plan was in place in 1987 for the Ketchikan area with a three-year area rotation and size limits modified slightly to 3 to 4.5 inches. A second interim plan was developed for 1991 through 1993 for the Sitka area. The Sitka area plan included a 3.2% annual harvest rate on the estimated biomass, three-year area rotations, weekly fishing periods of noon, Saturday through noon, Thursday, and no size limits.

In 1996, ADF&G and the sea urchin industry developed interim regulations and a management plan for the commercial urchin fishery in Southeast Alaska. This plan was implemented during the 1996/1997 season. The regulations were adopted by the commissioner under authority of 5

AAC 39.210 for High Impact Emerging Fisheries and became effective in December 1996. The Alaska Board of Fisheries formally adopted the red sea urchin management plan during their regular meeting in January 1997. The core elements are:

1. Annual guideline harvest levels are 6% of the biomass estimate. Fisheries will only be opened where biomass surveys have been conducted in the previous three years.
2. Harvest opportunities are to be distributed to each week of every month that the fishery is open. The fishery is to be managed to span approximately four months, subject to needs for conservation, law enforcement, reducing waste, and promoting fishery development. Size limits and trip limits may be imposed if needed to slow the pace of the fishery.
3. Processing vessels must carry observers, and vessels transporting unprocessed product out of Registration Area A must first obtain a transport permit.
4. In addition to fish ticket requirements, processors must submit records of the roe recovery within 30 days of landing.

The board made a modification to the regulation requiring onboard observers during the 2003 BOF meeting. New regulations with a three-year sunset clause allowed a catcher-seller to catch and process his own product onboard the harvest vessel (5 AAC 38.145 (n)). This regulation was permanently adopted during the January 2006 board of fisheries meeting.

During the 2006 meeting, the board extended the interval between assessment surveys from three to six years but no more than the equivalent of the combined three year annual guideline harvest levels could be harvested within those six years. This reduced the number of surveys required to maintain red sea urchin areas open to commercial harvest when those area's GHL were not entirely taken; the GHL not taken in any one year can be forwarded into subsequent year's GHL. This regulation allowed the more efficient and cost effective surveying of areas whose GHL is not taken each year, without increasing the overall harvest between surveys.

2007/08 RED SEA URCHIN COMMERCIAL HARVEST

The 2007/08 season opened by regulation on October 1, 2007 with a GHL of 5,599,500 lb. Due to changes in regulations extending intervals between surveys within individual commercial areas, no red sea urchin assessment surveys were completed during the 2007 survey season. The 2007/08 season's GHL was exactly the same as the 2006/07 season. A total of ten divers landed 659,816 lb of red sea urchins with an exvessel value of $237,534.

2008/09 OUTLOOK

Only one commercial area (Subdistrict 101-21) was surveyed by the department during the 2008 survey season. The estimated GHL for the 2008/09 season in Southeast Alaska is 5,440,100 lb (Figure 3). The fishery opened by regulation October 1, 2008.

SEA OTTERS

BACKGROUND

During the first half of the 20th century sea otters *Enhydra lutris* were not present in the Alexander Archipelago due to their near extermination roughly 100 years ago (Kenyon 1969).

As a result of this absence, many of the prey populations of sea otters likely responded to the reduced predation. Prey responses may have included increases in mean size, density, and biomass. These responses have been documented in sea urchin populations *Strongylocentrotus spp* (Estes and Palmisano 1974). In 1965 sea otters were first captured near Amchitka Island and in Prince William Sound and transferred to various locations in southeast Alaska where it was thought they would subsequently establish new populations (Jameson et al. 1982). On the outer coast of Southeast Alaska 412 otters were successfully released. The population remained low until 1987 when it began a period of rapid growth (Pitcher and Imamura 1990).

The annual rate of increase for the Southeast Alaska stock ranged from 15.7% to 23.3% between 1966 and 1988. A 1994 survey conducted for the entire Alexander Archipelago from Cape Spencer to Dixon Entrance estimated 11,697 individual otters (Agler et al. 1995). In 2002 there were an estimated 3,188 sea otters in the northern half of Southeast Alaska with 1,266 of those occurring in Glacier Bay and an additional estimated 6,008 in the remaining portions of the Alexander Archipelago (Bodkin 2004 personal communication). This data should be interpreted carefully for the estimates have large error components.

Opportunistic observations made by ADF&G divers on the outer coast of Southeast Alaska suggest sea otters select red sea urchins and pinto abalone when foraging on rock habitat and on several species of clams including geoduck clams when foraging on soft sand and mud substrate. Once these species have been depleted it appears they turn to less desirable prey such as sea cucumbers and snails.

