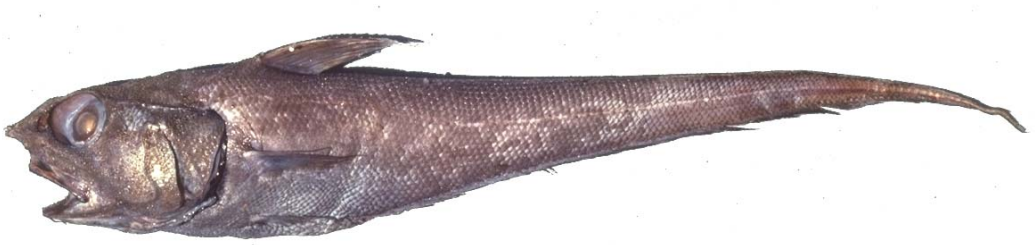
Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM®

Grenadier

Giant grenadier (*Albatrossia pectoralis*)
Pacific grenadier (*Coryphaenoides acrolepis*)
Shoulderspot grenadier (*Coelorinchus scaphopsis*)
Popeye grenadier (*Coryphaenoides cinereus*)
Smooth grenadier (*Nezumia liolepis*)
California grenadier (*Nezumia stelgidolepis*)



(Pacific Grenadier, courtesy of ODFW)

West Coast Region

Final Report
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About Seafood Watch® and the Seafood Reports

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from the Internet (seafoodwatch.org) or obtained from the Seafood Watch® program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices," "Good Alternatives," or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Fisheries Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling (831) 647-6873 or emailing seafoodwatch@mbayaq.org.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Executive Summary

Grenadier is a deep-sea fish, which dominates depths greater than 2,000 meters (m) in most ocean basins. Grenadier is caught incidentally in multiple groundfish fisheries off the U.S. West Coast. Giant grenadier is the most common grenadier species caught in Alaskan waters, although popeye and Pacific grenadier are also common in Alaska. Pacific grenadier dominates the grenadier catch in California, but smooth, shoulderspot, and California grenadier are also caught by California commercial fisheries targeting other species.

Little is known about the grenadier species found in the Pacific Ocean. Studies suggest that their life history traits vary by species; some species mature early in life and live relatively short lives, while other species have very long life spans. Pacific and giant grenadier, the species most commonly caught in commercial fishing operations, are slow-growing, long-lived species, and are thus considered inherently vulnerable to fishing pressure. Grenadier stocks in the Pacific Ocean have never been assessed and the status of these stocks is unknown.

Grenadier is typically caught incidentally in commercial fisheries targeting groundfish species such as sablefish and Dover sole. Landings data indicate that hundreds of thousands of pounds of grenadier are caught annually in Alaska, California, Oregon, and Washington, but these data are not reliable. Many fish are discarded at sea and those that are sold commercially are not identified by individual species. Grenadier is caught in both longline and bottom trawl fisheries. Bycatch in the bottom longline and trawl fisheries of the Gulf of Alaska is considered a moderate conservation concern. Habitat damage is less of a concern with bottom longlines, but is a high conservation concern with bottom trawls. On average, commercial fisheries that often catch grenadier cause moderate habitat damage. Grenadier management is considered ineffective as there are no regulations regarding grenadier catch in Alaska and only minimal regulations in Oregon and California where only the Pacific grenadier is managed under the "Other Fish" stock complex. The "Other Fish" complex does not set trip limits, size limits, gear restrictions, area closures, or specific catch limits with regard to Pacific grenadier. Until appropriate regulations are established and management of grenadier stocks is enforced, Seafood Watch® ranks the six species of grenadier evaluated in this report as "Avoid."

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability	√ Smooth; shoulderspot; California	√ Popeye	√ Pacific; giant	
Status of Stocks		√		
Nature of Bycatch		√		
Habitat Effects		√ Bottom longline	√ Bottom trawl	
Management Effectiveness			√	

About the Overall Seafood Recommendation:

- A seafood product is ranked **Avoid** if two or more criteria are of High Conservation Concern (red) OR if one or more criteria are of Critical Conservation Concern (black) in the table above.
- A seafood product is ranked **Good Alternative** if the five criteria "average" to yellow (Moderate Conservation Concern) OR if the "Status of Stocks" and "Management Effectiveness" criteria are both of Moderate Conservation Concern.
- A seafood product is ranked **Best Choice** if three or more criteria are of Low Conservation Concern (green) and the remaining criteria are not of High or Critical Conservation Concern.

Overall Seafood Recommendation:

All grenadiers in the Pacific:

Best Choice ▮ Good Alternative ▮ **Avoid** ▮

Introduction

Grenadiers inhabit the depths of all of the world's oceans except those of the high arctic (Cohen et al. 1990). They belong to the family Macrouridae within the order Gadiformes, and, like their Gadiforme relative the cod, are widespread, diverse, abundant, and frequently occur on the upper continental slope (Merrett and Haedrich 1997). Grenadiers are rarely found in waters shallower than 100 m and actually dominate depths greater than 2,000 m in both number of individuals and number of species.

Because of their long, tapered shape, the product recovery from grenadiers is relatively low (Matsui et al. 1990). The fillet yield from a Pacific grenadier, for instance, is only 22 – 26% and the protein contents of giant and Pacific grenadier fillets are very low compared to that of other fish (Matsui et al. 1990). Despite its low product yield, Pacific grenadier has proven to be a successfully marketable product. Pacific grenadier withstands frozen storage better than most other species of fish and the flesh is said to have a firm texture, agreeable white color, and favorable taste (Matsui et al. 1990). Giant grenadier has been considered a valuable food species because of its presumed abundance and the high vitamin and fat content of its liver and eggs. Nevertheless, this species has not received favorable reviews for human consumption. When tested by a panel of judges, giant grenadier received low scores for flakiness, chewiness, hardness, and fibrousness, and high scores only for moistness (Matsui et al. 1990). In the early years of the grenadier fishery, Japanese fleets caught grenadier for use in surimi, a minced fish product used to produce a traditional jellied fish product called kamaboko. Pacific grenadier produced good surimi, but giant grenadier did not and soon other species (including walleye pollock) replaced grenadier in the Japanese market for surimi (Matsui et al. 1990).

As deep-sea species, grenadiers were safe from commercial fisheries until developments in gear technology enabled fishermen to target deep-water stocks on the continental slope (Koslow et al. 2000). The Pacific grenadier fishery grew rapidly in California, particularly in Monterey Bay where the fishery grew from almost no landings in 1992 to the port's 5th largest fishery in 1996 (Leos 1996 and 1997 in Burton 1999).

There is some confusion about whether the Pacific grenadier fishery in California is a directed fishery or if all grenadiers are caught incidentally by vessels targeting other stocks. According to Leos (1997), cited in Andrews et al. (1999), and Burton (1999), more than 90% of grenadier landings in 1995 and 1996 were from lines targeting Pacific grenadier. The California Department of Fish and Game, however, states that there is no fishery for grenadier and that all grenadier is caught incidentally in other fisheries (Eres 2005). There is no directed fishery for grenadier in Alaska or Oregon; however, grenadier is often caught incidentally in other fisheries in these states.

While the grenadier fishery in the Pacific is relatively new and very little is known about the status and sustainability of these deep-water stocks, in the Atlantic, roundnose grenadier (*Coryphaenoides rupestris*) has been fished commercially for almost 40 years. This fishery began in 1967 when Soviet fleets landed approximately 20,000 tons of roundnose grenadier from the continental slope east of Newfoundland (Kelly et al. 1997; Savvatimsky 1971). In the mid-1970s, other nations joined the fishery, but the Soviet Union continued to dominate the fishery,

accounting for 90% of the total reported catch prior to 1980 (Atkinson 1995). The fishery was very successful in its early years with annual catches upwards of 82,500 metric tons (mt) from 1973 – 1978 (Kelly et al. 1997). Soviet landings of roundnose grenadier in the Northwest Atlantic peaked in 1971 when the fleet reported a catch of 82,000 metric tons (Moore 1999) while the Northeast Atlantic fishery yielded a maximum of 30,000 metric tons in 1975 (Koslow et al. 2000). Landings quickly declined as the fishery developed. In 1975, the Atlantic fishery yielded over 65,000 metric tons of roundnose grenadier but by 1986 the total catch had declined to 60,000 metric tons of grenadier with roundnose grenadier making up only 54% of the total catch (Matsui et al. 1990). By the mid-1980s landings of roundnose grenadier rarely reached 3,000 metric tons (Moore 1999) and in 1997 only a few hundred tons of roundnose grenadier were caught (Koslow et al. 2000).

