AMENDMENT 6
to the Fishery Management Plan for the Scallop Fishery off Alaska

In chapter 1.0 "Introduction", section 1.3.3 "Longevity and natural mortality" is replaced. In chapter 4.0 "Optimum Yield and Overfishing", the introductory paragraphs, section 4.1 "Assessment of the available scientific data", *Implications of Natural Mortality Rate*, and section 4.2 "Specification of OY and Overfishing" are replaced. In chapter 6.0 "Data Assessment and Collection" section 6.1 "At-Sea Catch Sampling" is added.

1.3.3 Longevity and natural mortality

Weathervane scallops are long-lived; individuals may live 28 years or more (Hennick 1973). The natural mortality rate (M) is thought to be low, although estimates vary. Instantaneous natural mortality (M) for weathervane scallops has been estimated by Kruse and Funk (1995), based on data presented in published papers (Kaiser 1986, Hennick 1973). A median M value of 0.13 was estimated using the methodology of Alverson and Carney (1975) based on growth parameters, Robson and Chapman (1961) based on catch curves, and Hoenig (1983) and Beverton (1963) based on maximum age. Little is known about the causes of natural mortality for scallops. Scallops are likely prey for various fish and invertebrates during the early part of their life cycle. Flounders are known to prey on juvenile weathervane scallops and seastars also may be important predators (Bourne 1991).

4.0 Optimum Yield and Overfishing

According to the Magnuson-Stevens Act, a fishery management plan for scallops must specify an optimum yield (OY) for the scallop fishery. The OY for a fishery means the amount of fish which will provide the greatest overall benefit to the nation, with particular reference to food production and recreational activities. The OY is specified on the basis of the maximum sustainable yield from the fishery, as reduced by any relevant economic, social, or ecological factors. The national standard 1 guidelines (50 CFR 600.310) state that the most important limitation on the specification of OY is that the choice of OY, and the conservation and management measures proposed to achieve it, must prevent overfishing. If a stock or stock complex becomes overfished, OY provides for rebuilding to the MSY level.

Overfishing is a level of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis. The definition of overfishing for a stock or stock complex may be expressed in terms of maximum level of fishing mortality or minimum stock size threshold. Overfishing must be defined in a way to enable the Council and the Secretary to monitor and evaluate the condition of the stock or stock complex relative to the definition. Overfishing definitions must be based on the best scientific information available and reflect appropriate consideration of risk. Risk assessments should take into account uncertainties in estimating harvest levels, stock conditions, or the effects of environmental factors.

4.1 Assessment of the available scientific data

Implications of Natural Mortality Rate. Natural mortality is one of the biological reference points commonly used in fisheries management to establish appropriate exploitation rates (Clark 1991). As discussed in section [1.3.3], the longevity (28 years) of weathervane scallops in Alaska implies that this species experiences a very low natural mortality rate (M = 0.13 percent annual mortality). The biological reference point, obtained by setting instantaneous fishing mortality (F) equal to M, implies that scallop harvest rates should not exceed 13 percent annually on any given stock. Unfortunately, other potentially useful benchmarks that would bear on the choice of appropriate exploitation rates for weathervane scallops are not presently available.

The biological reference point, F=M=0.13, implies that weathervane scallop stocks are at greater risk of overfishing than red king crab (Paralithodes camtschaticus) and Tanner crab (Chionoecetes bairdi) for which M=0.2 and M=0.3, respectively (NPFMC 1998). Also, unlike many crab stocks off Alaska, stock assessments of weathervane scallop biomass have not been made. Given these two observations, maintenance of healthy weathervane scallop stocks poses a serious challenge to fishery managers.

4.2 Specification of OY and Overfishing

The following definitions are based on the national standard 1 guidelines (50 CFR 600.310).

Maximum Sustainable Yield (MSY). MSY is the largest long-term average catch or yield that can be taken from a stock or stock complex under prevailing ecological and environmental conditions. The long-term average stock size obtained by fishing year after year at this rate under average recruitment may be a reasonable proxy for the MSY stock size, and the long-term average catch so obtained may be a reasonable proxy for MSY

MSY for weathervane scallops is 1.24 million lbs. (562.46 metric tons) of shucked adductor muscles. MSY was estimated based on the average catch from 1990-1997, (1995 data not included as fishery was closed most of the year), which was 1,240,000 lbs. (562.46 metric tons) of shucked meats. The time period from 1990 to 1997 reflects prevailing ecological conditions. The fishery was fully capitalized during this time period, and all areas of the state where scallops could be harvested were being exploited. Prior to that time period, vessels moved into and out of the scallop fishery, in part in response to economic opportunities available in other fisheries (Shirley and Kruse, 1995). However, since 1993, the fishery has been somewhat limited by crab bycatch limits, closure areas, and season length. As a consequence, a stable period during the history of this fishery does not exist. MSY estimation by averaging catches is problematic, however, a better solution does not exist at this point.

MSY Control Rule (F_{msy}). The MSY control rule is a harvest strategy which, if implemented, would be expected to result in a long-term average catch approximating MSY. The MSY control rule establishes a maximum fishing mortality threshold (MFMT), which may be expressed either as a single number or as a function of spawning biomass or other measure of productive capacity. The MFMT is set at the fishing mortality rate or level associated with the relevant MSY control rule. Exceeding the MFMT for a period of 1 year or more constitutes overfishing

In choosing an MSY control rule, Councils should be guided by the characteristics of the fishery, the FMP's objectives, and the best scientific information available. In any MSY control rule, a given stock size is associated with a given level of fishing mortality and a given level of potential harvest, where the long-term average of these potential harvests provides an estimate of MSY. The MSY control rule is based on natural mortality, using the estimate of M = 0.13, the MSY control rule F_{msy} equals M, or F_{msy} = 0.13. No control rule for spiny, pink, or rock scallops is recommended at this time.