COMMERCIAL FISHERY INTERACTION

The population of sea otters in coastal waters of Southeast Alaska is having negative effects on the region's dive fisheries. The commercial harvest of sea urchins in Sitka Sound has been eliminated by sea otter predation. Sea otters moved into the southern Sitka Sound red sea urchin fishing area in 1992 and, over the next year, removed an estimated 16,000,000 urchins or the majority of the standing stock (Davidson et al. 1993). Sea urchin biomass declined by nearly 100% in Southeast Alaska following the spread of sea otters into previously unoccupied habitats (Estes and Duggins 1995). Sitka Sound is currently closed to the harvest of red sea urchins due to extremely low biomass. The significant range expansion and rapid increase in otter populations occurred after the major harvest of abalone. Therefore, otter predation on abalone is not considered the major factor in the decline of abalone in the 1980s (Woodby et al. 2000). Otter predation is a major factor in the potential for further commercial abalone fishing. The Southeast Alaska abalone population remains at very low levels due in part to continued predation by sea otters. Sea otters have likely had a serious impact on numerous sea cucumber, geoduck clam, and red sea urchin commercial harvest areas with several areas closed to commercial harvest.

During the 2008 survey season multiple biomass surveys were conducted for geoduck clams and sea cucumbers in Sea Otter Sound in Districts 3 and 5. Opportunistic observations by department divers documented 297 otters during these surveys and estimate approximately half (46%) of the sea cucumber biomass remains in Sea Otter Sound when compared to the previous survey three years earlier. Two geoduck fisheries were resurveyed in the southern portion of Sea Otter Sound both with reduced biomass. One of the two fisheries will no longer support a commercial fishery. The department has documented areas where sea otters have been observed where no large invertebrates can be found to depths of 70 feet (70 feet is the maximum dive survey depth due to safety concerns).

OBSERVATIONS

The Department supports a substantial dive program in Southeast Alaska, primarily for red sea urchins, sea cucumber, geoduck clams, and herring spawn deposition as well as various studies for green sea urchins, horse clams, abalone, and other miscellaneous species. Annually, over 2,000 logged dives are completed. These studies occur throughout much of Southeast Alaska, providing opportunities to observe sea otter population distribution and their effect on invertebrate populations. To date, these opportunistic observations have not been recorded through a structured program nor are resources available to prioritize these observations. Beginning in 2004 the ADF&G dive assessment and vessel support personnel have systematically recorded all chance observations of sea otters during the field season which typically begins in mid-March and continues to approximately early to mid September (Figure 4). These observations suggest that sea otter competition for shellfish, crabs, and other species is high and the department and industry have expressed concern about those resources. In conversations with industry divers, many have indicated that sea otters have dramatically and negatively affected their harvest of shellfish. It is expected that the outer coastline will eventually become continuously populated with sea otters from Dixon Entrance to well north of Cape Spencer (Kelly 1995).

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TABLES AND FIGURES

Table 1.–Registration Area A (Southeast Alaska) commercial abalone harvest, effort, value, and season length, 1970/71 through 1996/97.

Season	Guideline Harvest Range (lb x 1,000)	Southern Southeast Harvest (lb)	District 13 Harvest (lb)	Total Southeast Harvest (lb)	Number of Divers	Exvessel Value	Season Length (days)
1970/71							365
1971/72		Confidential Data—Less than 3 divers reporting landings					365
1972/73		65	2,610	2,675	6	$2,675	365
1973/74			3,000	3,000	3	$4,500	365
1974/75			13,826	13,826	3	$20,739	365
1975/76		55	8,497	8,552	8	$17,104	365
1976/77		Confidential Data—Less than 3 divers reporting landings					365
1977/78		805	10,861	11,666	10	$14,816	365
1978/79		130,607	49,320	179,927	35	$253,697	365
1979/80		316,952	61,733	378,685	43	$408,980	287
1980/81	250	233,589	18,382	251,971	40	$420,792	273
1981/82	100–125	338,305	32,589	370,894	54	$445,073	59
1982/83	100–125	100,458	12,826	113,284	41	$240,162	36
1983/84	100–125	99,294	8,735	108,029	31	$302,481	126
1984/85	100–125	59,237	8,379	67,616	25	$165,659	151
1985/86	25–58	32,817	7,720	40,537	18	$117,963	71
1986/87	25–58	47,404	13,820	61,224	24	$168,366	146
1987/88	25–58	57,209	10,406	67,615	42	$208,930	36
1988/89	25–58	65,928	10,172	76,100	45	$307,444	33
1989/90	25–58	57,784	4,020	61,804	67	$330,651	40
1990/91	25–58	62,779	5,607	68,386	97	$374,071	9
1991/92	25–58	35,987	8,095	44,082	96	$267,578	35
1992/93	25–58	26,905	9,083	35,988	100	$386,151	19
1993/94	25–58	27,680	7,172	34,852	86	$487,928	7
1994/95	25–58	15,055	7,824	22,879	102	$330,373	8
1995/96	0–16	8,524	5,828	14,352	100	$126,526	7
1996/97			———closed———				

Table 2.–Registration Area A (Southeast Alaska) commercial sea cucumber harvest, effort, and value, 1986/87 through 2008/09.

