PETITION TO LIST COPPER ROCKFISH AND QUILLBACK ROCKFISH IN THEIR PUGET SOUND PROPER DISTINCT POPULATION SEGMENTS AS THREATENED SPECIES UNDER THE ENDANGERED SPECIES ACT (ESA)

TO: SECRETARY OF COMMERCE, UNITED STATES DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICE.

From: Sam Wright (Petitioner), 1522 Evanston CT NE, Olympia, Washington, 98506 (Tel. 360-943-4424). Petitioner is a fish biologist with 44 years experience in managing fish populations and fish habitat and is Certified as a Fisheries Professional (CFP) by the American Fisheries Society.

Subject: Petition the Secretary of Commerce to list as Endangered or Threatened the Puget Sound Proper Distinct Population Segments (DPSs) of copper rockfish (*Sebastes caurinus*) and quillback rockfish (*S. maliger*) and to designate critical habitat. These same populations were previously evaluated for ESA listing in the following report: Stout, H.A., B.B. McCain, R.D. Vetter, T.L. Builder, W.H. Lenarz, L.L. Johnson, and R.D. Methot. 2001. Status review of Copper Rockfish, Quillback Rockfish, and Brown Rockfish in Puget Sound, Washington. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-46, 158 p.

This report, herein referred to as Stout et al. (2001), defined DPSs for greater Puget Sound populations of these three rockfish species, including DPSs for a portion of the area defined as Puget Sound Proper. However, the report did not recommend ESA listings based on selected scientific evidence examined at the time of report preparation. Stout et al. (2001) did concede that the three DPSs did meet the Musick et al. (2000) criteria to be considered *vulnerable* pending further analysis and that they could not entirely rule out the possibility that the DPSs at present are likely to become in danger of extinction. A critical flaw or omission in Stout et al. (2001) was a failure to recognize the advantages of longevity in rockfish species and the implications to population dynamics of management policies that ignore these evolved advantages. These issues had been recognized in the scientific literature at least as early as 1984 (Leaman, B.M., and R.J. Beamish. 1984. Ecological and management implications of longevity in some northeast Pacific groundfishes. International North Pacific Fisheries Commission Bulletin 42:85-97). The above reference (Leaman and Beamish 1984) did not even appear in the Citations section of Stout et al. (2001). In terms of fisheries resource management, the concept of substantial "yield" is mutually exclusive with maintenance of the age composition structure in rockfish species.

A feature article in the August 2004 issue of *Fisheries* dealt with the same subject (Berkeley, S.A., M.A. Hixon, R.J. Larson, and M.S. Love. 2004. Fisheries sustainability via protection of age structure and spatial distribution of fish populations. Fisheries 29(8):23-32.). They determined that fishing truncates the size and age structure of fish populations. Research indicates that old-growth age structure, combined with a broad spatial distribution of spawning and recruitment, is at least as important as spawning biomass in maintaining sustainable populations. Berkeley et al. (2004) found that older, larger female rockfishes produce larvae that withstand starvation longer and grow faster than the offspring of younger fish, that stocks may actually consist of several reproductively isolated units, and that recruitment may come from only a small and different fraction of the spawning population each year.

Dulvy et al. (2004:258) could well have had Puget Sound Proper rockfish in mind when they concluded that "The intrinsic factors or correlates underlying the major routes to local, regional and global scale extinction in the sea appear to be *large body size, small geographical range* and *ecological specialization*. The key intrinsic factor appears to be a high degree of exposure to a causal factor, i.e., *high catchability of exploited species*. These patterns are broadly similar to the main correlates of global scale freshwater and terrestrial extinctions." (emphasis added) (Dulvy, N.K., Ellis, J.R., Goodwin, N.B., Grant, A., Reynolds, J.D., and S. Jennings. 2004. Methods of assessing extinction risk in marine fish. Fish Fish. 5:255-276.)

Based on past as well as new scientific evidence, plus the passage of over five years since the temporary classification as "vulnerable", re-examinations of the original ESA listing decisions are warranted for Puget Sound Proper DPSs of two rockfish species - copper and quillback. Petitioner believes that these two Puget Sound Proper DPSs now clearly qualify for ESA listings as Threatened.

Due to multiple uses of the term "Puget Sound", Stout et al. (2001:xiii) "adopted conventions for geographical regions in the inland waters of Washington State and British Columbia" and thus defined Puget Sound Proper "as marine waters south of Admiralty Inlet and east of Deception Pass". This Petition is restricted to two rockfish DPSs in this specific area. At least four other rockfish species are believed to still exist in significant numbers (black, yellowtail, brown and redstripe). Except for their early life history stages, these species are primarily dependent upon a meager *14 square kilometers* of suitable rocky reef habitat. In addition, this group of closely related species must practice habitat partitioning, a basic tenet of evolution. Thus, each individual species can only use a fraction of the available critical habitat.

Stout et al. (2001) was prepared in response to an earlier effort by the Petitioner (Wright, S. 1999. Petition to the Secretary of Commerce to list as threatened or endangered 18 "species/populations" of "Puget Sound" marine fishes and to designate critical habitat. Petition to the U. S. National Marine Fisheries Service, February 1999, 32 p.). There were 13 species of rockfish originally proposed for status review but only the three most abundant (and also with the most information) were actually examined. It is logical to assume that these are the three that would be the least likely to become threatened or endangered. The inherent flaw with this "data dependent" approach is that at least one of the other 10 species, bocaccio (*Sebastes paucispinis*), has now become extinct under WDFW stewardship but did not possess enough "data" to originally merit examination. At least three other rockfish species may be nearing extinction in Puget Sound Proper (yelloweye, canary and greenstriped) but without having access to any of the recent WDFW stock assessment data, this is little more than speculation.