The rapid decline in roundnose grenadier landings in the Atlantic is likely related to the species' life history. Like other species of grenadier, roundnose grenadier is a slow-growing, long-lived fish. Such species are inherently vulnerable to fishing pressure because individuals are often captured before they have reached their reproductive potential. Roundnose grenadier has been shown to live up to 70 years and yet the majority of fish caught are between 9 and 30 years of age (Merrett and Haedrich 1997; Savvatimsky 1971). In addition, even younger, sexually immature individuals are often killed as bycatch in trawls (Koslow et al. 2000). Such heavy fishing pressure on young individuals likely led to the decline of the roundnose grenadier fishery and the stock's subsequent failure to recover.

In the mid-1960s, roundnose grenadier was said to exist in "commercial concentrations," giving fishermen a green light to exploit these resources without an analysis of the biology and population dynamics of the stocks (Atkinson 1995). According to Atkinson (1995) the fishery proceeded to expand "at a pace dictated by man's desire for fish rather than based on any *a priori* consideration of what level of removals the resource might be able to absorb" (p. 82). The fishery operated without regulation until 1974 when the first assessment of the fishery resulted in a recommended total allowable catch (TAC) of 30,000 tons. As landings declined, the total catch of roundnose grenadier never actually reached the TAC, and management was forced to adjust the TAC downward in response to the apparent decrease in fish abundance (Atkinson 1995). Under this reactive management scheme and reduced fishing pressure, roundnose grenadier has shown no sign of recovery (Atkinson 1995; Clausen and Gaichas 2004). Merrett and Haedrich (1997) warn that if exploitation of these stocks increases, they will continue to decline and eventually vanish.

Using the case of roundnose grenadier as a model for grenadier fisheries in the Pacific, it is important to recognize the unique biology of deep-sea fishes and their subsequent vulnerability to fishing pressures. The long life span, late maturity, and high fecundity of deep-sea fishes suggest that these species have sporadic recruitment success and are therefore at the extreme end of the vulnerability spectrum (Roberts 2002).

> Perhaps the greatest lesson to be learned is that without adequate scientific knowledge and understanding of the resource coupled with careful management, these deepwater resources may easily be depleted, and once they are fished 'out,' they may well be gone for at least the foreseeable future. It is our obligation and duty not to let this happen. (Atkinson 1995, p. 83)

Scope of the analysis and the ensuing recommendation:
Pacific grenadier is targeted by a commercial fishery in California, while other species of grenadier are commonly landed as incidental catch in groundfish fisheries in Alaska, Oregon, and California. Although Pacific and giant grenadier occur in the waters of Washington, these species are rarely landed in the groundfish fishery (Program 2005). This report focuses on the grenadier species most commonly landed along the Pacific coast of North America (Pacific grenadier, giant grenadier, popeye grenadier, shoulderspot grenadier, smooth grenadier, and California grenadier).

Availability of Science

Little is known about the life history of grenadiers. Age and growth studies are only available for Pacific grenadier and giant grenadier, and spawning behavior is unknown for all species. Intrinsic rate of increase, 'r,' has not been published for any species of grenadier; however, FISHBASE provides an estimation of 'r' using length and F_{MSY} (Froese and Pauly 2005). At this time, there have been no stock assessments of grenadiers in the Pacific.

Market Availability

Common and market names:
Grenadier is also known as rattail or Pacific roughy.

Seasonal availability:
Grenadier is available year-round.

Product forms:
Pacific grenadier is the most common species of grenadier marketed as fresh or frozen fillets. While giant, popeye, shoulderspot, smooth, and California grenadier may also be sold as fillets, these species are more often marketed as fish paste, fish meal, or fertilizer.

Import and export sources and statistics:
The U.S. does not import or export any of the grenadiers discussed in this report.

Analysis of Seafood Watch® Sustainability Criteria for Wild-caught Species

Criterion 1: Inherent Vulnerability to Fishing Pressure

This report covers six species of grenadier found in the Pacific: Pacific grenadier, giant grenadier, popeye grenadier, shoulderspot grenadier, smooth grenadier, and California grenadier. In general, these fish are large in size (30 cm – 150 cm) and long-lived; age and growth studies have shown that giant grenadier live as long as 56 years and Pacific grenadier as long as 73 years (Burton 1999; Andrews et al. 1999). These species also reach sexual maturity late (20 – 40 years of age for Pacific Grenadier and 14 – 16 years of age for female giant grenadier) (Andrews et al. 1999; Burton 1999). Other grenadier species have not been studied as extensively as Pacific and giant grenadier, but they tend to have a moderate lifespan—from 12.3 years for smooth grenadier to 22 years for popeye grenadier (Table 1). Popeye grenadier reach sexual maturity at 5.1 years (moderate level) while shoulderspot, smooth, and California grenadier reach maturity at a young age—3.4, 3.1, and 3.4 years, respectively (Table 1).

Spawning behavior of all grenadier species is largely unknown. Stein and Pearcy (1982) reported a range of 22,657 – 118,612 eggs per female Pacific grenadier, but spawning frequency has yet to be determined. Drazen (2002a) hypothesizes that Pacific grenadier spawning is asynchronous and occurs year-round, yet each individual female is only able to spawn every two or three years. Recent evidence suggests that male and female Pacific grenadier have different depth distributions, with females inhabiting deeper waters than males (Drazen 2005). Giant grenadier spawning is also thought to occur year-round (Clausen and Gaichas 2004) and as with Pacific grenadier, giant grenadier females are segregated from giant grenadier males; however, with giant grenadier the behaviors are reversed. Giant grenadier females inhabit shallower waters than giant grenadier males. Novikov (1970) speculates that females migrate to deeper waters during the fall and winter when their ovaries ripen and possibly migrate to shallower waters to spawn in the spring and summer (Burton 1999).

Table 1. Life history characteristics of grenadier evaluated in this report.

Common Name	Intrinsic Rate of Increase (r)	Growth Rate	Max Size	Age at Maturity	Maximum Age	Fecundity	Species Range	Special Behaviors	Sources
Pacific grenadier	r = 0.22	k = 0.02	95 cm TL	Males: 20 yrs; females: 20-40 yrs	144.3 yrs (max reported age = 73 yrs)	22,657 – 118,612 eggs per female	North Pacific, N. Japan to Okhotsk and Bering Seas; N. American coast to N. Mexico	Segregation by sex; females inhabit deeper depths than males	Andrews et al. 1999; Clausen & Gaichas 2004; Cohen et al. 1990; Drazen, pers. comm.; Froese & Pauly 2005; Stein and Pearcy 1982
Giant grenadier	r = 0.26	k = 0.05	150 cm TL	Avg: 11.8 yrs; females: 14-16 yrs	57.9 yrs (max reported age = 56 yrs)	Unknown	North Pacific, N. Japan to Okhotsk and Bering Seas; GOA[1]; Baja California, Mexico	Segregation by sex; females inhabit shallower depths than males, migrate deep to spawn	Burton 1999; Clausen & Gaichas 2004; Cohen et al. 1990; Froese & Pauly 2005
Popeye grenadier	r = 0.66	k = 0.13	56 cm TL	5.1 yrs	22.0 yrs	Unknown	North Pacific, N. Japan to Okhotsk and Bering Seas; Oregon	None	Clausen & Gaichas 2004; Cohen et al 1990; Foese & Pauly 2005
Shoulderspot grenadier	r = 1.06	k = 0.21	34 cm TL	3.4 yrs	13.5 yrs	Unknown	Eastern Pacific, S. California, N. Gulf of California	None	Cohen et al 1990; Froese & Pauly 2005
Smooth grenadier	r = 1.16	k = 0.23	30 cm TL	3.1 yrs	12.3 yrs	Unknown	Eastern Central Pacific; Baja California, Mexico; Gulf of California	None	Cohen et al. 1990; Froese & Pauly 2005
California grenadier	r = 1.14	k = 0.20	45 cm TL	3.4 yrs	14.2 yrs	Unknown	Eastern Pacific, Vancouver Island, Canada to S. Peru	None	Cohen et al. 1990; Froese & Pauly 2005

[1] GOA = Gulf of Alaska

Synthesis

A high intrinsic rate of increase ('r') is defined by a value greater than 0.16. All of the grenadier species evaluated in this report have 'r' values greater than 0.16 according to FISHBASE. These values have been estimated using estimated values for length and F_{MSY} and are of questionable accuracy. When 'r' is unavailable or unknown the inherent vulnerability rank should be based on the ranks of the other primary factors: age at 1st maturity, Von Bertalanffy growth coefficient ('k'), maximum age, and reproductive potential. The smooth, shoulderspot, and California grenadiers each have a low age at maturity, a high 'k' value, a medium maximum age, and no known special behaviors. These species are therefore considered resilient to fishing pressure. Popeye grenadier has a medium age of maturity, a medium 'k' value, a medium maximum age, and no known special behaviors. The inherent vulnerability of popeye grenadier, therefore, is considered neutral. Pacific and giant grenadiers mature late in life, have low 'k' values, have long life spans, and are segregated by sex, which may increase the ease or consequences of capture. Pacific and giant grenadier are therefore considered vulnerable to fishing pressure.