Season[a]	Guideline Harvest Level (lb)	Total Harvest (lb)	Average Price / lb[b]	Estimated Exvessel Value[b]	Number of Divers	Number of Landings	Average lb / Diver	Average Earnings / Diver[b]
Data prior to 1986/1987 season is confidential.								
1986/87	34,043	34,043	$0.21	$7,149	7	44	4,863	$1,021
1987/88	65,056	65,056	$0.21	$13,662	11	143	5,914	$1,242
1988/89	801,405	801,405	$0.21	$169,096	57	922	14,060	$2,967
1989/90	2,318,305	2,318,305	$0.42	$969,142	205	2,263	11,309	$4,728
1990/91	704,491[c]	804,184	$0.59	$472,386	143	890	5,624	$3,303
1991/92	839,160[c]	869,988	$0.80	$697,970	187	704	4,652	$3,732
1992/93	1,100,440	1,249,621	$0.79	$988,628	240	1,003	5,207	$4,119
1993/94	799,235	964,343	$1.03	$995,783	320	949	3,014	$3,112
1994/95	1,351,000	1,322,219	$1.79	$2,361,541	261	1,379	5,066	$9,048
1995/96	1,157,500	1,332,095	$1.39	$1,846,556	424	1,582	3,142	$4,355
1996/97	939,300	909,789	$1.29	$1,169,612	294	1,234	3,095	$3,978
1997/98	892,410	894,739	$1.63	$1,458,425	226	976	3,959	$6,453
1998/99	1,026,345	1,055,572	$1.55	$1,636,137	219	971	4,820	$7,471
1999/00	1,580,000	1,569,626	$1.95	$3,060,771	200	1,378	7,848	$15,304
2000/01	1,122,500	1,158,385	$2.23	$2,583,199	220	913	5,265	$11,742
2001/02	1,425,200	1,438,451	$1.75	$2,517,289	235	1,201	6,121	$10,712
2002/03	1,576,700	1,639,440	$1.26	$2,042,882	201	1,313	8,156	$10,164
2003/04	1,637,700	1,698,650	$1.42	$2,472,456	195	1,296	8,711	$12,679
2004/05	1,381,200	1,374,532	$2.12	$2,769,116	194	1,139	7,085	$14,274
2005/06	1,475,800	1,437,731	$2.00	$2,875,462	198	1,418	14,523	$14,523
2006/07	1,598,700	1,597,457	$1.97	$3,146,990	175	1,237	17,983	$17,983
2007/08[d]	1,384,300	1,418,305	$2.66	$3,774,428	179	1,260	7,923	$21,086
2008/09	1,122,100							

[a] Season = October 1 thru September 30. Experimental fishing program prior to 1990/1991 season.

[b] Based on CFEC (annual) data prior to the 1998/1999 season, then based on ADF&G fish ticket data.

[c] Quota originally calculated in numbers of sea cucumbers.

[d] Does not include data for the Yakutat sea cucumber fishery

Table 3.–Registration Area A (Southeast Alaska) commercial geoduck clam harvest, effort, and value, 1985/86 through 2008/09.