Basis for the Petition

Section 4 of the ESA contains provisions allowing interested persons to petition the Secretary of Commerce or the Secretary of Interior to add a species to, or remove a species from, the List of Endangered or Threatened Wildlife. Petitioner files this petition under the Endangered Species Act, 16 U.S.C. section 1531-1543 (1982), its implementing regulations, 50 C.F.R. part 424, and the Administrative Procedures Act, 5 U.S.C. section 553 ©. The National Marine Fisheries Service (NMFS) has jurisdiction over this petition under 16 U.S.C. section 1533 (a) and the August 26, 1974 Memorandum of Understanding Between the U.S. Fish and Wildlife Service and National Marine Fisheries Service Regarding Jurisdictional Responsibilities and Listing Procedures Under the Endangered Species Act of 1973.

Basis for the DPS Delineation

Stout et al. (2001:xiv) summarized determinations of three Puget Sound Proper DPSs as follows: "The BRT examined environmental, geological, biogeographic, life history, and genetic information in the process of identifying DPSs. In particular, biogeography, ecological and habitat factors, and genetic population structure were found to be most informative for the species considered in this status review. Based on this examination, the BRT identified a DPS for each of the three rockfish species in Puget Sound Proper *that can be considered a species under the ESA.*" (emphasis added).

Assessment in 2006: There does not appear be any critical flaws in the original assessment or any compelling recent information from the past five years that would justify a re-examination of the Puget Sound DPSs previously defined by Stout et al.(2001).

Basis for the Risk Conclusions

Stout et al. (2001:xv,xvii) summarized the risk conclusions for copper rockfish as follows: "The BRT utilized criteria and methods of Wainwright and Kope (1999) and Musick et al. (2000) to assist in organizing the information presented regarding risk to the Puget Sound proper DPS. Bearing the results of the above comparisons in mind, the BRT considered whether the Puget Sound proper DPS was in danger of extinction, likely to become in danger of extinction, or not likely to become in danger of extinction. However, most members expressed concern they could not entirely rule out the possibility that this species at present is likely to become in danger of extinction. The BRT also concluded that this DPS met the International Union for the Conservation of Nature (IUCN) criteria to be considered vulnerable (Musick et al. 2000). The BRT agreed that populations of this species had declined over the last three or four decades, with over-harvesting being a likely factor. Nevertheless, the populations in the DPS had appeared to be stable over the past five years, and the lower population numbers in this DPS compared to the larger numbers in northern Puget Sound are roughly in proportion to the greater amounts of kelp and high-relief habitat in North Puget Sound. The BRT considered the risk to copper rockfish in North Puget Sound to be no greater than the risk to copper rockfish in Puget Sound proper. The BRT also expressed caution that important changes in resource management (e.g., increased harvest levels) and in the ecosystem (e.g., increased numbers of marine mammals or predatory fish species), as well as increased habitat degradation, could result in increased extinction risk for copper rockfish in this DPS."

Stout et al. (2001:xix) summarized the risk conclusions for quillback rockfish as follows: "The BRT, bearing in mind their deliberations regarding risk, using West (1997), Wainwright and Kope (1999), and Musick et al. (2000), considered whether the Puget Sound proper DPS of quillback rockfish was in danger of extinction, likely to become in danger of extinction or not likely to become in danger of extinction. The majority of the BRT concluded that the Puget Sound proper DPS of quillback rockfish are neither at risk of extinction nor likely to become so. However, most members expressed concern that they could not rule out the possibility that this species at present is likely to become in danger of extinction. The BRT also concluded that this DPS met the IUCN criteria to be considered vulnerable. The BRT agreed that populations of quillback rockfish had, according to a self-contained underwater breathing apparatus (SCUBA) survey, declined to 14% of its 1988 size, with over-harvesting being a likely major factor. Nevertheless, the populations in the DPS had appeared to be stable over the last five years, and the lower population numbers in this DPS compared to the larger numbers in North Puget Sound are roughly in proportion to the greater amounts of kelp and high-relief habitat in North Puget Sound. The BRT considers the risk to quillback rockfish in North Puget Sound to be no greater than the risk to quillback rockfish in Puget Sound proper. The BRT also expressed the same caution as they did with copper rockfish, which is that important changes in resource management practices (e.g., increased harvest levels) and in the ecosystem (e.g., increased numbers of marine mammals or predatory fish species), as well as increased habitat degradation, could result in increased extinction risk for this species in Puget Sound proper and in North Puget Sound."

Stout et al. (2001:xxi) summarized the risk conclusions for brown rockfish as follows: "The BRT used methods and criteria from Wainwright and Kope (1999) and Musick et al. (2000) to organize information regarding risk to the Puget Sound proper DPS of brown rockfish. They considered whether the species was in danger of extinction, likely to become in danger of extinction or not likely to become in danger of extinction. A majority of the BRT concluded that brown rockfish in Puget Sound proper are neither at risk of extinction nor likely to become so. Factors in this decision included the increasing numbers of brown rockfish observed in SCUBA surveys in central Puget Sound proper during the late-1990s. Moreover, brown rockfish are more habitat generalists than quillback and copper rockfish and consume a wider range of prey species, making them more adaptable to the types of intertidal and subtidal habitats and associated food organisms available in the DPS. However, most members also expressed concern that they could not entirely rule out the possibility that this species is at present likely to become in danger of extinction. The BRT considered brown rockfish in North Puget Sound and the Strait of Juan de Fuca to be associated with the Puget Sound proper DPS and to be vagrants from that DPS. The BRT expressed the same caution as they did with copper and quillback rockfish, that important changes in resource management practices (e.g., increased harvest levels) and in the ecosystem (e.g., increased numbers of marine mammals or predatory fish species) as well as increased habitat degradation, could result in increased risk of extinction for brown rockfish in greater Puget Sound."

Problems with the Risk Conclusions

Failure to Recognize the Values of Longevity. The most serious omission by Stout et al. (2001) was a complete failure to even consider the values of longevity in rockfish species, especially since this was specifically identified as a critical problem in the original ESA petition that included these three rockfish species (Wright 1999). This knowledge was readily available in the scientific literature as early as 1984 (Leaman and Beamish 1984). This failure was the worst because it irretrievably tainted all of the "assessments" described above.