Inherent Vulnerability Rank:

Smooth, shoulderspot, and California grenadier:

Resilient Neutral Vulnerable

Popeye grenadier:

Resilient **Neutral** Vulnerable

Pacific and giant grenadier:

Resilient Neutral **Vulnerable**

Criterion 2: Status of Wild Stocks

Stock status is unknown for all the grenadier stocks in the Pacific as no formal assessments of grenadier have been performed (Miller 2005). Although grenadiers are not the target of commercial fisheries in the Pacific, they represent a large portion of the demersal fish landings of fisheries along the U.S. West Coast. Grenadiers are the most abundant fishes caught in deep-water trawls off Oregon and Washington (Matsui et al. 1990). In 1997, Pacific grenadier and giant grenadier ranked 7th and 8th, respectively, in biomass of demersal fish caught on the continental slope in the Pacific, and 1st and 3rd, respectively, when considering only the 1098 – 1280 m depth range (Drazen et al. 2001). Each of the grenadier species evaluated in this report is caught in commercial fisheries; however, management does not require fishing operations to specify the species of grenadier caught because they are incidental catch. Therefore, with the exception of Alaska, all grenadier landings are reported as "Grenadier, unspecified." In 1999, fishery observers in Alaska began recording landings of both "Grenadier, unspecified" and giant grenadier, although giant grenadier is still included under the "Grenadier, unspecified" category

(Plotnick 2005). In 2005, observers in the Alaska groundfish fishery were instructed to record giant grenadier only as its own category (Clausen 2005).

California

In California, there is a developing fishery for Pacific grenadier that is partially dependent on the sablefish fishery (Andrews et al. 1999). The fishery began in Eureka, California, but quickly spread to the central coast of California where the majority of catches occur today (Andrews et al. 1999; CDFG 2005a). In 1996, the Monterey Bay, California fishery landed about 2 million pounds (900 mt) of Pacific grenadier (Leos 1996 and 1997 in Andrews et al. 1999). Early on, Pacific grenadier were caught using trawls, but in 1995 and 1996 more than 90% of the total grenadier catch came from set lines targeting Pacific grenadier (Leos 1997 in Andrews et al. 1999). In 1996, the fishery landed approximately 2.5 million pounds (1130 mt) of Pacific grenadier, making it the 5th largest fishery in Monterey Bay, California and the 13th largest in all of California (Leos 1996 and 1997 in Andrews et al. 1999) (Figures 1, 2, and 3). Since the fishery's peak in landings and value ($350,918, Figure 3) in 1996, landings have decreased dramatically with only 364,007 pounds landed in 2003 (Figures 2 and 3). The cause of this decline in landings is unknown, but may be due to decreased grenadier abundance or a reduction in effort in California groundfish fisheries. According to Andrews et al. (1999), 95% of the Pacific grenadier catch landed in the Monterey Bay fishery are approximately 30 – 50 years of age, and 5% of this catch is approximately 10 years of age and may be sexually immature. Giant grenadier is often taken with Pacific grenadier, but this fish has not been commercially successful because of its soft, watery texture and "unpalatable" taste (Matsui et al. 1990).

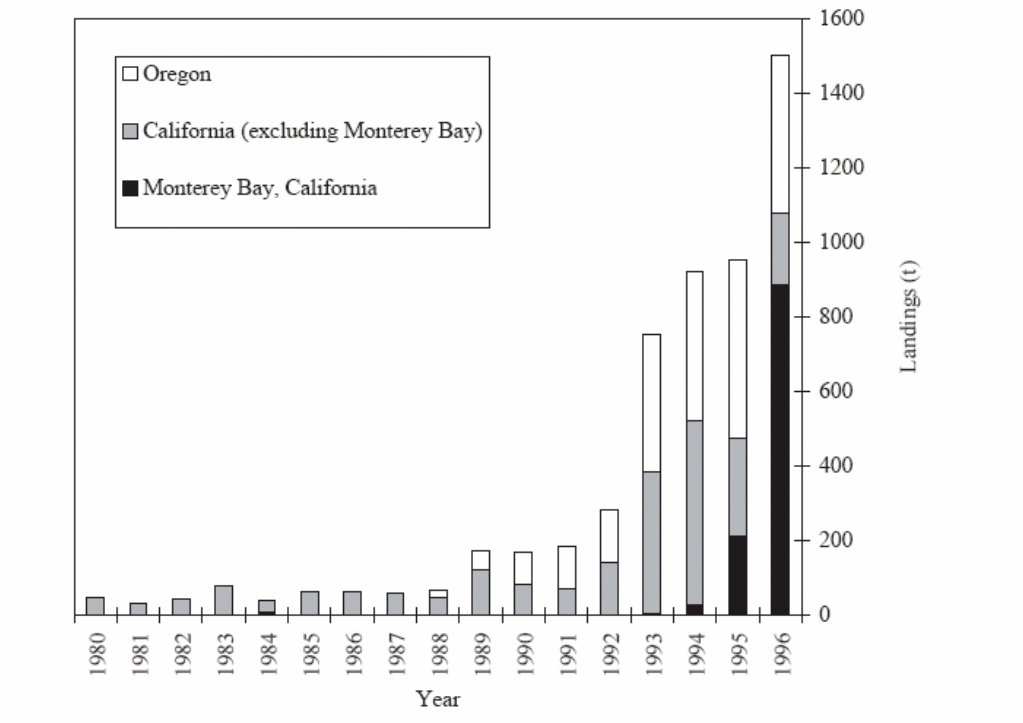

Figure 1. Landings of Pacific grenadier for California and Oregon from 1980 to 1996 given in metric tons (mt). Landings for Washington, Canada, and Alaska have been 0 or negligible (Andrews et al. 1999).

