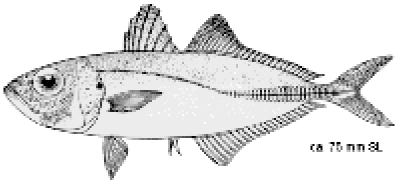
Seafood Watch
Seafood Report

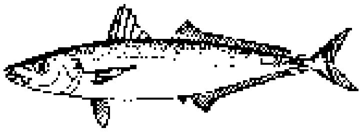
MONTEREY BAY AQUARIUM®

Big-eye scad: akule
(Selar crumenophthalmus)



(Courtesy: FishBase)

Mackerel scad: 'ōpelu
(Decapterus macarellus)



(Courtesy: Hawaii Division of Aquatic Resources
Dept. Land & Natural Resources)

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 that originating from species, wild-caught or farmed, that can exist into the long-term through maintained or increased stock abundance and conservation of the structure, function, biodiversity and productivity of the surrounding ecosystem. 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 (www.montereybayaquarium.org) or obtained from the program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and to shift the purchasing habits of consumers, restaurateurs and other seafood purveyors to support sustainable fishing and aquaculture practices.

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 Alternative" or "Avoid". 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® Fishery 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, fishery 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

Although nearshore fisheries account for only a minor portion (~7%) of the total landed catch in Hawaii, they are important to small-scale local recreational and commercial fishers both as food fish and bait for larger pelagic species. Big-eye and mackerel scad, *akule* and ‘*ōpelu* respectively, are culturally important to native Hawaiians, who have been fishing on schools of these two species for generations. Akule and ‘ōpelu are small, fast-growing pelagic fishes and are thought to have a short life cycle (<5 years). They are fished by handline and surround net, methods that involve low bycatch and negligible impact to seafloor habitats. Because akule and ‘ōpelu inhabit mostly nearshore waters, they are managed by the State of Hawaii through a set of administrative rules that seek to maintain the stock through gear restrictions, bag limits, and area and time closures. The state monitors the stock abundance through fisheries-dependent data collection, and enforces regulations with a limited (but dedicated) fleet of marine patrol officers. The most recent stock assessment (2000) indicates both species are moderately exploited, with estimates of stock biomass 20-80% above Maximum Sustainable Yield (MSY).

Table of Ranks-

Sustainability Criteria	Concern: Low	Concern: Moderate	Concern: High	**Concern: Critical**
Inherently Vulnerability	√			
Status of Stocks	√			
Nature of Bycatch	√			
Habitat Effects	√			
Management Effectiveness	√			

Overall Seafood Rank:

Big-eye scad (akule) Avoid ☐ Caution ☐ [✓ **Best Choices** ☐]

Mackerel scad (‘ōpelu) Avoid ☐ Caution ☐ [✓ **Best Choices** ☐]

Introduction

Big-eye and mackerel scad, *akule* and *'ōpelu* respectively, are small, schooling fishes in the Carangid family (jacks/trevallies, or Latin American pompanos). They are targeted by recreational and subsistence fishers and comprise the principal component of nearshore commercial fisheries in the Main Hawaiian Islands (MHI) (Smith 1993). Juvenile big-eye scad, known as *hahalalu,* are also targeted by recreational fishers (Smith 1993). The two species are fished off almost every island in the main Hawaiian archipelago and rank within the top ten fisheries on all the Hawaiian islands (Smith 1993). Akule reach a maximum size of 60 centimeters[1] (cm)(Berry and Smith-Vaniz 1978), while 'ōpelu reach a maximum size[2] of 40 cm (Edwards 1990).

The catch of akule and 'ōpelu has increased over the last two decades presumably in response to increased fishing pressure and changes to Hawaii's population level. The majority of the 'ōpelu catch is concentrated in small areas of the islands; more than half of the catch comes from two areas along the Kona coast of Hawaii (Weng and Sibert 2000). Another important region for these and other nearshore pelagic species is the Waianae Coast of O'ahu (Smith 1993). Between 1980 and 1990, mean annual catches of akule were consistently higher than 'ōpelu on each island at around 46 metric tons (mt) per year (Table 1), except for the island of Hawaii, where catches of 'ōpelu were by far the highest, with a mean annual catch of 83 mt per year (Smith 1993). From 1998 to 2001, akule landings averaged 505 mt and 'ōpelu landings averaged 114 mt (HDAR 2003b).

Table 1. Mean annual catch (mt) of akule and 'ōpelu reported for 1980-1990 by geographic region (Smith 1993).

Island Group	Akule	Opelu
Kauai Complex	44	10
Oahu	61	17
Maui Complex	48	4
Hawaii	31	83

Scope of the analysis and the ensuing recommendation:
Because their distribution is circumtropical, big-eye and mackerel scads are caught in many other areas around the globe (Froese and Pauly 2003). This report, however, deals only with the stocks inhabiting the western central Pacific and their Hawaii-based fisheries.

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[1] The record in Hawaii (Official State Record in Hawaii Fishing News) is 2.03 lbs (about 42 cm)

[2] The record in Hawaii (per Hawaii Fishing News) is 3.44 lbs (about 33 cm)

Availability of Science

Most of the available information for this report came from an analysis of the fisheries for akule and ‘ōpelu in Hawaii, authored by Kevin Weng and John Sibert (Weng and Sibert 2000) and funded jointly by the Joint Institute for Marine and Atmospheric Research (JIMAR) and the National Oceanic and Atmospheric Administration (NOAA). In the study, the authors conducted a comprehensive literature review of the two species, and used a 30-year fishery database to determine trends of abundance (Biomass, B) relative to an estimate of maximum sustainable yield (MSY).