Leaman and Beamish (1984:88) described the importance of longevity as follows: "The most obvious potential benefit of a relatively long life is a long reproductive life. The extension of the period of reproduction reduces the risk that a long period of unfavourable environmental conditions will result in the loss of a stock. When the period between favourable environmental conditions for a species is relatively long (5-15 yr) it appears that the life span is also relatively long." Leaman and Beamish (1984:87) also determined that "Maintenance of unique age composition among geographically proximate stocks implies little mixing of adult fish among stocks."

Leaman and Beamish (1984:95) conclude their Discussion as follows: "The characteristics of the species considered in this paper typify the problems of managing exploited populations of longer-lived fish. Their extreme life spans appear to be an adaptive feature for ensuring evolutionary persistence under reproductive uncertainty, rather than for maximization of population growth rate. These species have repeated spawning and exploitation has often reduced the number of spawning groups and placed the responsibility for population maintenance on fewer, younger age-groups. There are additional ecological considerations such as the importance of continuously occupying a space, the importance of dispersed spawning, or the selective advantage of specific reproductive products. Extreme longevity in fishes may also allow adults to exist in low productivity environments where the probability of regular recruitment is very low. Exploitation strategies for fishes with long reproductive lives must consider the evolved traits that enable it to meet particular environmental and evolutionary challenges. The production and growth-oriented management strategies derived for shorter-lived species may result in rapid over-exploitation of accumulated biomass and a prolonged period of rehabilitation for the long-lived species. In extreme cases, a competing species may capitalize on vacant space or resources and prevent the over-exploited species from regaining its former abundance."

Stout et al. (2001) did not even consider the Leaman and Beamish (1984) report since it was not listed in their Citations section. The earlier report was based mainly on the simple yet very compelling logic that certain fish species would not be characterized by extreme longevity unless it was essential for ensuring their sustainability. Two decades later, a new report (Berkeley et al. 2004) would provide a great deal more empirical evidence to demonstrate that this logic is indeed correct (see subsequent New Information section).

Problems with Wainwright and Kope (1999) Approach. The first problem, as stated above, is failure to address the longevity issue. In addition, the three risk conclusions from Stout et al.(2001) cited above are incorrect in stating that Musick (2000) was used in conjunction with Wainwright and Kope (1999) for all three species. In fact, the text of Stout et al. (2001) reveals that Wainwright and Kope (1999) was used exclusively to make the three determinations. Musick et al. (2000) was only used to make vulnerable ratings after the ESA determinations had already been finalized. West (1997) did not play any meaningful role in the risk conclusions for quillback rockfish.

The fundamental problem with using Wainwright and Kope (1999) is that scientists must make numerical ratings for population parameters that they are unwilling or unable to quantify directly. This gives the illusion of a quantitative scientific assessment but is merely putting arbitrary numbers on some very subjective and strictly qualitative personal opinions. The recommendations for or against ESA listings become largely dependent upon resource management philosophies and areas of expertise of individual BRT members. Given the same type of factual basis, people working with terrestrial wildlife, salmonids, or marine mammals would have produced different quantitative values. However, Stout et al. (2001) used this disparity between treatment of different resources as "proof" that three Puget Sound Proper rockfish DPSs were not at-risk. In this particular case, failure of the Wainwright and Kope (1999) process to discriminate is clearly evident in very similar risk conclusions being reached for copper and quillback rockfish in both Puget Sound proper and North Puget Sound as well as for brown rockfish that are more habitat generalists. Five very different factual situations produced essentially the same end result using Wainwright and Kope (1999).

Problem with Unrecognized High Risk Factors in Puget Sound Proper. The North Puget Sound area has a huge advantage in suitable habitat for copper and quillback rockfish. Pacunski and Palsson (1998) determined that there were over 200 square kilometers of rocky reef habitat in North Puget Sound as opposed to only *fourteen square kilometers* in all of the remaining Puget Sound Proper basins. In addition, the Puget Sound Proper habitat is typically non-contiguous and a significant part of it is "vacant" in term of the presence of copper and quillback rockfish. There were also wide disparities described in Stout et al. (2001) favoring North Puget Sound with respect to presence of chemical contaminants, degree of human modification of the shoreline, extent of marine vegetation and rockfish growth rates.

The Main Basin of Puget Sound Proper receives about 80% of the amount of waste discharged from urban and industrial point-sources in the entire region (PSWQA 1988). The WDNR (1998) estimates that 52% of the shoreline in the Main Basin has been modified by human activities and it has a relatively small amount of intertidal vegetation, with a point estimate of 28.3% coverage (Bailey et al. 1998). Quillback rockfish from Puget Sound Proper had slower growth rates and were smaller than fish from North Puget Sound (West and O'Neill 1995). Comparable data were not available for copper rockfish and brown rockfish are rare in North Puget Sound.

The only place in Puget Sound Proper where it is even possible to estimate what an unfished or "virgin" population of rockfish might look like is the 27 acre Edmonds Underwater Park (EUP), which has been protected since 1970. Palsson and Pacunski (1998) estimated that the reproductive potential of copper rockfish at EUP exceeded the potential of the average fished site in central Puget Sound by a ratio of 55 to one - and they did not even assign any extra value to production from larger fish on a per egg basis. The difference due to different length frequency distributions between no-take and fished sites accounted for a four-fold increase in estimated egg production while the difference due to densities accounted for almost a fifteen-fold increase in estimated egg production.

Problems with Musick et al. (2000) Approach. In addition to failure with respect to the longevity issue, Musick et al. (2000) was not even employed in determination of the ESA risk assessments. It was only used after the fact to reach vulnerable ratings. Musick et al. (2000) has an inherent methodology advantage over Wainwright and Kope (1999) in that risk ratings are determined directly from quantitative measures of population parameters. In addition, the results in Musick et al. (2000) are simply the application to individual fish species of a rating system already finalized in Musick (1999) and there was no opportunity for other scientists to achieve modifications to it (Musick, J.A. 1999. Criteria to define extinction risk in marine fishes. Fisheries 24(12):6-14.). Note: Petitioner was one of the co-authors of Musick et al. (2000) and did not support the basic approach used (Wright, S. 2002. A critical flaw in the American Fisheries Society initiative to protect marine, estuarine, and diadromous fish stocks: Failure to account for depensation. Prepared for Center for Biological Diversity, Oakland, CA.).