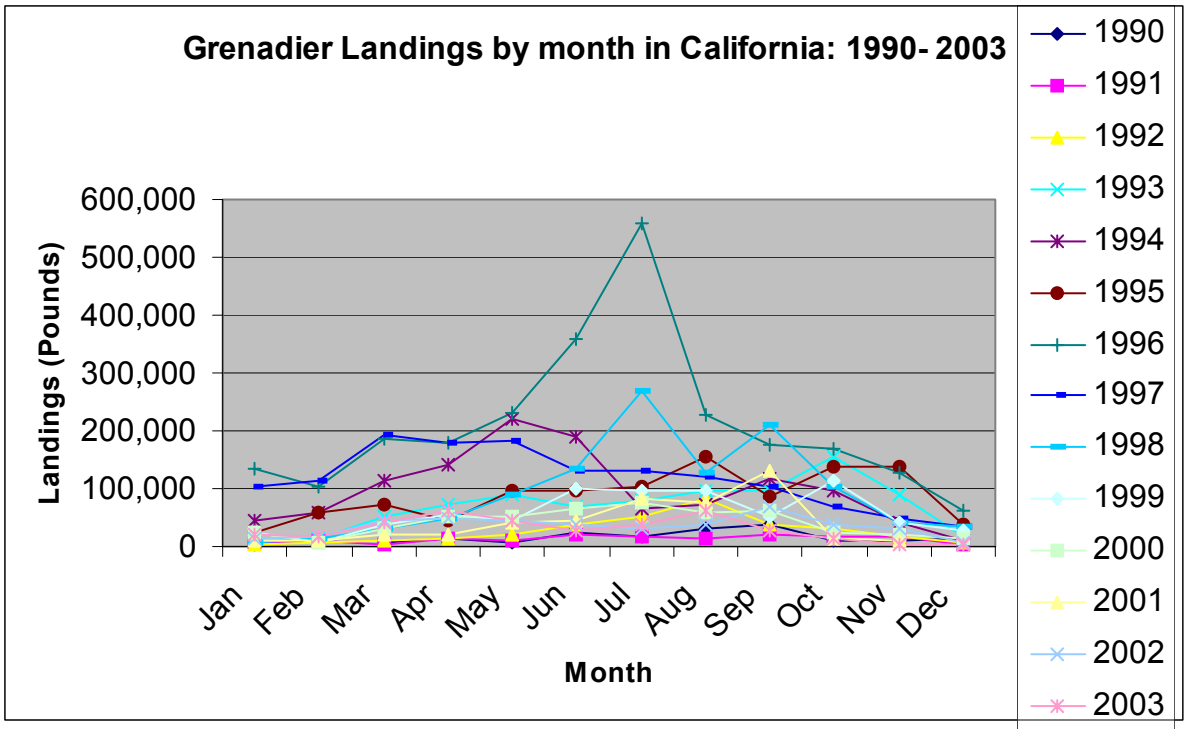

Figure 2. Monthly landings of all species of grenadier in California (NMFS 2003).

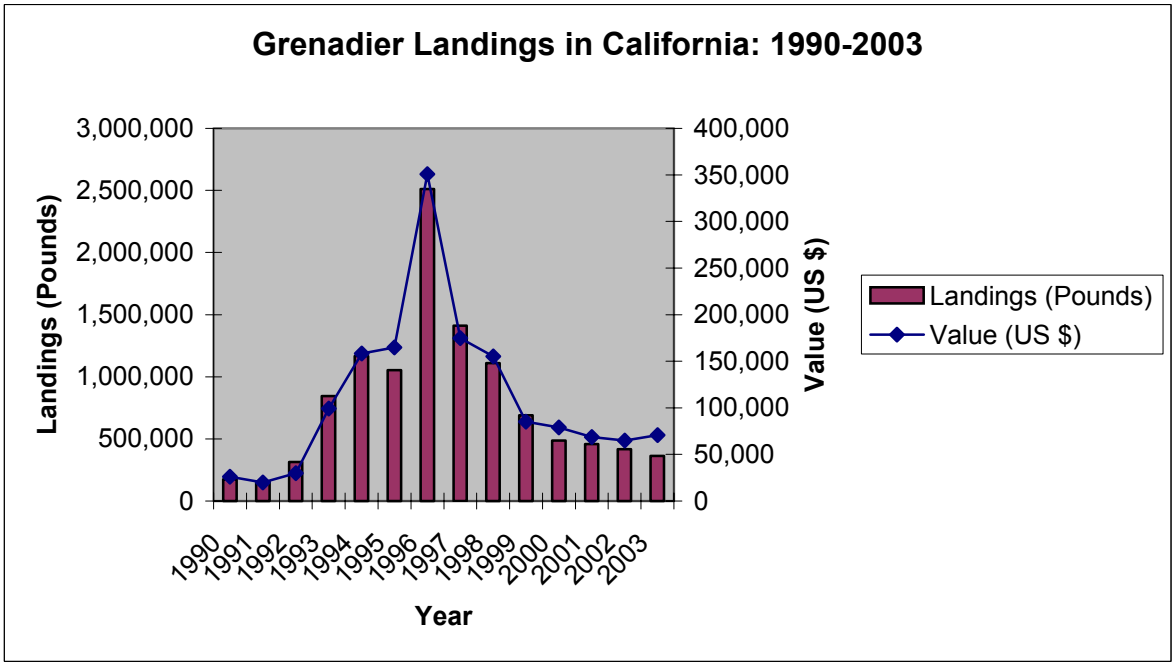

Figure 3. Annual commercial landings of all species of grenadier in California waters (NMFS data).

Oregon

Grenadiers are not the target of a commercial fishery in Oregon (Karnowski 2005), but in 1995, 1,050,256 pounds of unspecified grenadier were landed in the state (Figures 4 and 5). Oregon's grenadier fishery is not as valuable as its California counterpart. Peak grenadier landings in Oregon were almost half the peak landings in California, and the maximum value of Oregon's grenadier catch ($150,109) was more than $200,000 less than the maximum value of California's catch (Figures 3 and 5). Of the Pacific grenadier landed in Oregon, 91% of the fish are males ranging in size from 450 – 650 mm, likely ranging in age from less than 10 to 50 years of age (Mike Hosie, ODFW in Andrews et al. 1999).

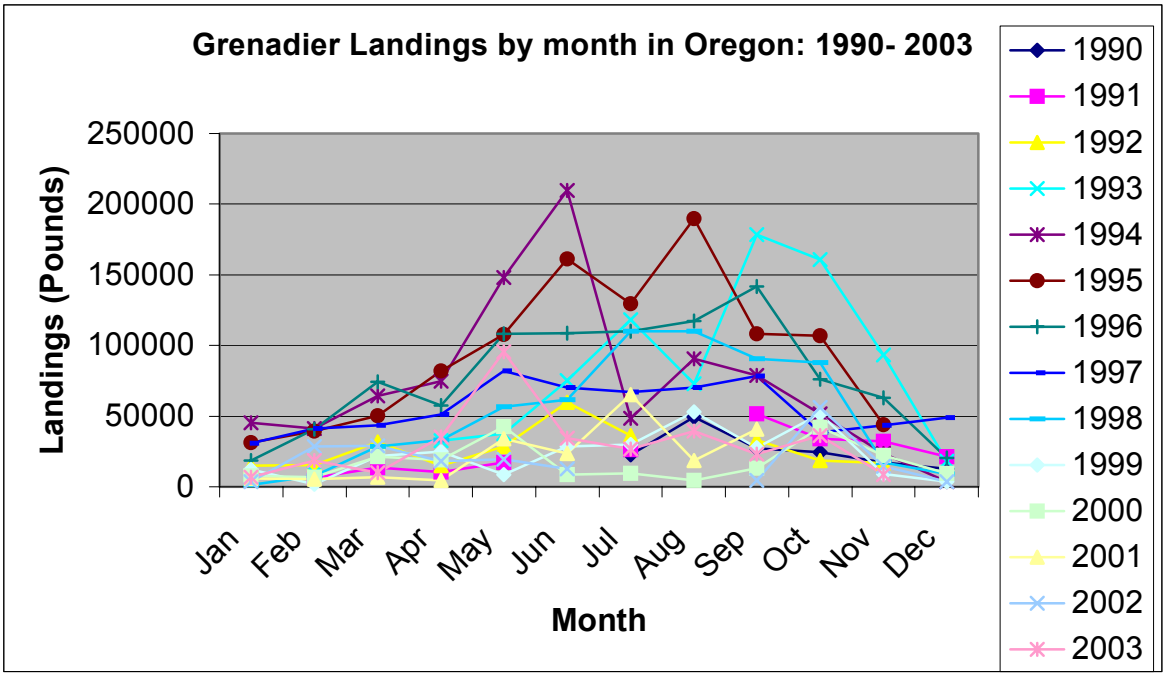

Figure 4. Monthly landings of all species of grenadier in Oregon (NMFS data).