MSY Stock Size (B_{msy}). The MSY stock size is the long term average size of the stock or stock complex, measured in terms of spawning biomass or other appropriate units, associated with the production of MSY. It is the stock size that would be achieved under an appropriate MSY control rule. It is also the minimum standard for a rebuilding target when remedial management action is required.

As noted earlier, MSY for weathervane scallops is established at 1.24 million lbs. (562.46 mt) of shucked adductor muscles. Therefore, MSY stock size is estimated as MSY/M = 9.54 million lbs. (4,326.6 mt) of shucked meat biomass. In terms of whole animals (including shells and gurry) B_{msy} would be 95.4 million lbs. (43,273 mt), as expanded by a product recovery rate of 10%.

Minimum Stock Size Threshold (MSST). The minimum stock size threshold (MSST), to the extent possible, should equal whichever is greater: one half the MSY stock size, or the minimum stock size at which rebuilding to the MSY level would be expected to occur within 10 years if the stock or stock complex were exploited at the maximum fishing mortality threshold. Should the actual size of the stock or stock complex in a given year fall below MSST, the stock or stock complex is considered overfished. The MSST should be expressed in terms of spawning biomass or other measure of reproductive capacity. Based on the national standard guidelines, a MSST for weathervane scallops is established based on ½ MSY stock size = $½B_{msy}$ = 4.77 million lbs. (2,163.7 mt) of shucked adductor muscles.

Overfishing Control Rule ($F_{overfishing}$). The national standard guidelines define the terms "overfishing" and "overfished" to mean a rate or level of fishing mortality that jeopardizes the capacity of a fishery to produce MSY on a continuing basis. Overfishing is established for weathervane scallop stocks as a fishing rate in excess of the natural mortality rate. Hence, $F_{overfishing} = M = 0.13$.

Optimum Yield (OY). Optimum yield should be established on the basis of MSY. OY is upper bounded by $MSY = F_{msy} B_{msy} = M B_{msy}$ (= 1,240,000 lbs or 562.46 mt.). Hence, a numerical range for OY of 0-1,240,000 lbs. (562.46 mt) can thus be established for Alaska weathervane scallops. Because MSY cannot be estimated for the other scallop species, OY cannot be quantified for rock scallops, pink scallops, or spiny scallops.

Sufficient conservatism is built into establishing an annual OY cap of 1.24 million lbs. (562.46 mt) for the following reasons:

1. the years of averaging include years when no fishing occurred in the Bering Sea, but obviously some sustainable harvest was possible;
2. the period of averaging includes other areas and years when the harvest was constrained by fishery controls, such as recently by bycatch PSCs, and therefore the resulting catch underestimates the productivity of scallop stocks;
3. substantial areas are closed to scallop dredging due to concerns about bycatch, yet these areas have substantial productivity;
4. closed areas can almost be thought of as marine refuges and potential yields from these areas are not factored into MSY estimates;
5. there are years during the history of the fishery when effort was low due to market (not abundance) conditions;
6. $F_{30\%}$ is probably a better estimator of $F_{overfishing}$ than is F=M, yet $M<F_{30\%}$ so the overfishing rule is conservative; and
7. In years of good recruitment, the stocks are likely greater than B_{msy}, thus we will fish at $F<F_{overfishing}$ to achieve OY=MSY (recall $MSY = F_{msy} B_{msy}$, so if $B>B_{msy}$, then $F<F_{msy}$).

In the future, better quantitative estimates of appropriate scallop yields by area may be generated based on observer data analysis. Additional information on biomass and long-term potential yield of pink, spiny and rock scallops also may be available in the future. At such time, MSY and OY would be re-estimated and the FMP amended.

Because scallops only have been harvested by U.S. vessels in the past, and effort remains high, it is likely that the OY can be fully harvested by U.S. vessels and fully processed by U.S. processors in future years. In fact, current capacity of the U.S. scallop fleet in Alaska exceeds current guideline harvest levels for scallops. Hence, no considerations have been made to allow a foreign fishery on Alaskan scallops.

6.1 At-Sea Catch Sampling

The focus of the State of Alaska's onboard scallop observer program is two-fold. One is to monitor bycatch, and the second is to collect biological and commercial fishing information relating to the weathervane scallop. Onboard sampling is designed to answer questions necessary to the successful management of the resource.

The scallop observer program collects a variety of biological data on a daily basis. The daily goal is to sample a single dredge from one tow for species haul composition and a single dredge from six different tows for crab and halibut bycatch and discarded scallop catch as well as sampling two tows for scallop meat (adductor muscle) recovery data.

Haul composition sampling is used to document all species of bycatch by weight. Dredge contents, including noncommercial species, are sorted into baskets by species and weighed. Observer haul composition samples are summarized and reported by management area and district. Data from each management area and district is then summarized.

From each of the six tows sampled daily for crab and halibut bycatch, one dredge per tow is examined. Observers identify, count, and record the number of crab and halibut encountered as well as examining both the retained and discarded scallop catch. In addition to enumerating crab, carapace measurements, shell age, sex, injuries and mortality are recorded. All Pacific halibut encountered are measured for length and examined for injuries and overall body condition. The discarded scallop catch is collected from the deck and weighed. A subsample is examined to determine the weight and number of broken and intact scallops, and shell heights. From the retained scallop catch; shell height, sex, and gonad development is collected. Shells are collected from both the retained and discarded scallop catch for shell aging.