Another critical flaw in Stout et al. (2001) is that they often portray the *vulnerable* in Musick et al. (2000) as being from the "IUCN" (which is incorrect) and as a definite at-risk step below *threatened*. Musick et al. (2000:7) describe the specific intent as follows: "If the decline equals or exceeds the threshold for the appropriate productivity category, the DPS would be automatically listed as *vulnerable* and flagged for further study by expert scientists, who may decide to upgrade the level of threat to *threatened* or *endangered*, or downgrade the status, if appropriate." Musick et al. (2000) is essentially an incomplete process. The intended step described above was never taken for the two Puget Sound Proper rockfish DPSs that are now the subject of this Petition.

If Stout et al. (2001) had used Musick et al. (2000) as actually written, they might have taken the interim *vulnerable* classification and then focused on the following two sections from Musick et al. (2000:7) to finalize their work: "(2) **Small range and endemics:** Species that are endemic or restricted in range to some relatively small, contiguous geographic entity (i.e., island, archipelago, river system, etc.) in which the habitat is or may be under threat of degradation or destruction should be classified as *vulnerable*. Where significant habitat loss has occurred or is occurring, such species should be classified as *threatened* or *endangered*. Significant habitat loss should be evaluated on a case by case basis in the context of the biology of the DPS under consideration and on both the amount of critical habitat available and the vulnerability of that habitat. (3) **Specialized habitat requirements**: Some species may be relatively widespread but occupy very specific habitats within their range and/or during some specific life history stage. Therefore, their area of occupancy may represent only a small part of that range. When habitats are particularly vulnerable (such as coral reefs or seagrass beds) and subject to degradation, destruction, or fragmentation, habitat loss could be the critical factor leading to population reduction or extirpation. Habitat loss should be examined as a risk factor in the context of the biology of the DPS under consideration."

The critical question *not quantified* by Musick et al. (2000) is how small can the geographical range be before there is a high risk of extinction. The IUCN *Red List* uses thresholds called "extent of occurrence" and "area of occupancy" (IUCN 2001 cited in Dulvy et al. 2004). Extent of occurrence is the area within the shortest continuous imaginary boundary that can be drawn to encompass the taxon. Area of occupancy is the area actually occupied by a taxon within its extent of occurrence (Hilton-Taylor 2000 cited in Dulvy et al. 2004). In order to qualify as threatened, the extent of occurrence must be less than 20,000 square kilometers and the area of occupancy must be less than 2,000 square kilometers. The entire Greater Puget Sound Basin only covers an area of approximately 2,330 square kilometers (Stout et al. 2001). Puget Sound Proper appears to account for less than half of this total and is clearly below either of the IUCN thresholds. The extent of occurrence is only about 5% of the 20,000 square kilometer threshold. The actual area of occupancy - 14 square kilometers of rocky reef habitat - is only 0.7% of the 2,000 square kilometer threshold.

Problems with the Sustainable Fisheries Act. During Petitioner's involvement in the American Fisheries Society initiative described above - which included a number of NMFS scientists - it became evident that there was a definite policy objective (written or unwritten) within NMFS to handle any problems with at-risk marine fish populations under the Sustainable Fisheries Act (SFA) of 1997, not the Endangered Species Act. This belief was reinforced by extensive discussion of the subject by Stout et al. (2001:126-129). However, "inland waters of Puget Sound proper and North Puget Sound were excluded in the original language of the MSFCMA in 1976." (Stout et al. 2001:126). The NMFS probably has some understandable concerns over the issue of "precedents" between Puget Sound Proper DPSs and marine fish species managed under the SFA. However, the Puget Sound DPSs for copper and quillback rockfish have only a tiny fraction of suitable habitat as compared to any of the species managed in the ocean. In addition, rockfish species managed under the SFA by the Pacific Fishery Management Council have rebuilding plans that span many decades and reach a high of 92 years for bocaccio, *Sebastes paucispinus* (Shipp, R.L. 2003. A perspective on marine reserves as a fishery management tool. Fisheries 28(12):10-21.). These plans are based on population modeling with numerous tenuous assumptions, including inherent beliefs that the underlying spawner-recruit relationships will be at least stable (i.e., a flat trend line) for most of this century and that they will never have the "multiple domains of attraction" described by Peterman (1977). From the outside perspective of the Petitioner, it seems ludicrous to make these types of assumptions in light of the current state of knowledge on global warming. It will be decades before it is even known if any of these plans can be successful. In any case, it is illogical to champion a similar approach for two rockfish DSPs in Puget Sound Proper which only have a tiny fraction of the suitable rockfish habitat available in the ocean but the maximum degree of human-caused environmental stress.

Failure to Recognize Ecological Interactions with Hatchery Chinook. The WDFW professional staff has, for many years, recognized the potential adverse impacts on rockfish populations from their massive hatchery program for Chinook salmon (West 1997). For obvious reasons, this opinion has been effectively muzzled by the WDFW administration in recent years, particularly since the numbers of hatchery Chinook released have been reduced and most marine area net pen rearing programs have been eliminated (WDFW and Puget Sound Treaty Tribes. 2004. Puget Sound Chinook salmon hatcheries. A Component of the Comprehensive Chinook Salmon Management

Plan.). However, the reduced potential for adverse impacts on rockfish populations is more illusion than fact.

WDFW and P.S. Treaty Tribes (2004:4) state the following under *Ecological Interactions*: "4) releasing fish at a time, size, and physiologically condition that provides a low likelihood of residualization and promotes rapid migration through the estuary to marine waters. Programs typically release subyearling Chinook salmon that are in the 40 to 90 fish per pound (77 to 100mm fork length) during the months of May and June. Fish released at this time are expected to move rapidly through estuarine areas; 5) releasing subyearling fish that are a larger size than natural-origin Chinook salmon of the same brood year to reduce the potential for diet overlap with any co-occuring natural origin fish in marine waters."