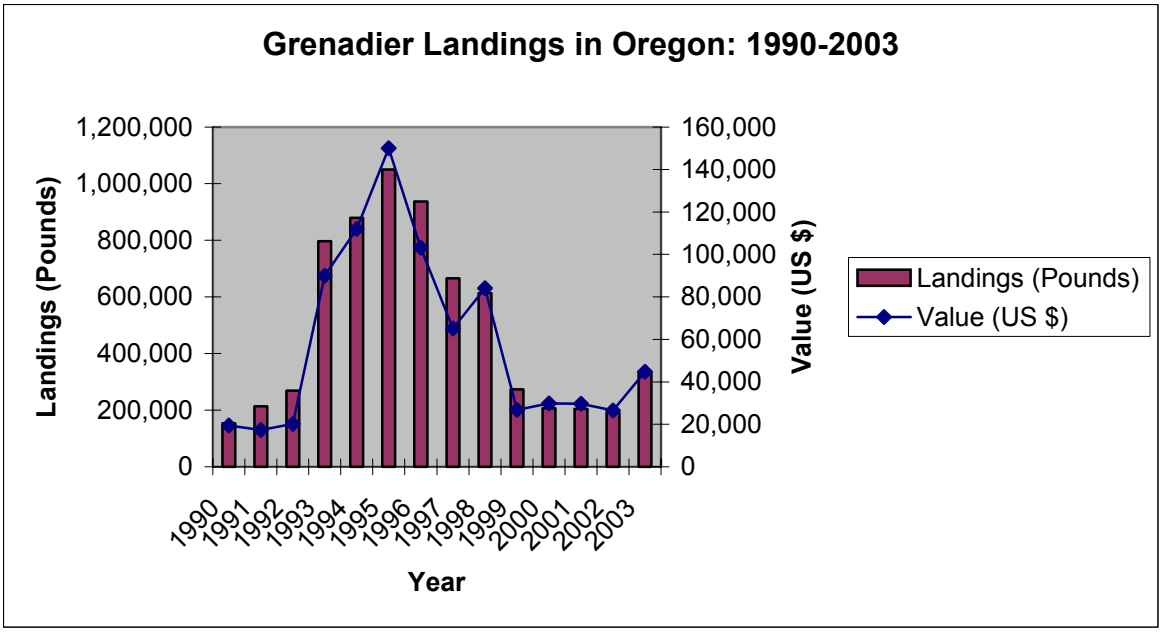

Figure 5. Annual commercial landings of all species of grenadier in Oregon waters (NMFS data).

Alaska

Grenadier landings are not formally reported in Alaska, but fishery observers record catches of grenadier as part of their comprehensive species composition sampling. National Marine Fisheries Service (NMFS) scientists extrapolate these observed estimates of catch to estimate the total catch of grenadier in regions of Alaska (Gaichas 2005).

At least seven species of grenadier occur in Alaskan waters, but only giant, Pacific, and popeye grenadier occur at shallow enough depths to be caught in commercial fishing operations or fishery surveys (Clausen and Gaichas 2004). Of these three species, giant grenadier is by far the most commonly encountered because of its shallow distribution and large biomass (Table 2) (Clausen and Gaichas 2004). In the 1980s, one survey resulted in the estimate that the total population of giant grenadier in Alaska was 140 million individuals, 93.5% of which occurred in the Aleutian Islands region (Ronholt et al. 1986 in Burton 1999). In the Gulf of Alaska, in 1999, giant grenadier made up 94% of the aggregate grenadier biomass; popeye and Pacific grenadier were the next two most abundant species, respectively. In surveys of the Eastern Bering Sea, giant grenadier comprised the majority of grenadier biomass (89% in 2002 and 93% in 2004). In the Gulf of Alaska and the Eastern Bering Sea slope, nearly all the grenadier caught at depths less than 600 – 700 m was giant grenadier (Clausen and Gaichas 2004). In the 1999 Gulf of Alaska survey covering the continental slope and shelf, giant grenadier followed arrowtooth flounder, Pacific Ocean perch, walleye pollock, and Pacific halibut as the 5th most abundant species in terms of catch per unit effort (CPUE). When considering only the continental slope deeper than 400 m, giant grenadier was the most abundant species in this survey in terms of CPUE (Clausen and Gaichas 2004).

Giant grenadier is not only the most abundant grenadier species caught in Alaskan waters, but it is also among the most abundant groundfish in Alaskan waters. In the 2002 Bering Sea slope

survey, giant grenadier had the largest estimated biomass, ahead of Pacific Ocean perch and popeye grenadier (Hoff and Britt 2003). Giant grenadier was caught in every tow deeper than 500 m and was the most abundant fish on the continental slope at 400 – 1,000 m depth in all surveyed areas except the Eastern Gulf of Alaska (Britt and Martin 2001; Clausen and Gaichas 2004). Giant grenadier was the 5th most abundant groundfish in terms of CPUE in all areas surveyed and was among the five most abundant species in all but the Southeast subarea (Britt and Martin 2001).

Table 2. Comparative biomass estimates (mt) for the three common grenadier species in recent NMFS trawl surveys in Alaska that sampled the upper continental slope (Clausen and Gaichas 2004).

Region	Year	Giant grenadier	Pacific grenadier	Popeye grenadier
Gulf of Alaska	1999	386,294	8,240	16,260
Bering Sea	2002	426,397	2,461	50,329
Bering Sea	2004	668,615	4,004	44,497

Estimated annual grenadier landings in Alaskan waters range from 4,000 – 8,000 metric tons in the Bering Sea/Aleutian Islands region and 10,000 – 15,000 metric tons in the Gulf of Alaska. While some grenadier are caught using bottom trawls, most of the grenadier catch in these regions is by bottom longline fishing gear (over 90%) used by the sablefish and Greenland turbot fisheries (Clausen and Gaichas 2004). In the Gulf of Alaska, where most of the grenadier landings are taken in the sablefish fishery, there is more grenadier caught and discarded than sablefish landed (Clausen and Gaichas 2004). Although specific grenadier species are not identified, Clausen and Gaichas (2004) surmise that the majority of the grenadier caught in the sablefish fishery is giant grenadier. These fisheries likely fish in the 400 – 800 m depth range where the highest concentrations of sablefish occur. Giant grenadier is abundant at this depth range, but few popeye and Pacific grenadier are found this shallow. Additionally, longlines rarely catch small fish such as popeye grenadier.

According to the Alaska Department of Fish and Game, much grenadier is caught and discarded at sea, but reported grenadier landings in state-managed waters are substantial. In 1991, 2,149,883 pounds of grenadier was caught in Alaskan waters (Figure 6). Reported landings have declined since 1991, but remain high with 1,631,555 pounds landed in 1998. In 1999, observers began reporting total catch of giant grenadier as well as total catch of all grenadier. In 2003, giant grenadier landings (553,547 pounds) made up more than half of total grenadier landings (1,037,666) (Figures 6 and 7).

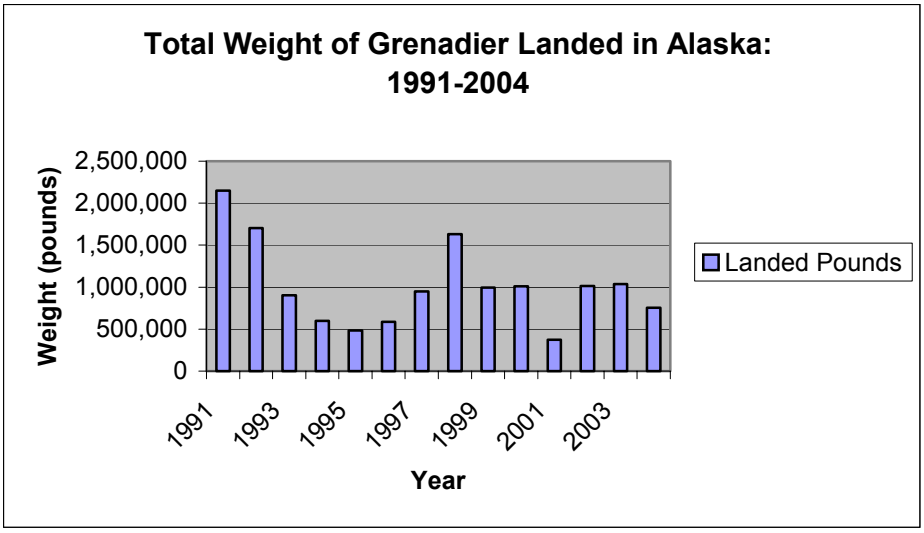

Figure 6. Annual Landings of all species of grenadier in Alaska waters (ADFG 2005).