Season[a]	Guideline Harvest Level (lb)	Total lb Landed	Average Price per lb[b]	Estimated Exvessel Value[b]	Number of Divers	Number of Landings	Total Days Open	Average lb per Diver	Average Earnings per Diver[b]
1985/86	[c]	143,868	$0.20	$28,774	8	40	240	17,984	$3,597
1986/87	[c]	28,191	$0.25	$7,048	3	9	240	9,397	$2,349
1987/88	125,000	185,674	$0.30	$55,702	6	156	240	30,946	$9,284
1988/89	189,232	143,188	$0.30	$42,956	9	127	240	15,910	$4,773
1989/90	199,000	207,083	$0.51	$105,612	18	165	240	11,505	$5,867
1990/91	196,000	189,585	$0.51	$96,688	15	130	176	12,639	$6,446
1991/92	219,000	193,074	$0.63	$121,637	20	131	33	9,654	$6,082
1992/93	196,000	189,379	$1.12	$212,104	22	109	19	8,608	$9,641
1993/94	219,000	209,322	$1.48	$309,797	39	115	10.5	5,367	$7,944
1994/95	195,000	197,246	$1.64	$323,483	64	190	14	3,082	$5,054
1995/96	209,000	229,681	$2.25	$516,782	109	401	10	2,107	$4,741
1996/97	196,000	203,017	$2.55	$517,693	97	359	6	2,093	$5,337
1997/98	196,000	180,440	$4.00	$721,760	110	312	3	1,640	$6,561
1998/99	112,500	111,311	$2.12	$235,979	98	206	66	1,136	$2,408
1999/00	250,400	202,260	$1.60	$400,640	61	240	50	4,105	$6,568
2000/01	391,100	438,334	$1.06	$414,566	74	544	148	5,285	$5,602
2001/02	285,322	283,405	$0.72	$204,052	37	324	78	7,711	$5,515
2002/03	382,100	392,406	$1.69	$663,166	50	537	35	7,848	$13,263
2003/04	341,000	377,584	$2.87	$1,083,666	49	482	25	7,706	$22,116
2004/05	477,000	535,516[d]	$3.95	$2,115,288	61	724[d]	24	8,779	$34,676
2005/06	403,800	436,040	$2.05	$893,882	64	545	51	6,813	$13,967
2006/07	687,100	726,866	$3.87	$2,812,971	66	812	42	11,013	$42,621
2007/08	517,500	610,807	$3.20	$1,954,582	59	674	30	10,353	$33,129
2008/09	868,700								

[a] Season = October 1 thru September 30.

[b] Based on CFEC (annual) data prior to the 1998/1999 season, then based on ADF&G fish ticket data.

[c] Only Noyes Island open (Subdistrict 103-70). Five-year GHL established of 300,000 lb for all three areas. Separate GHLs first established for 1988/1989 season. Therefore, 1987/1988 GHL does not include remaining GHL from Noyes Island (e.g. 125,000 for Gravina Island only).

[d] Excludes 2005 mariculture site purge fishery commercial harvest of 167,822 lb.

Table 4.–Southeast Alaska commercial geoduck clam harvest areas, current guideline harvest levels, original open season, and recent reconnaissance/survey funding sources, 1987/88 through 2008/09.

Harvest Area	Current Annual GHL (lb)	First Open Season	Funding Source (recent areas only)
Biorka / Legma Islands	10,200	1998/99	SHD[a]
Taigud / Kolosh Islands	3,600	1998/99	SHD[a]
Elovoi / Golf Islands	600	1998/99	SHD[a]
Symonds Bay	3,100	1989/90	
Port Alice / Cone Bay	11,800	1998/99	SARDFA[b]
Turn Point	1,700	1998/99	SARDFA[b]
Steamboat Bay	20,700	1985/86	
Little Steamboat Bay	7,900	1985/86	
Ulitka Bay	4,600	1985/86	
Cone Island North	106,900	2002/03	SARDFA[b], NSIV [e]
Cone I. South / Paloma Pass	134,000	2002/03	SARDFA[b], NSIV [e]
Vallenar Bay	7,000	1987/88	
South Vallenar Point	0	1988/89	
Middle Gravina	7,800	1989/90	
Nehenta Bay	4,000	1990/91	
Foggy Bay	25,500	1990/91	
Kirk Point / Bullhead Cove	7,600	1991/92	
Cape Fox	7,800	1999/00	SARDFA[b]
Lord / Sitlan Is.	6,700	1999/00	SARDFA[b]
Blanquizal Islands	9,400	2002/03	SARDFA[b]
Palisades Islands	19,300	2002/03	SARDFA[b]
Port Santa Cruz	26,500	2000/01	SARDFA[b]
Percy Islands	14,900	2001/02	NSII[c]
Vegas / Hotspur Islands	11,800	2001/02	NSII[c]
Bucareli Bay	3,600	2001/02	NSII[c]
Portillo Channel	36,100	2001/02	NSII[c]
Port Real Marina	6,800	2001/02	NSII[c], SARDFA[b]
East San Fernando Island	7,100	2002/03	NSII[c]
Kelp Island	10,900	2003/04	NSIII[d]
Northwest Dall Island	21,400	2004/05	NSIV [e]
North Lulu Island	35,500	2004/05	NSIV [e]
Kaigani Strait	24,500	2003/04	NSIII[d], NSIV [e]
Cat and Dog Island	7,900	2004/05	NSII[c], NSIII[d], NSIV[e]
Slate Island	4,700	2004/05	NSIV [e]
Maurelle Islands	25,550	2007/08	NSVII [f]
Tlevak Strait	10,850	2007/08	NSVIII [f]
Davidson Inlet	4,500	2008/09	NSVIII [f]
Warren Island	13,350	2008/09	NSVIII [f]

[a] SHD = Sitka Harvest Divers.
[b] SARDFA = Southeast Alaska Regional Dive Fisheries Association.
[c] NSII = Nearshore II federal funding.
[d] NSIII = Nearshore III federal funding.
[e] NSIV = Nearshore IV federal funding.
[f] NSVIII = Nearshore VIII federal funding.