The current hatchery Chinook program shows that 45.6 million subyearlings and 2.6 yearlings are released annually in the Greater Puget Sound Basin. Approximately 74% of the subyearlings and 88% of the yearlings are released in Puget Sound Proper (WDFW and P.S. Treaty Tribes 2004). Millions of these fish are now released from rearing sites on small stream systems that did not originally have significant natural Chinook populations and reach marine waters in times ranging from a matter of minutes (e.g., Hoodsport Hatchery on Finch Creek) to a few hours - Tulalip Bay, Grovers Creek, Gorst Creek, Chambers Creek, Minter Creek, Deschutes River (Capitol Lake) , Big Beef Creek. The *biomass* of hatchery fish actually reaching Puget Sound marine waters each year is undoubtedly at an all time high. During the massive fin-marking studies of lower Columbia River hatchery fall run chinook in the 1960s, it was estimated that only about 30% of the fish survived to reach the estuary. This was not a dam passage problem since most of the fish were released below Bonneville Dam or in the Bonneville pool. The primary problems were small average fish size, premature (too early) release timing and diseases - problems also common to Puget Sound in the 1960s (WDF. 1992. Salmon 2000 technical report. Phase 2: Puget Sound, Washington Coast and integrated planning.).

New Information on the Status of Two Puget Sound Rockfish DPSs

Species with Extreme Longevity - A Special Case. In recent years, it has become obvious that status of rockfish populations cannot be judged in terms of traditional resource management paradigms - that each kilogram of spawning stock biomass is identical regardless of adult age, that all larvae have an equal probability of survival regardless of parental age, and that any effects of fishing mortality are reversible. Berkeley et al. (2004:24) provide the proper context for judging rockfish as follows: "we believe that at least part of the explanation for stock collapses is the result of our failure to appreciate the value of both large old fish and fine-scale spatial dynamics of recruitment in the replenishment of fish populations. We discuss recent research that provides what we believe to be a compelling case that the age structure of a stock combined with the spatial distribution of recruitment are as important as spawning biomass in maintaining long-term sustainable population levels. In particular, there are an increasing number of examples of complex population structure in species currently managed as a unit stock, and increasing evidence that only a small fraction of spawners in a stock - those that spawn at the right time and place, which varies annually - successfully contribute to each new cohort. Moreover, it is large, old female fish that produce offspring most likely to recruit successfully to these new cohorts. Based on this evidence, we believe that the best and perhaps only way to ensure old-growth age structure and complex spatial structure in populations of groundfish is through interconnected networks of fully protected marine reserves."

A Single 80cm Fish is Worth nearly ten 40cm Fish. An important consideration for Puget Sound Proper rockfish comes from Berkeley et al. (2004:27): "It is well documented that fecundity increases nearly linearly with body mass in adult teleost fishes, and geometrically with body length, which is a decelerating function of age (Weatherly 1972; Wootton 1990). This relationship is due to larger fish not only having a greater body volume for holding eggs, but also devoting a greater proportion of energy stores to egg production. Thus, a 40-cm TL (0.65-kg) bocaccio rockfish produces an average of just over 200,000 eggs per year, whereas an 80-cm (5.41-kg) fish at double the length produces nearly 2 million eggs, nearly 10 times the fecundity (Love et al. 1990). In other words, considering only fecundity per se - let alone egg or larval quality - a single 80-cm bocaccio is worth nearly ten 40-cm fish."

Importance of Maternal Age and Larval Quality. Some of the most relevant quantitative information now available regarding status of two Puget Sound Proper rockfish DPSs comes from recent studies documenting greater values for older spawners that extend far above their higher fecundity. Berkeley et al. (2004:28) provided the following discussion on the subject: "A variety of studies indicate that egg and larval size and/or viability also increase with female size and age (Chambers et al. 1989; Zastrow et al. 1989; Buckley et al. 1991). Recent experiments with black rockfish by Berkeley et al. (2004), in which gravid females were held until parturition and the larvae reared under controlled conditions, revealed that maternal age was much more predictive of larval growth and survival than either maternal size or condition index. Larvae from the oldest fish (age 17) survived starvation 2.5 times longer than those of the youngest fish (age 5) (Figure 2b), and grew more than 3 times as fast on the same diet (Figure 2a). These differences may be conservative since larvae were reared under constant environmental conditions, with ad libitum rations in fed treatments and no exposure to predators or competitors (other than their siblings). Results of a multiple regression analysis indicated that maternal age accounted for most of the variability in larval survival and growth. Maternal length provided a small but significant increase in goodness-of-fit. These results suggest that older females produce higher quality larvae, and that females that are both old and large produce the highest quality larvae. The mechanism appears to be the volume of the larval oil globule at birth, which is strongly related to maternal age (Berkeley et al. 2004).

It seems likely that such large differences in growth and starvation tolerance have a profound effect on larval survival and subsequent recruitment (review by Heath 1992). The ability of larval fish to survive a period of starvation is often critical due to the spatial and temporal unpredictability of encountering patches of zooplankton prey (Letcher and Rice 1997). Fast growth has clear benefits in allowing larvae to more quickly pass through the most vulnerable life history stages and to develop more rapidly those morphological and physiological capabilities that improve detection and capture of prey, avoidance of predators, and resistance to other environmental challenges (Miller et al.

1988; Bailey and Houde 1989). Indeed, field studies on marine fish larvae have demonstrated that differences in growth rate, especially in the youngest larvae, can have a profound effect on survival. A doubling of the growth rate in larval bluefish (*Pomatomus saltatrix*) and Atlantic cod (*Gadus morhua*) can increase survival by a factor of 5-10 (Meekan and Fortier 1996; Hare and Cowen 1997). Larval quality can also vary in terms of behavioral attributes directly related to survival (Fuiman and Cowan 2003)."