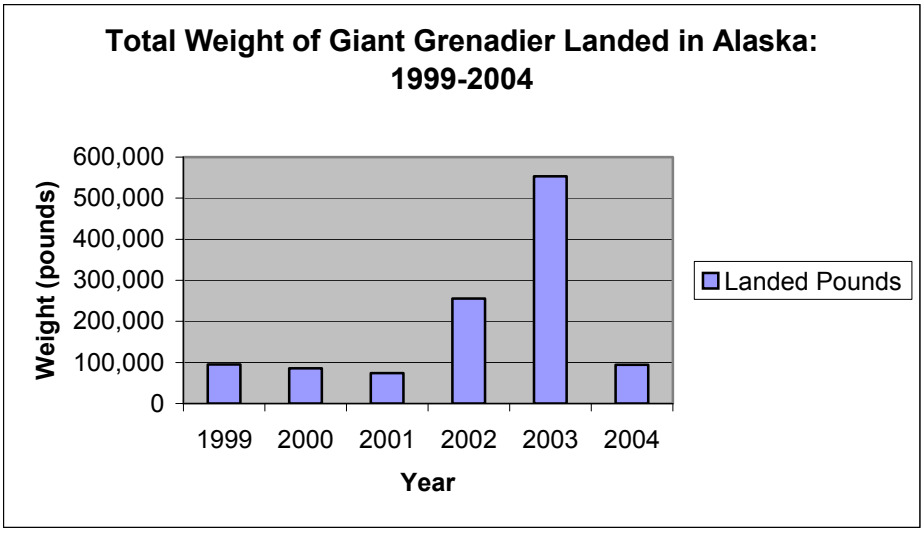

Figure 7. Annual landings of giant grenadier in Alaska waters (ADFG 2005).

Although grenadier is thought to be very abundant in Alaska, our knowledge of grenadier stocks remains minimal. Often, trawl surveys do not tow deep enough on the continental shelf to gain meaningful estimates of grenadier biomass (Gaichas 2000). Additionally, catch rates reported by surveys, which may be skewed by competition among species for baited hooks and bottom trawls, may underestimate the biomass of giant grenadier as these fish may be pelagic in their search for prey (Clausen and Gaichas 2004). In addition, fisheries observers are not trained to identify individual species of grenadier so the majority of grenadier caught in Alaskan groundfish fisheries are reported as "Grenadier, unidentified" (Gaichas 2000).

According to fisheries surveys and reported catch data, grenadier is very abundant in Alaska, but the long-term sustainability of grenadier stocks is still questionable. Substantial numbers of

grenadier are caught and discarded as bycatch in the sablefish and Greenland turbot fisheries. While the high biomass of the stocks may be able to support intense fishing pressure, the slow growth and long life span of these fish make them inherently vulnerable to fishing pressure. Of additional concern is the fact that the majority of the giant grenadier caught is likely female, as females inhabit shallower waters, where commercial fishing operations are more intense. Surveys indicate that giant grenadier commonly occur at depths between 400 and 1,000 m; however, it is possible that some giant grenadier live deeper than 1,000 m. If a substantial portion of the population lives below 1,000 m, they may be safe from current fishing pressure and may serve as a de facto reserve to replenish the shallower giant grenadier removed by the fishery (Clausen and Gaichas 2004).

Synthesis

The stock status is officially unknown for all grenadier stocks in the Pacific Ocean; therefore, the conservation concern for these stocks is moderate.

Without stock assessments, the status of wild stocks must be evaluated using fishery landings data. These data may not always be reliable. As Tables 3 and 4 demonstrate, in both Oregon and California, landings reported by the National Marine Fisheries Service differ substantially from those reported by the state agencies in some years.

Table 3. Grenadier landings data (in pounds) for the state of Oregon from the Oregon Department of Fish and Wildlife (ODFW) and the National Marine Fisheries Service (NMFS). The difference appears in bold.

Year	NMFS	ODFW	Difference
1990	153,605	191,831	**38,226**
1991	213,345	254,024	**40,679**
1992	269,239	310,459	**41,220**
1993	796,181	817,038	**20,857**
1994	879,490	879,490	**0**
1995	1,050,256	1,050,256	**0**
1996	936,982	936,982	**0**
1997	665,289	665,289	**0**
1998	614,025	614,025	**0**
1999	273,292	273,292	**0**
2000	206,676	206,676	**0**
2001	204,565	206,935	**2,370**
2002	190,790	191,391	**601**
2003	334,908	334,908	**0**
2004		90,648	

Table 4. Grenadier landings data (in pounds) for the state of California from the California Department of Fish and Game (CDFG) and the National Marine Fisheries Service (NMFS). The difference appears in bold.

Year	CDFG	NMFS	Difference
1990	176,963	173,827	**3,136**
1991	156,290	156,290	**0**
1992	314,012	314,012	**0**
1993	844,891	844,891	**0**
1994	1,167,200	1,167,200	**0**
1995	1,051,886	1,052,186	**300**
1996	2,509,944	2,509,944	**0**
1997	1,408,463	1,411,450	**2,987**
1998	1,112,316	1,109,657	**2,659**
1999	692,549	690,842	**1,707**
2000	496,279	487,177	**9,102**
2001	470,267	457,497	**12,770**
2002	416,716	416,344	**372**
2003	364,249	364,007	**242**
2004	305,735		

Status of Wild Stocks Rank:

Healthy | **Moderate** | Poor | Critical

Criterion 3: Nature and Extent of Bycatch

Seafood Watch® defines a sustainable wild-caught species as that captured using techniques that minimize the catch of unwanted and/or unmarketable species. Bycatch is defined as species that are caught but subsequently discarded because they are of undesirable size, sex, or species composition. Unobserved fishing mortality associated with fishing gear (e.g., animals passing through nets, breaking free of hooks or lines, ghost fishing, illegal harvest and under or misreporting) is also considered bycatch. Bycatch does not include incidental catch (non-targeted catch) if it is utilized, is accounted for, and is managed in some way.

There is no directed fishery for grenadier on the west coast of the United States so all grenadier landings are incidental catch or bycatch. In California, Pacific grenadier is often caught by fishing vessels trawling for sablefish (Andrews et al. 1999) while other species of grenadier are often caught by vessels trawling for Dover sole (Matsui et al. 1990).

In Oregon, grenadier is caught incidentally, primarily in the thornyhead and Dover sole fisheries. In 2000, close to 100% of the grenadier landed in Oregon came from the thornyhead fishery. In 2002, about 80% of the grenadier catch was from vessels targeting thornyhead and 15% was from the Dover sole fishery. In 2004, only about 25% of the grenadier catch came from the thornyhead fishery while close to 50% was from vessels targeting Dover sole (Mark Karnowski, pers. comm.).

Bycatch levels for many of the directed fisheries that catch grenadier have not been documented; however, bycatch of many groundfish fisheries is moderate (Stevens 2004). For instance, an average of 15% of the total weight of Dover sole landings is discarded at sea (Sampson and Wood 2001 in Stevens 2004). Additionally, between 1994 and 2000, 10% of the rex sole catch was discarded at sea (Turnock et al. 2000 in Stevens 2004).

Alaska

In the Eastern Bering Sea and Aleutian Islands region the directed fisheries for turbot, sablefish, and Pacific cod land the most grenadier, while in the Gulf of Alaska the sablefish, deepwater flatfish, and Pacific cod fisheries catch the majority of grenadier (Table 5).

Table 5. Estimated commercial catch (mt) of grenadier (all species combined) in the Eastern Bering Sea/Aleutian Islands region and Gulf of Alaska, 1997-1999, by target fishery (Clausen & Gaichas 2004).

Eastern Bering Sea/Aleutian Islands					Gulf of Alaska				
Target species	**1997**	**1998**	**1999**	**Average**	**Target species**	**1997**	**1998**	**1999**	**Average**
Arrowtooth	0	1	43	15	Arrowtooth	102	28	140	90
Atka mackerel	10	92	1	34	Cod	191	1	439	211
Cod	835	693	571	700	Deepwater flats	318	232	285	278
Flathead	3	11	3	6	Demersal shelf rockfish	0	-	0	0
Other flats	0	0	6	2	Flathead sole	46	6		26
Other rockfish	232	1	4	79	Northern rockfish	44	149	2	65
Other species		0	59	29	Other species	0	0	0	0
Other targets	0	0	0	0	Pelagic shelf rockfish	83	7	26	39
Pollock B	0	0	0	0	Pollock B	0	2	29	10
Pollock P	36	41	79	52	Pollock P	28	0	52	27
POP	149	104	115	123	POP	185	136	29	117
Rock sole	0	0	0	0	Rex sole	166	77	26	90
Sablefish	2,309	881	2,008	1,732	Sablefish	10,806	14,023	10,351	11,727
Shortraker / rougheye		49	0	24	Shallow water flats	20	21	0	14
Turbot	2,276	4,713	4,499	3,830	Shortraker / rougheye	2		8	5
Yellowfin sole	1	3	0	1	Thornyhead	38			38
Total	5,852	6,589	7,388	6,610	Total	12,029	14,683	11,388	12,700