Table 5.–Registration Area A (Southeast Alaska) commercial red sea urchin harvest, effort, and value, 1980/81 through 2008/09.

Season	Guideline Harvest Level (lb)	Total Landed (lb)	Average Price Per lb[a]	Estimated Exvessel Value[a]	Number of Divers	Number of Landings	Average lb per Diver	Average Earnings per Diver[a]
1980/81[b]				———Confidential———				
1981/82[b]				———Confidential———				
1982/83[b]				———Confidential———				
1983/84		23,303	$0.12	$2,796	4	9	5,826	$699
1984/85		188,023	$0.17	$31,906	16	84	11,751	$1,994
1985/86		58,303	$0.13	$7,288	8	32	7,288	$911
1986/87		890,092	$0.14	$125,335	26	459	34,234	$4,821
1987/88[b]				———Confidential———				
1988/89		223,883	$0.41	$91,106	11	128	20,353	$8,282
1989/90		23,617	$0.25	$5,833	9	33	2,624	$648
1990/91		174,233	$0.26	$45,823	6	91	29,039	$7,637
1991/92		428,220	$0.30	$128,894	37	256	11,574	$3,484
1992/93		143,485	$0.29	$41,467	17	108	8,440	$2,439
1993/94		0		0	0		0	
1994/95[c]	3,000,000	2,088,395	$0.45	$944,329	1	1,391	2,088,395	$944,329
1995/96[c]		877,212	$0.52	$458,508	1	705	877,212	$458,508
1996/97	6,093,579	4,929,280	$0.38	$1,878,056	150	3,483	32,862	$12,520
1997/98	4,255,364	4,083,877	$0.34	$1,408,397	129	2,465	31,658	$10,918
1998/99	4,822,700	3,075,095	$0.40	$1,230,038	62	1,524	49,598	$19,839
1999/00	5,748,700	2,676,456	$0.38	$1,017,053	47	1,094	56,946	$21,639
2000/01	6,806,700	2,373,993	$0.36	$854,637	56	842	42,393	$15,261
2001/02	5,689,300	2,720,241	$0.34	$924,882	32	995	85,008	$28,903
2002/03	5,309,900	3,578,493	$0.32	$1,133,706	36	1,265	99,403	$31,492
2003/04	5,095,100	2,834,872	$0.33	$895,369	40	1,019	70,872	$22,384
2004/05	5,518,300	1,801,893	$0.32	$576,605	31	651	58,125	$18,600
2005/06	5,753,100	1,024,282	$0.31	$317,527	17	354	60,252	$18,678
2006/07	5,599,500	622,501	$0.33	$205,425	11	209	56,591	$18,675
2007/08	5,599,500	659,816	$0.36	$237,534	10	252	65,982	$23,753
2008/09	5,440,100							

[a] Based on CFEC (annual) data prior to the 1998/1999 season, then based on ADF&G seasonal fish ticket data.

[b] Confidential information, ≤ 3 permits participating.

[c] Department test fishery. GHL is the agreed test fishery maximum poundageage taken during spring 1995–spring 1996, in exchange for research funds.