Importance of Adult Body Size and Condition. Berkeley et al. (2004:27) have the following discussion on the subject: "In rockfishes and in other teleosts, body condition and deposition of lipid reserves increase disproportionately with fish length or stage of maturity (Iles 1974; Eliasson and Vahl 1982; Larson 1991). If volumetric variables such as body weight, liver weight, and weight of fat reserves grow proportionately to the rest of the fish, they would increase with the cube of body length. In rockfish, Guillemot et al. (1985) found varying relationships between mesenteric fat weight and fish length (often with low R2 values). However, Larson (1991), benefiting from fish consistently collected in the same areas (in contrast to the fish available to Guillemot), found disproportionate relationships between measures of condition and fish length in kelp rockfish (*Sebastes atrovirens*) and black-and-yellow rockfish (*S. chrysomelas*). Body weight was proportional to slightly greater than the cube of length, liver weight to around the 4^{th} power of length, and mesenteric fat weight to about the 6^{th} power of length. Whether body reserves are utilized directly in reproduction (MacFarlane et al. 1993; Norton and MacFarlane 1994), for overwintering maintenance (Guillemot et al. 1985), or a combination of the two (Larson 1991), the amount of reserves may affect the timing (Lenarz and Wyllie Echeverria 1986) or amount (Eliasson and Vahl 1982; Lambert and Dutil 2000; Blanchard et al. 2003) of reproduction, and the potential for overwintering or post-spawning survival (Guillemot et al. 1985; Lambert and Dutil 2000). The positive allometry of reserves and body condition in fishes indicates that larger (and presumably older) fish may make greater reproductive contributions than smaller fish, and also that larger fish may be able to reproduce and survive reproduction under a greater range of environmental conditions than smaller fish."

Importance of Maternal Age and Time of Spawning. For Puget Sound Proper rockfish, yet another distinct advantage is described by Berkeley et al. (2004:27): "Older marine teleosts generally spawn earlier during the reproductive season than younger fish (Berkeley and Houde 1978; Pedersen 1984; Lambert 1987). In a recent study of black rockfish (*Sebastes melanops*) off Oregon, Bobko and Berkeley (2004) found that older fish gave birth earlier in the year than progressively younger fish (a trend also noted in yellowtail rockfish, *Sebastes flavidus*, off southern California, Love et al. 1990). Black rockfish, like other rockfishes, are primitive livebearers and normally produce a single batch of larvae annually. Parturition dates were estimated from advanced stage gonads sampled during the pre-parturition period (Bobko 2002). These data were applied to the age distribution of the population to estimate the percentage of larval production by age class for each week. Birthdates of young of the year benthic juveniles were then determined from daily growth rings on their otoliths, from which estimates were made of the relative contribution to recruitment by time period, and thus by implication, age group. By comparing birthdate distributions to adult spawning output, Bobko (2002) determined whether recruitment was proportional to spawning output or whether certain periods during the parturition season were responsible for a greater proportion of recruits. Results indicated that, in 1 of 3 years, significantly greater recruitment came from earlier in the spawning season, a time when few young fish were spawning.

Timing of spawning is likely to be a highly conserved trait in most fishes, as larval survival is highly dependent on larval production coinciding with peak zooplankton production (i.e., the "match-mismatch hypothesis" of Cushing 1969,1975). For fishes that exhibit age-related temporal patterns of spawning, elimination of older age classes through fishing will effectively shorten the spawning season. In those years when successful recruitment is centered early in the season, elimination of older age classes could result in recruitment failure that would otherwise be avoidable if the age structure was intact. Indeed, Marteinsdottir and Thorarrisson (1998) found that strong year classes of Icelandic cod (*Gadus morhua*) occurred only when the population contained a broad age distribution, suggesting that this relationship may be applicable to a variety of species."

Importance of Heterogeneity and Recruitment. In view of the factors discussed above, the following from Berkeley et al. (2004:24) is also relevant to Puget Sound Proper rockfish: "Although marine populations are obviously affected by the vagaries of larval survival (Houde 1987), the spatial and temporal features of year-class formation are not yet clearly understood. Hedgecock (1994a,b) proposed the "sweepstakes hypothesis" to explain small-scale genetic heterogeneity observed in some widely distributed marine populations. According to this hypothesis, most spawners fail to produce surviving offspring because their reproductive activity is not matched in space and time to favorable oceanographic conditions for larval survival during a given season. As a result of this mismatch (sensu Cushing 1969, 1975), the surviving year class of new recruits is produced by only a small minority of adults that spawned within those restricted temporal and spatial oceanographic windows that offered good conditions for larval survival and subsequent recruitment."

Berkeley et al. (2004:24,25) continue: "One testable prediction of Hedgecock's hypothesis is that a cohort of new recruits would show less genetic diversity than the adult population, reflecting the underlying pattern of only a few adults successfully passing their genome to each new cohort. This hypothesis was tested during 1994, when the National Marine Fisheries Service Tiburon Lab conducted a sampling survey of the entire pelagic stage of shortbelly rockfish (*Sebastes jordani*) combined with juvenile and adult surveys (Larson et al. 1995; Julian 1996). Results supported the Hedgecock hypothesis (Table 2): levels of genetic diversity were lower for later stage ("June" and "Farallon") pelagic juveniles and their haplotype frequencies were different from both adults and most earlier stages of larvae and juveniles. Results also indicated that these differences were not due to seasonal spawning by a unique portion of the adult population, but were in fact the result of differential survival during the pelagic larval stage. In contrast, Gilbert (2000) found no reduction in genetic diversity within a very strong year class of kelp rockfish (*S. atrovirens*). Burford (2001) also found no reduction in genetic diversity in a year class of blue rockfish (*S. mystinus*) but did find genetic differences among recruits from different locations that were not matched by differences among adult populations.