Longline fisheries

Between 1997 and 2002, approximately 95% of the estimated commercial catch of grenadier in the Eastern Bering Sea/Aleutian Islands and Gulf of Alaska occurred in longline fisheries (Table 6). Seabird bycatch is a concern in Alaskan longline fisheries. Of the five seabird species commonly taken in Alaskan longline fisheries, one species is protected under the U.S. Endangered Species Act (short-tailed albatross) and two others are listed on the IUCN Red List of Threatened Species (the Laysan albatross—vulnerable, and the black-footed albatross—endangered). Between 1993 and 2003, an average of 12,619 seabirds died annually in groundfish longline fisheries in the Bering Sea and Aleutian Islands—a bycatch rate of 0.71 birds per 1,000 hooks (NMFS 2005). During this same period, an average of 932 seabirds was taken annually as bycatch in the Gulf of Alaska longline fisheries (about 0.24 birds per 1,000 hooks) (NMFS 2005). While bycatch of seabirds due to longline fisheries in the Gulf of Alaska and Bering Sea has declined overall in the past 10 years, recent declines in populations of the Laysan albatross and black-footed albatross may be a result of bycatch of these species in Alaskan longline fisheries (BirdLifeInternational 2004). The seabird avoidance measures implemented in 1997 were successful at reducing the seabird bycatch rates in the BSAI and the GOA, as well as the number of albatrosses caught as bycatch. Seabird bycatch is this fishery is considered a moderate conservation concern.

Trawl fisheries

In Alaska, up to 40% of the fish caught by deep-sea trawling operations is grenadier (Crapo et al. 1999). Grenadier is often caught incidentally in the walleye pollock fishery in Alaska (Michael Plotnick, pers. comm.). Walleye pollock is caught using mid-water trawls which are believed to have low bycatch of seabirds, sea turtles, marine mammals, and sharks, and moderate bycatch of finfish (Chuenpagdee et al. 2003). In the Bering Sea, no more than 10% of the pollock catch has been discarded since 1992. In 2002, 2% of the total bycatch of the fishery was labeled as "other species," which included salmon shark, starfish, smelts, octopus, grenadier, tunicates, lanternfish, sharks, benthic invertebrates, seapens, crabs, and anemones (Ianelli et al. 2003 in Marsh 2005). The overall extent of bycatch in the walleye pollock fishery is low (Marsh 2005).

As with longline fisheries, seabird bycatch may also be a concern in Alaskan trawl fisheries, although there is considerable uncertainty in the estimates of seabirds taken in this fishery. Seabirds such as northern fulmars, shearwaters, and Laysan albatrosses may interact with a trawl's net, the doors of an otter/bottom trawl, or the "third wire" used to monitor the performance of the trawl. Between 1999 and 2003, the average annual estimate of seabirds taken in the Pacific cod trawl fishery ranged from 1,343 to 15,343 (NMFS 2005).

Synthesis

Overall, bycatch in West Coast grenadier fisheries is unknown because grenadier themselves are incidental catch. Some grenadier is landed in bottom trawl fisheries which tend to catch multiple species due to the indiscriminate nature of the gear. While the nature of bycatch associated with grenadier catch is largely unknown, trawl fisheries that catch grenadier may also catch rockfish (*Sebastes sp*.). Eight species of rockfish found in U.S. West Coast waters have been declared overfished. Due to the uncertainty surrounding the nature and extent of bycatch associated with grenadier catch in trawl fisheries on the U.S. West Coast, grenadier receives a moderate bycatch rank. The rates of seabird bycatch in bottom longline fisheries in Alaskan waters are declining, and the nature of this bycatch remains a moderate conservation concern.

Nature of Bycatch Rank:

Low | **Moderate** | High | Critical

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Habitat Effects

In Alaska, the vast majority of grenadier landings come from bottom-set longlines, but bottom trawls and pelagic trawls also contribute to grenadier catch (Table 6). According to Cascorbi (2004), approximately 88% of the sablefish landed in Alaska is caught with longline gear. Although longlining near deep-sea corals can cause detrimental effects to marine habitat, fishing with longlines near the sandy and muddy bottoms preferred by giant grenadier is not known to negatively impact the marine habitat (Cascorbi 2004).

Table 6. Estimated commercial catch (mt) of grenadier (all species combined) in the Eastern Bering Sea/Aleutian Islands and Gulf of Alaska, 1997-2002, by gear type (n.a. = data not available) (Clausen and Gaichas 2004).

Gear	1997	1998	1999	2000	2001	2002[a]
Eastern Bering Sea and Aleutian Islands						
Bottom trawl	214	241	132	359	198	242
Pelagic trawl	36	41	79	33	11	-
Pot	0	0	0	6	7	15
Longline	5,602	6,307	7,177	6,923	3,538	7,909
Total	5,852	6,589	7,388	7,321	3,754	8,166
Gulf of Alaska						
Bottom trawl	965	655	529	n.a.	n.a.	n.a.
Pelagic trawl	28	5	81	n.a.	n.a.	n.a.
Pot	0	0	0	n.a.	n.a.	n.a.
Longline	11,037	14,023	10,777	n.a.	n.a.	n.a.
Total	12,029	14,683	11,388	11,610	9,685	n.a.
All Alaska, All Gears Combined						
Grand Total	17,881	21,272	18,776	18,931	13,430	n.a.

[a]For the Eastern Bering Sea and Aleutian Islands in 2002, the catch listed as "bottom trawl" includes bottom trawls and pelagic trawls combined.

In California, grenadier is most often caught using bottom trawl gear, but other gear types, including midwater trawls, longlines, hook-and-line gear, and fish traps, also land grenadier (CDFG 2005b). The vast majority of grenadier landings in Oregon come from bottom trawl nets (Mark Karnowski, pers. comm.). Bottom trawling is known to cause a great deal of damage to marine habitats as the gear scrapes along the ocean floor damaging three-dimensional habitat, removing and/or damaging non-target species, and stirring up sediment.

The degree of damage caused by demersal trawls depends on the type of gear used, the frequency of disturbance, and the bottom type. Otter trawls, the primary gear type used in Pacific sole fisheries, are said be less destructive to bottom habitat than other types of bottom trawls (Stevens 2004). Nevertheless, a study of lightly- versus heavily-trawled areas within the Monterey Bay National Marine Sanctuary demonstrates that otter trawls decrease the complexity and diversity of bottom habitat (Kvitek and Engel 1998). Benthic areas composed of coarse sediment such as sand are more resilient to trawling than soft, muddy, or structurally complex

areas of the sea floor (Collie et al. 2000). Bottom trawls that land grenadier in the Pacific likely encounter various bottom types as grenadier are found close to sandy, muddy, and rocky bottoms as well as in the water column (Table 7).

Table 7. Reported habitat and depth preference of grenadier species along the U.S. Pacific coast.

Species	Habitat Preference	Sources
Pacific grenadier	Benthopelagic – continental slope; 620 – 3,700 m (most abundant > 800 m)	Clausen & Gaichas 2004; Cohen et al. 1990; Froese & Pauly 2005; Mecklenburg et al. 2002
Giant grenadier	Bathydemersal – on or near sandy mud bottom; 140 – 3,000 m (most abundant between 300 – 900 m)	Clausen & Gaichas 2004; Cohen et al. 1990; Froese & Pauly 2005; Iwamoto and Stein 1974; Mecklenburg et al. 2002
Popeye grenadier	Benthopelagic; 150 – 3,500 m (most abundant > 800 m)	Clausen & Gaichas 2004; Cohen et al. 1990; Froese & Pauly 2005; Mecklenburg et al. 2002
Shoulderspot grenadier	Benthopelagic; 180 – 300 m	Cohen et al. 1990; Froese & Pauly 2005
Smooth grenadier	Bathydemersal – continental slope; steep rocky habitat; 768 – 1660 m	Cohen et al. 1990; Froese & Pauly 2005; Hoff et al. 2000
California grenadier	Bathydemersal – continental slope; 277 – 909 m	Cohen et al. 1990; Froese & Pauly 2005; Hoff 2000

Ecosystem Effects

Little is known about the role grenadier play in deep-sea ecosystems; however, because of their large size, generalized feeding habits, and abundance in the deep-sea, Drazen et al. (2001) speculates that they may be apex predators. Apex predators control prey populations, exert selective pressure on other members of their community (Drazen et al. 2001), and in turn, help maintain high species diversity (Pearcy and Ambler 1974). The removal of these predators could have a significant impact on community dynamics in the deep-sea.