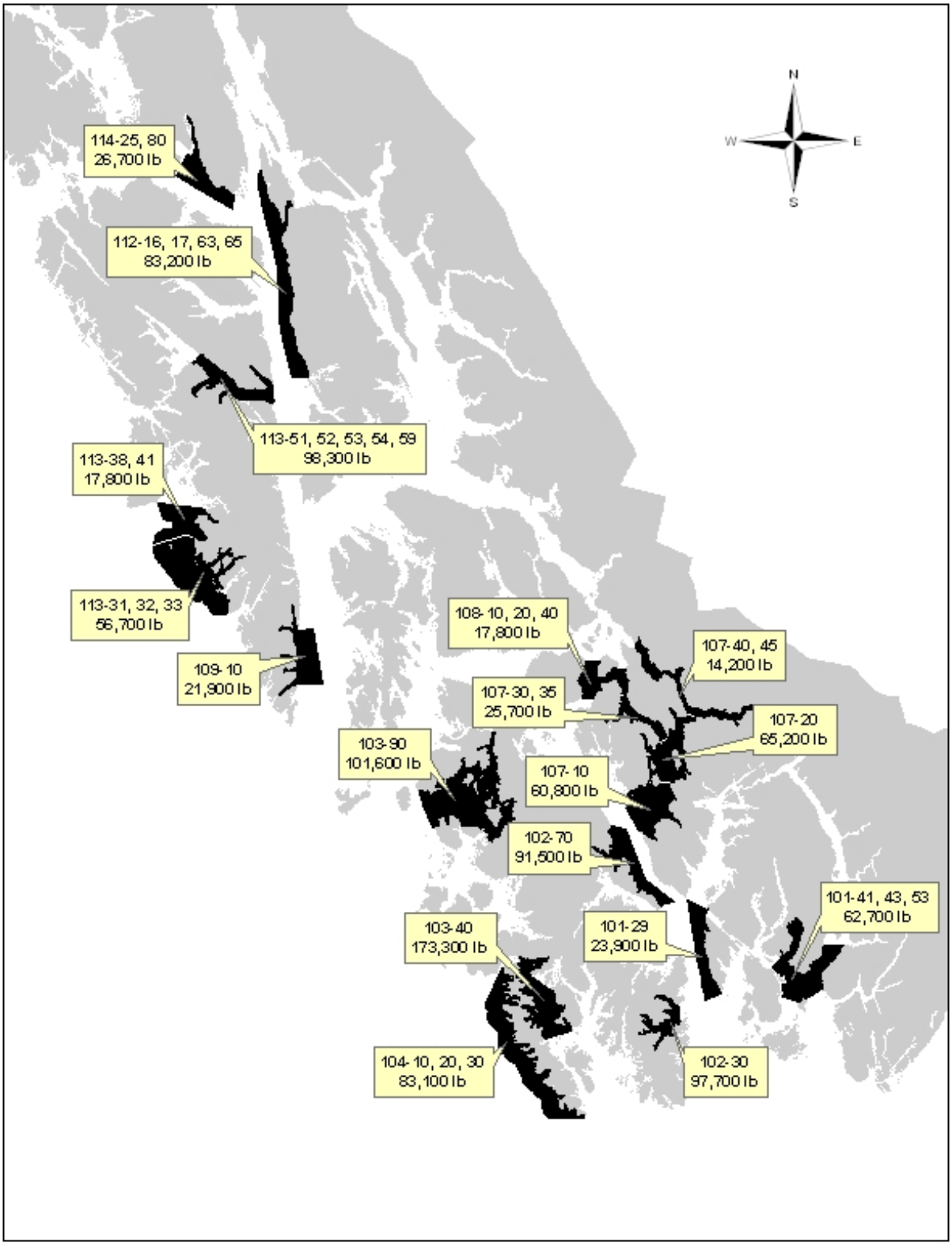

Figure 1.–Sea cucumber commercial harvest areas for the 2008/09 season.