Gomez-Uchida and Banks (in press), studying the population genetics of darkblotched rockfish (*S. crameri*), found that the breeding population was several orders of magnitude smaller than the spawning stock size indicated by the stock assessment. Only several thousand breeders, rather than the millions of adults in the whole population, would successfully reproduce. While not a direct test of Hedgecock's hypothesis, these results nevertheless suggest that recruitment is not uniformly distributed throughout the adult population.

Thus, although the generality of Hedgecock's hypothesis remains in question, indications are that it may be true under at least some circumstances, and that the genetic composition of recruits may otherwise be quite complicated spatially. This suggests that the geographic source of successful recruits may differ from year to year. Based on these observations, management should strive to preserve a minimal spawning biomass throughout the geographic range of the stock (Larson and Julian 1999)."

The Bottom Line - Avoiding Age Class Truncation. In aggregate, all of the previous sections indicate that the age class structure created in Puget Sound Proper rockfish populations during thousands of years of evolution should have been maintained. However, severe truncation has already occurred due to fishing. The nature of the problem is described by Berkeley et al. (2004:25): "Many marine species, such as those in the north temperate waters of the Pacific Ocean, exhibit long life spans, with the rockfishes being particularly striking in this regard (Table 3). The adaptive value of allocating reproductive output across many years (iteroparity) is generally thought to be a bet-hedging strategy that ensures some individual reproductive success despite long periods of environmental conditions unfavorable for larval survival (Leaman and Beamish 1984). At the population level, longevity ensures that there will be sufficient reproductive output for the population to maintain itself between favorable recruitment events (Longhurst 1999, 2002).

Age truncation - the removal of older age classes via fishing - occurs at even moderate levels of exploitation (Figure 1). Leaman and Beamish (1984) suggest that age truncation will be most detrimental when reproductive success is highly variable, since stock maintenance may be dependent on the relative stability of reproductive output that results from a broad spectrum of age classes. Most, if not all rockfish stocks on the U.S. west coast fall into this category of highly variable and episodic recruitment (Hollowed et al. 1987; Moser et al. 2000)."

Berkeley et al. (2004:26) continue on the same subject: "While the advantage of longevity for persistence of a population in a variable environment is intuitive, a growing body of evidence suggests that a broad age distribution can also reduce recruitment variability (Lambert 1990; Marteinsdottir and Thorarinsson 1998; Secor 2000a,b). There are at least two mechanisms by which stabilization of recruitment could occur: (1) there may be age-related differences in the time and location of spawning (Berkeley and Houde 1978; Lambert 1987; Hutchings and Myers 1993), thereby spreading larval production to cover temporal and spatial variability in favorable environmental conditions, and (2) older fish may produce larger, healthier, or otherwise more fit larvae (Hislop 1988; Marteinsdottir and Steinarsson 1998), which may survive under conditions that are inadequate for the survival of progeny from younger fish. Even slightly enhanced rates of early survival and growth have a cumulative effect that can translate into a greatly increased probability of successful recruitment (Houde 1987).

Long life spans are necessarily associated with low rates of mortality during the adult stage (Stearns 1992). For most teleosts, size-dependent processes, especially lower risk of predation with increasing body size, result in decreasing natural mortality as fish grow older and larger (Hare and Cowan 1997; Sogard 1997). Fishing, however, generally selects for larger, older fish, imposing a selection pressure that works opposite to that of most natural mortality agents. One of the most predictable effects of fishing is the reduction or removal of the older age classes, i.e., age truncation (Figure 1). Prior to reaching a size acceptable to the fishery (either due to market demand or minimum size regulations intended to allow fish to attain reproductive maturity), younger age classes are reduced only through natural mortality, but once vulnerable to fishing gear, a cohort is reduced through both natural and fishing mortality. These sources of mortality are cumulative throughout the life of the cohort."

Fishing Induced Genetic Change. A subpart of the age class truncation problem described above is the high risk of induced genetic change. Berkeley et al. (2004:29) describe this risk as follows: "As shown above, fishing generally results in age truncation of the population. It has long been recognized that fishing, by removing the largest and oldest fish inadvertently removes fish that are genetically predisposed to fast growth and late maturation, creating a selection pressure that should theoretically favor early-maturing, slow-growing individuals. Nevertheless, this question has been largely ignored in fisheries management, which tacitly assumes that exploited populations will always retain their inherent rates of productivity and tend to return to their previous levels of abundance. A recent paper by Olsen et al. (2004) challenges these long-held beliefs. Results of this study strongly suggest that heavy and continuous fishing pressure in northern cod resulted in a rapidly-evolved, genetically-based shift in maturation patterns towards earlier and smaller sizes at maturity. The implications of this finding for management are profound. If evolutionary change in response to fishing turns out to be the rule rather than the exception, then, as Hutchings (2004) observed, we must address issues of reversibility of these changes, and their consequences for sustainable harvesting, population recovery and species persistence. At the very least, we believe that these results suggest that some portion of the population should be protected from the impacts of fishing, providing a sanctuary for the genes of fast-growing, late-maturing individuals."

Extinction of Bocaccio (*Sebastes paucispinis*)

Both Wright (1999) and Stout et al. (2001) were remiss in that they did not examine one data source that was relevant to the status of Puget Sound rockfish. There are 12 years of catch estimates for the Puget Sound recreational fisheries from 1975 through 1986 that breakdown part of the rockfish catches by species. These estimates are beset by a number of technical problems including small sample sizes and sampling percentages, large increments of unidentified rockfish and a dependence on expansion or conversion factors from the recreational salmon fishery. Nevertheless, they do provide some rough measures of the presence and relative abundance of the individual species.