Synthesis

Lack of information about grenadier fishing practices and deep-sea ecosystems presents an obstacle to the evaluation of the effect of fishing practices. While bottom trawling causes severe damage to benthic habitats, bottom longlining has a minimal impact on these habitats. Until grenadier fishing practices are thoroughly documented, the impacts of fishing practices for grenadier caught using longlines (mostly in the sablefish fishery in Alaska) are ranked as moderate. Bottom trawls, the primary gear used to catch grenadier in California and Oregon, have a severe impact on benthic habitats and ecosystems and thus their impact is ranked severe.

Effect of Fishing Practices Rank:

Longlines (primarily Alaska):

Benign | **Moderate** | Severe | Critical

Bottom trawls (California and Oregon):

Benign | Moderate | **Severe** | Critical

Criterion 5: Effectiveness of the Management Regime

California and Oregon

In California, Oregon, and Washington, Pacific grenadier are managed by the Pacific Fishery Management Council's (PFMC) Pacific Coast Groundfish Fishery Management Plan (FMP). Pacific grenadier fall under the "Other Fish" stock complex within the FMP, which contains all species in the Groundfish FMP that have not been assessed and are neither rockfish nor flatfish. Ten species are managed under the "Other Fish" complex: big skate (*Raja binoculata*), California skate (*Raja inornate*), leopard shark (*Triakis semifasciata*), longnose skate (*Raja rhina*), soupfin shark (*Galeorhinus zyopterus*), spiny dogfish (*Squalus acanthias*), finescale codling (*Antimora microlepis*), Pacific grenadier (*Coyphaenoides acrolepis*), ratfish (*Hydrolagus colliei*), and kelp greenling (*Hexagrammos decagrammus*) (PFMC 2004). The accepted biological catch for the "Other Fish" complex is 14,597 metric tons for 2005 and 14,592 metric tons for 2006. The optimum yield harvest target for the "Other Fish" complex is 7,300 metric tons for both 2005 and 2006 (Devore 2005). According to landings data from the National Marine Fisheries Service, 165.1 and 151.1 metric tons of grenadier were landed in California and Oregon[2], respectively, in 2003 (NMFS 2003). The species composition of these landings is unknown as neither the California Department of Fish and Game nor the Oregon Department of Fish and Wildlife requires fishermen or fish wholesalers to identify the species of grenadier on their landings or retail reports (Roberts 2005).

Although the PFMC reports that grenadier are managed under the "Other Fish" complex in the Groundfish FMP, Andrews et al. (1999) suggest that Pacific grenadier is not included in this category in California.

> Before 1995, greater than 95% of the landings were from trawlers. For 1995 and 1996, greater than 90% of the landings were from set lines targeting the Pacific grenadier (Leos 1997). Because of these landings, the Pacific grenadier is no longer in the "other" category and has become the fifth largest fishery in Monterey Bay, California, and thirteenth in the state of California at 1130 t (~2.5 million pounds) for 1996 (Leos 1996 and 1997). (Andrews et al. 1999)

This confusion, in itself, suggests that stocks of Pacific grenadier in California are not managed effectively. No other species of grenadier is managed under the PFMC's Groundfish FMP (PFMC 2004).

Alaska

Prior to 1979, grenadier was managed under the "Other" category of the Gulf of Alaska FMP. In 1979, however, Amendment 5 of the Gulf of Alaska FMP established a separate management category for grenadier and set a total allowable catch (TAC) of 13,200 metric tons to prevent grenadier bycatch from causing premature closure of target fisheries. In 1980, grenadier was moved to the non-specified category of the FMP (Gaichas 2000). In Alaska, all species of grenadier are classified as "Non-specified species" under the North Pacific Fishery Management Council's groundfish FMPs for the Bering Sea/Aleutian Islands and the Gulf of Alaska (Sarah Gaichas, pers. comm.). As a result, management does not officially track grenadier catch and

[2] The 2003 Oregon data does not include the month of December.

fishermen are not required to report grenadier catch or to limit their catch or retention of grenadier (Clausen and Gaichas 2004). After a recent review of Gulf of Alaska grenadier landings, the Gulf of Alaska Plan Team expressed interest in establishing some management for grenadier, at least as part of the "Other" category (Gaichas 2000).

Even though they are only caught incidentally, grenadiers may be more susceptible to over fishing because of their life history traits. Given these life history traits and our limited knowledge of grenadier stocks, Gaichas (2000) believes that the observed catches of grenadier in Alaska are high enough to warrant further investigation and management attention and places them 2nd in priority to receive increased protection within the non-target species group. Clausen and Gaichas (2004) state that only giant grenadier warrant management concern in Alaska at the present time. Moore (1999) and Andrews et al. (1999) call for more data on stock size, distribution, movements, and CPUE to manage the Pacific grenadier fishery sustainably.

Table 8. Commercial harvest management measures for the grenadier fishery.

Management Jurisdictions & Agencies	Total Allowable Landings	Size Limit	Gear Restrictions	Trip Limit	Area Closures
In CA and OR: PFMC's "Other Fish" complex. In AK: NPFMC's "Non-specified species"	ABC[b] for entire "Other Fish" complex = 14,597 mt	None	None	None	None

[b]ABC = Allowable Biological Catch.

Synthesis

Effective fishery management must meet the following objectives: stock assessments must be complete and robust, regular collection and analysis of data with respect to the short and long-term abundance of the stock must occur, management must maintain a track record of not setting catch quotas beyond those recommended by its scientific advisors and external scientists, management must address the effect of fishing methods on habitats and ecosystems, fishery regulations must be enforced, and conservation measures enacted by management must result in long-term maintenance of stock abundance and ecosystem integrity. No stock assessments of grenadier species along the Pacific coast have been completed and none are planned. Because grenadier is not part of a directed fishery, fishermen are not required to report catch data or identify individual species. While the PFMC has set catch quotas for the "Other Fish" complex at the level recommended by their scientific advisors, these quotas do not specify what portion of the "Other Fish" catch may be composed of grenadier and are therefore ineffective in controlling the effort on grenadier. Grenadier is not managed under any FMP in Alaska, so there is no quota for annual grenadier landings. Because there is essentially no management for grenadier in the Pacific, management of grenadier fisheries is considered ineffective.

Effectiveness of Management Rank:

Highly Effective | Moderately Effective | **Ineffective** | Critical

Overall Evaluation and Seafood Recommendation

Of the six species of grenadier evaluated in this report, three are thought to be resilient to fishing pressure—smooth, shoulderspot, and California grenadier—and one is moderately resilient to fishing pressure—popeye grenadier. The two species most commonly caught in commercial fishing operations, Pacific grenadier and giant grenadier, however, are inherently vulnerable to fishing pressure because of their long life spans (approximately 144.3 years for Pacific grenadier and 57.9 years for giant grenadier) and late age of maturity (20 – 40 years for Pacific grenadier and 11.8 – 16 years for giant grenadier). Very little is known about the role that grenadier play in deep-sea ecosystems. The status of grenadier stocks is unknown and fishery landings data are often unreliable and fail to identify individual species of grenadier. Grenadier is caught in both longline and trawl fisheries. Bycatch in the bottom longline fishery in Alaska, and the trawl fisheries, is a moderate conservation concern. Bottom trawls can cause severe damage to demersal habitats, while habitat impacts from bottom longlines are only a moderate concern. In Alaska, grenadier catch is not regulated, while in Oregon and California grenadier catch is managed only minimally (under the "Other Fish" complex, which sets an acceptable biological catch for all species in the category). The grenadier fishery is not managed effectively on the U.S. West Coast, thus management for the sustainability of grenadier stocks is of high conservation concern. Until grenadier stocks have been assessed and some management is put into place, the overall seafood recommendation for all grenadier stocks in the Pacific is "Avoid."

Table of Sustainability Ranks

	Conservation Concern			
Sustainability Criteria	**Low**	**Moderate**	**High**	**Critical**
Inherent Vulnerability	√ Smooth; shoulderspot; California	√ Popeye	√ Pacific; giant	
Status of Stocks		√		
Nature of Bycatch		√		
Habitat Effects		√ Bottom longlines	√ Bottom trawls	
Management Effectiveness			√	

Overall Seafood Recommendation:

All grenadiers in the Pacific:

Best Choice | Good Alternative | **Avoid**

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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