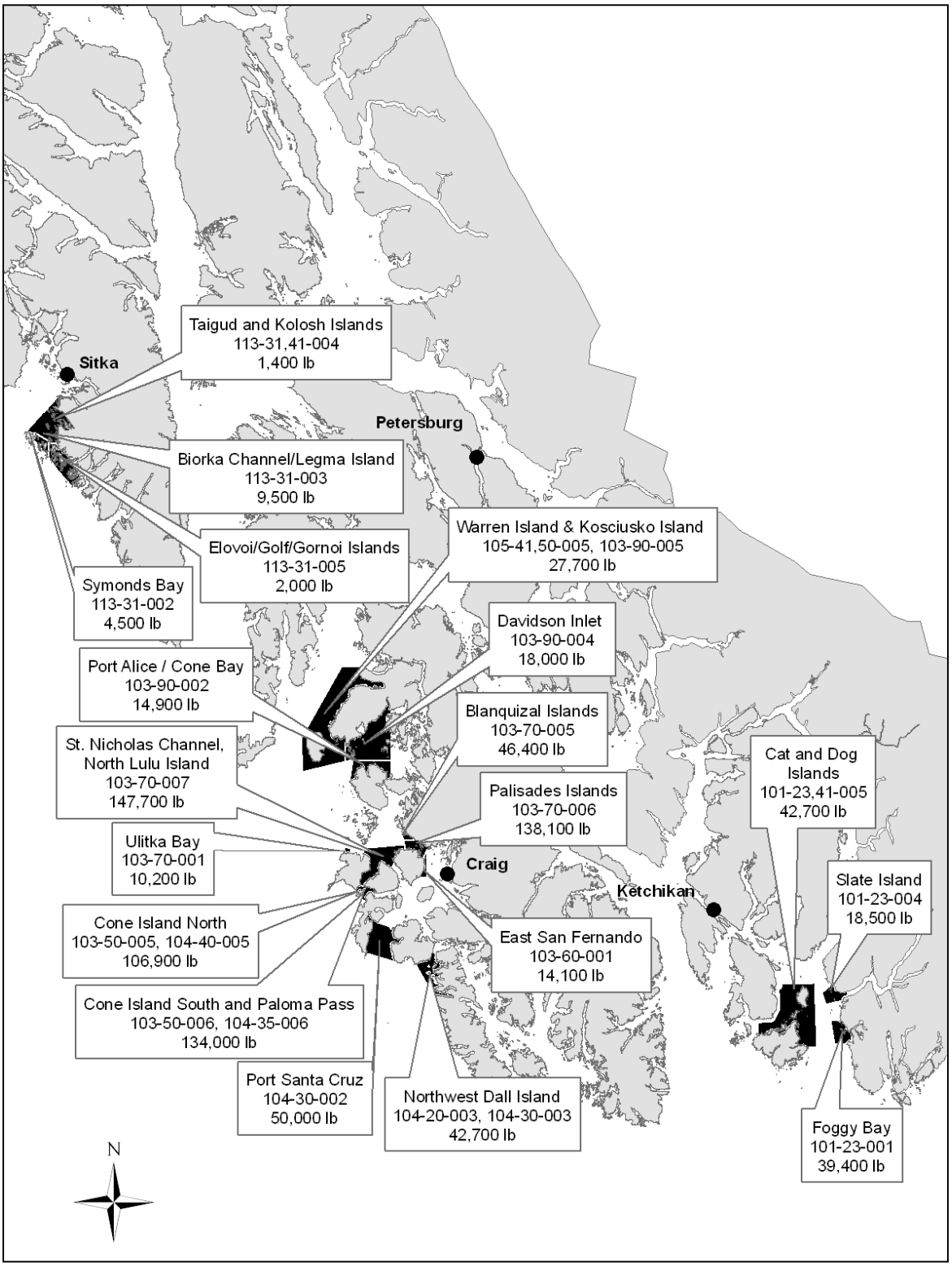

Figure 2.–Geoduck clam commercial harvest areas for the 2008/09 season.

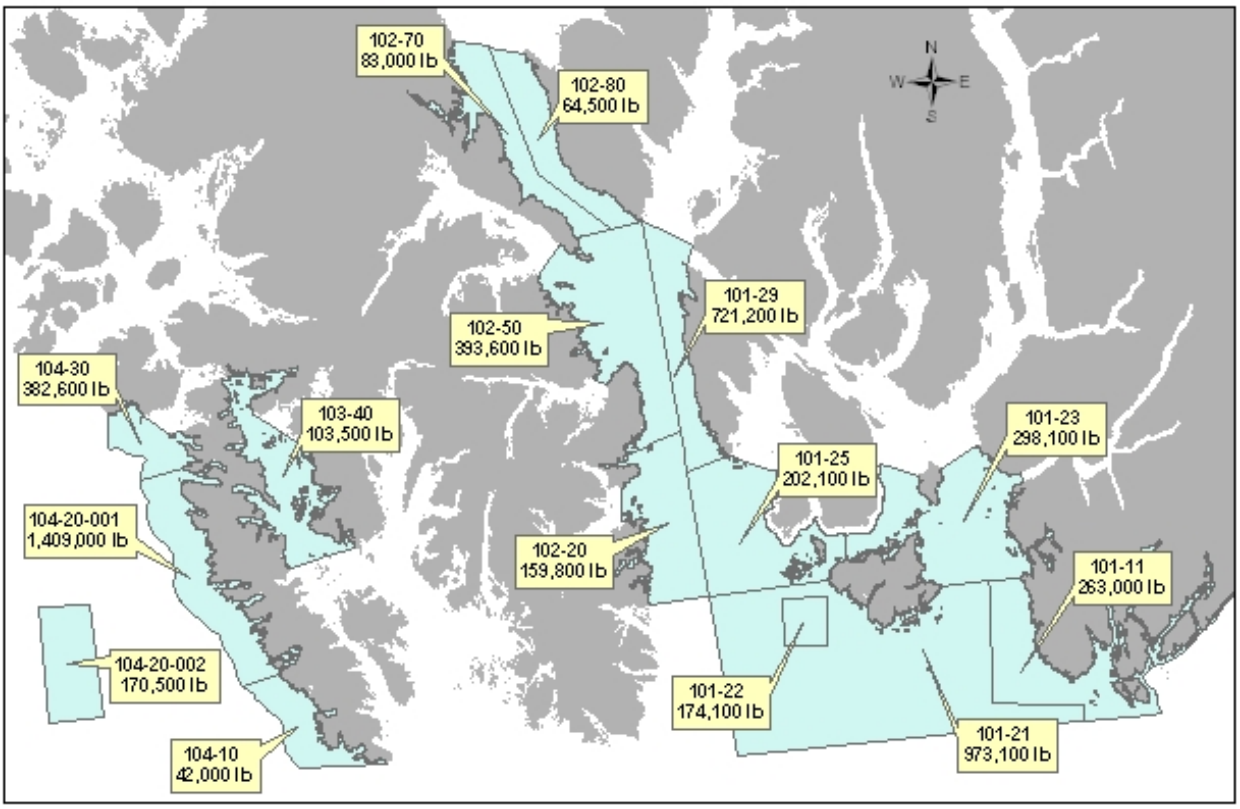

Figure 3.–Red sea urchin commercial harvest areas for the 2008/09 season.