The WDFW reported estimated catches of bocaccio taken in Puget Sound Proper (corresponding to Catch Areas 8 through 13) were as follows:
1975 - 675
1976 - 1973
1977 - 9275
1978 - 4915
1979 - 1836
1980 - 1081
1981 - 605
1982 - 1418
1983 - 759
1984 - 9
1985 - 0
1986 - 344

A definite downward trend is evident and bocaccio were nearing extinction by the mid-1980s. Of the 22890 total estimated catch of bocaccio, 18742 or 82% were taken from the Tacoma Narrows southward (Catch Area 13). This extreme southerly abundance concentration in Puget Sound Proper makes it obvious that this was not some small transient "fringe" of a much larger population of bocaccio somewhere to the north. Clearly, a former DPS has been extirpated since WDFW biologists recently revealed that the species has not been observed in Puget Sound Proper for about 20 years. This means that the species was missing for about 15 years at the time of consultations between NOAA Fisheries and WDFW on the original effort of the Petitioner (Wright 1999). An obvious question is whether or not this knowledge was provided to NOAA Fisheries since there was no hint of any such problem in Stout et al. (2001). Bocaccio were one of 13 rockfish species designated as "important species of bottomfish in Puget Sound" by Palsson et al. (1997). This same "important" status was soon reiterated in the Puget Sound Groundfish Management Plan (Bargmann 1998).

Resource Management by Washington Department of Fish and Wildlife

In response to declining resource abundance, there have been a number of recent changes in rockfish management for recreational fishing in Puget Sound Proper but only two qualify as partial but legitimate conservation regulations. In any open access fishery where there is no direct control of fishing mortality (fishing effort), the only legitimate conservation regulations are those that apply to *every individual fish* (Hunt, R.L. 1970. A compendium of research on angling regulations for brook trout conducted at Lawrence Creek, Wisconsin. Wisconsin Department of Natural Resources, Research Report 54, Madison.). In 2003, the retention of yelloweye and canary rockfish was banned but hooking mortality continued as a significant cause of fishing mortality. The need for this ban on retention is the only indication that these two species may be nearing extinction - the public is not allowed access to any recent WDFW stock assessment data. In 2004, spear fishing for rockfish was closed and recreational angling for rockfish was restricted to times when fishing was allowed for lingcod and/or Pacific salmon. It is not known whether or not this change was prompted by concerns for only two species - again due to a lack of public access to WDFW stock assessment data. However, any possible “savings” from these changes was probably lost because there was no direct control of fishing mortality (effort) during remaining open fishing periods. At best, the rates of population declines have been slowed down.

The main recent change that was touted by WDFW as a conservation regulation was the reduction to a one rockfish daily bag limit in 2000. However, daily bag limit reductions, by themselves, have never been a legitimate conservation regulation in open access fisheries since they violate the fundamental rule of not applying to *every individual fish*. There have been countless failures with this approach but these failures have rarely been documented. The largest documented percentage reduction failure that the Petitioner is aware of (80%) occurred when Idaho reduced their daily bag limit on trout from 15 fish all the way down to three fish but could not detect any positive response in the trout populations (Johnson, T.H., and T.C. Bjornn. 1978. Evaluation of angling regulations in the management of cutthroat trout. Idaho Cooperative Fishery Research Unit, University of Idaho, Job Completion reports F-59-R-7, F-50-R-8, Moscow.) Bag limits have a legitimate place in recreational fishery management, but only as a means of distributing the allowable catch among more participants, thus optimizing the recreation benefits that can be derived from a given fishery.

Two variables that WDFW failed to factor into the restrictions described above are (1) that most anglers will fish for boat or group limits rather than individual limits, and this technically illegal action cannot be controlled; and (2) that temporary harvest reductions are often cancelled out by a significant degree of increased fishing effort at a later time, as well as higher catch per unit of effort (both in response to higher-than-expected fish population levels) (Wright, S. 1992. Guidelines for selecting regulations to manage open-access fisheries for natural populations of anadromous and resident trout in stream habitats. North American Journal of Fisheries Management 12:517-527).

It is obvious to concerned members of the public that the rockfish resources of Puget Sound Proper are in trouble. Boat anglers see the increasingly truncated size composition of the rockfish populations as well as their obvious declines in abundance. The fact of extensive catch sorting and its associated hooking mortality is now common knowledge, caused by declining size of the fish and exacerbated by a one fish daily bag limit. SCUBA divers fail to even see rockfish in many areas where they were abundant in the past. The fish that are present are noticeably smaller. These concerns on behalf of the public prompted then-Governor Locke to direct WDFW to produce a resource assessment and management plan for Puget Sound rockfish resources by December 31, 2004. This assignment has never been completed. There was apparently no follow-up demands from the new Governor even though the same political party controlled the office and many of the same staff members were retained. Staff work has continued within WDFW but a final product has yet to emerge from the continued recycling of various drafts through multiple layers of review.

It is easy to deduce the cause for this delay. It is common knowledge that WDFW has evolved into a very harvest oriented agency, especially with respect to recreational fisheries. They have stated publicly that they want to prevent any further ESA listings in Puget Sound. They also have a firm policy of not releasing any newer resource assessment data to the public until it is an integral part of a finalized resource management plan. The obvious conflict involved is adjacent or comingled populations of rockfish and Chinook salmon. It is hard to imagine a successful rockfish management regime that would not have some significant impacts on Chinook salmon fishing opportunities. It is certainly ironic that the main conflict involved is with ESA listed Puget Sound Chinook. In the short-term, the perceived easiest course of action by WDFW is probably doing nothing for as long as possible.

Assessment of Viability

The viability of Puget Sound Proper rockfish DPSs has been severely compromised by past and current fisheries management practices, especially the resultant severe truncation of age classes. The key elements that makes management of rockfish different than all other fish populations is *their extreme longevity and their inability to adjust to hydrostatic changes when brought quickly to the surface*. All rockfish have a swimbladder and typically do not survive due to the internal trauma of expansion and rupture of the swimbladder during capture. This is also a unique marine area ecosystem in which numerous closely related rockfish species must rely upon a meager 14 square kilometers of suitable rocky reef habitat. Due to habitat partitioning, each species will only have available a fraction of this already small number.

In view of the facts cited and presented in this Petition, *the Puget Sound Proper populations of copper and quillback rockfish are in danger of extinction throughout all or a significant portion of their range or are likely to become so in the foreseeable future.*