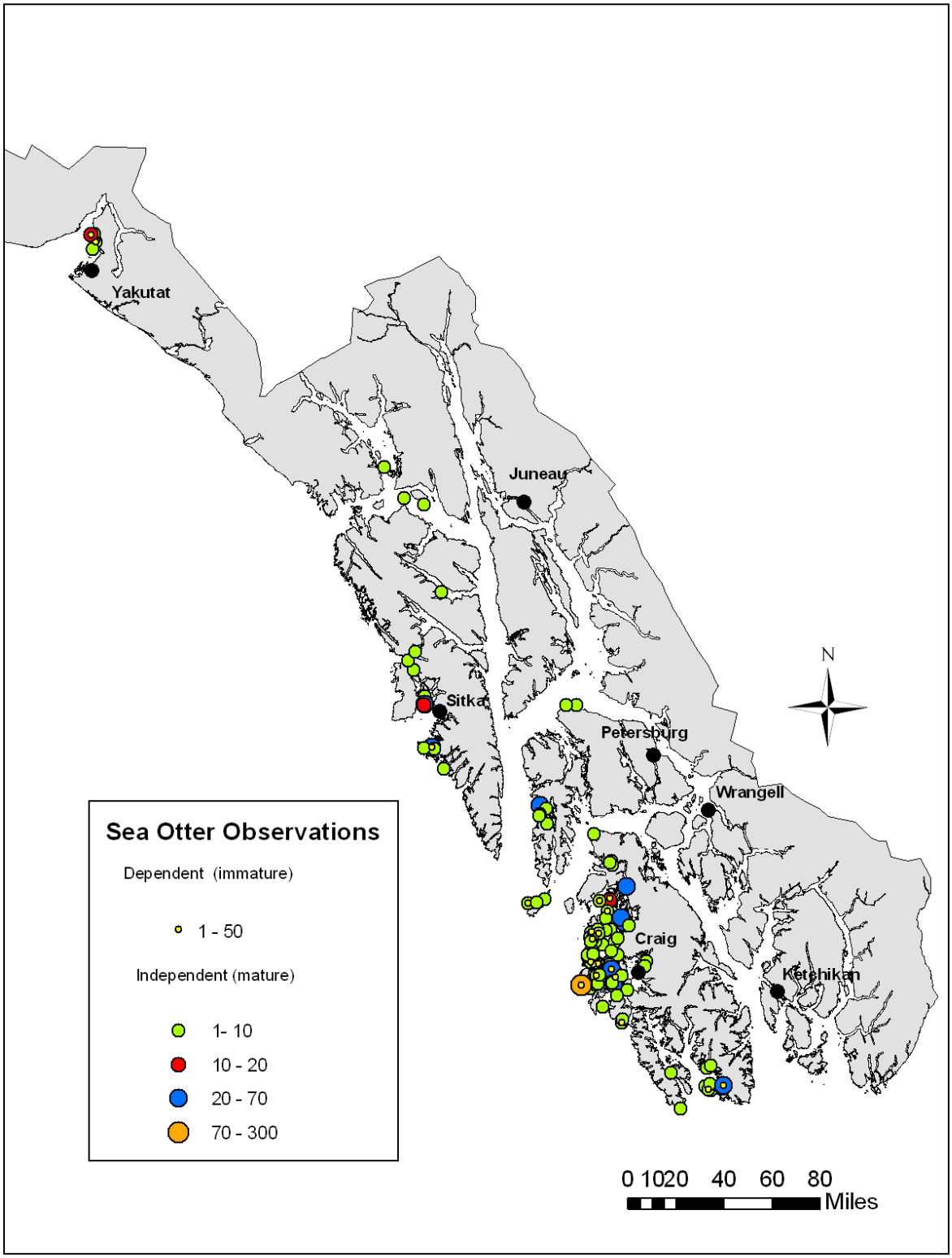

Figure 4.–Sea otter observations recorded by department during dive assessment in Southeast, Alaska during the 2004 through 2007 survey seasons.