Market Availability

Common/Market Names

The Hawaiian name for big-eye scad is *akule*; young big-eye scad are called *hahalalu.* Mackerel scad is also known as round scad, and bears the Hawaiian name *‘ōpelu*.

Seasonal Availability

The fishery occurs year-round in the nearshore waters around the Main Hawaiian Islands (MHI), although the quantity of catch may be limited by seasonal gear restrictions. From July through October, the use of nets for catching big-eye and mackerel scad is prohibited (HDAR 2003a), as schools tend to move offshore seasonally and become invulnerable to this gear in deeper waters.

Product Forms

Because the fishery is local, fish are usually sold fresh, and may be eaten raw. They may also be dried or salted[3].

Import/Export Statistics

Akule and ‘ōpelu are caught and consumed locally. The primary market for akule is Honolulu, where the majority of Hawaii’s population lives (Weng and Sibert 2000). ‘Ōpelu has a longer shelf life than akule, and may be shipped in small quantities to the U.S. mainland, but the majority of the catch stays in Hawaii[4].

Analysis of Criteria

Criterion 1: Inherent Vulnerability to Fishing Pressure

Akule is a schooling fish that travels in compact groups of hundreds to thousands of fish, and is commonly found close to shore or on shallow reefs (Smith-Vaniz 1986). ‘Ōpelu also school but are usually found farther offshore or in mid-waters of deep lagoons and coastal bays. ‘Ōpelu is generally not found over coral reefs (Weng and Sibert 2000). Adult akule feed nocturnally on shrimp, small fishes, and other small prey, while adult ‘ōpelu feed mainly on macroplanktonic crustaceans and fish larvae (Weng and Sibert 2000). Tagging studies on individual akule

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[3] Lowe, M.K. 2003. Personal Communication. Hawaii Division of Aquatic Resources, 1151 Punchbowl Street, Room 330, Honolulu, HI 96813.

[4] Brooks Takenaka. 2003. Personal Commun., United Fishing Agency, 117 Ahui St, Honolulu HI 96813.

indicate they exhibit limited movement between populations in the northern, western, and southern waters of Oahu (Kawamoto 1973). Movement of ʻōpelu has not been studied.

The life history characteristics of akule and ʻōpelu are compared in Table 2. Both species are heterosexual, iteroparous (egg-layers), and aggregate to spawn seasonally (Clarke and Privitera 1995; Weng and Sibert 2000). Akule spawn multiple times during the spawning season, but the frequency of ʻōpelu spawning is unknown (Weng and Sibert 2000). Larvae of both species are pelagic for up to four months before joining adult schools (Kawamoto 1973). Both species grow rapidly, but akule is reported to grow up to three times faster than ʻōpelu (k = 0.21/month vs. 0.075 /month) (Weng and Sibert 2000). Akule is thought to reach maximum size in one to two years, ʻōpelu in two to three years (Weng and Sibert 2000).

Direct measurements of maximum age (otolith growth zone counts) have not been made. The best estimate of maximum age for akule is two years, based on tag/recapture data (length and time since capture) from Kawamoto (1973) applied to a von Bertalanffy Growth Function (VBGF) (Weng and Sibert 2000). The best estimate for ʻōpelu is four to five years, from somatic growth rates estimated by Yamaguchi (1953) and applied to Weng and Sibert (2000) VBGF. Although these estimates of maximum age involve a higher degree of uncertainty than direct measurements, they are supported by other life history characteristics indicative of a short life span (Table 2).

Table 2. Life history parameters for akule and ʻōpelu, based on the work of Clark and Privitera (1995), except where noted.

Factor:	**Big-eye scad (akule)**	**Mackerel scad (ʻōpelu)**
Intrinsic rate of increase (r)	1.94/yr [1,2]	1.86/yr [1,3]
Age at 50% maturity	7 months [1]	18 months [1]
Size at maturity	≤ 20 cm SL *	~ 24.5 cm SL *
Maximum age (validated?)	2 years (no) [1]	4-5 years (no) [1,3]
Growth rate (k)	0.215/month [1]	0.075/month [1]
Fecundity/Spawning	~92,000 eggs per batch, spawning frequency once every 3 days during spawning season (April – Sep/Oct.)	~136,000 eggs per batch, spawning frequency unknown. Spawning season: April - August
Species range	Circumtropical	Circumtropical
Special behaviors	Nighttime spawning aggregations, schooling	Spawning aggregations, schooling
Evidence of high population variability	Unknown	Unknown

* Standard length (from tip of snout to caudal peduncle)
[1] (Weng and Sibert 2000)
[2] (Kawamoto 1973)
3 (Yamaguchi 1953)

Synthesis

Akule and ‘ōpelu are fast-growing, fecund, short-lived fishes. Although their maximum age is not validated, their growth characteristics and small size corroborate the existence of a short life span (< 5 yrs). Thus, they are inherently resilient to fishing pressure.

Inherent Vulnerability Rank: Vulnerable ☐ Neutral ☐ **Resilient** ☑

Criterion 2: Status of Wild Stocks

Although commercial fishers take the majority of akule and ‘ōpelu catch, subsistence and recreational catches are also thought to be significant (Weng and Sibert 2000). There are no landings data for subsistence and recreational sectors, but the State of Hawaii Division of Aquatic Resources (HDAR) has a record of commercial catch dating back almost 50 years (Fig. 1). Based on this time series, it appears that the catch of both species is variable between years and decades, especially for akule. The cause of variability in landings is not well understood, but may be due to changes in fishing effort, abundance of fish, or a combination of both.

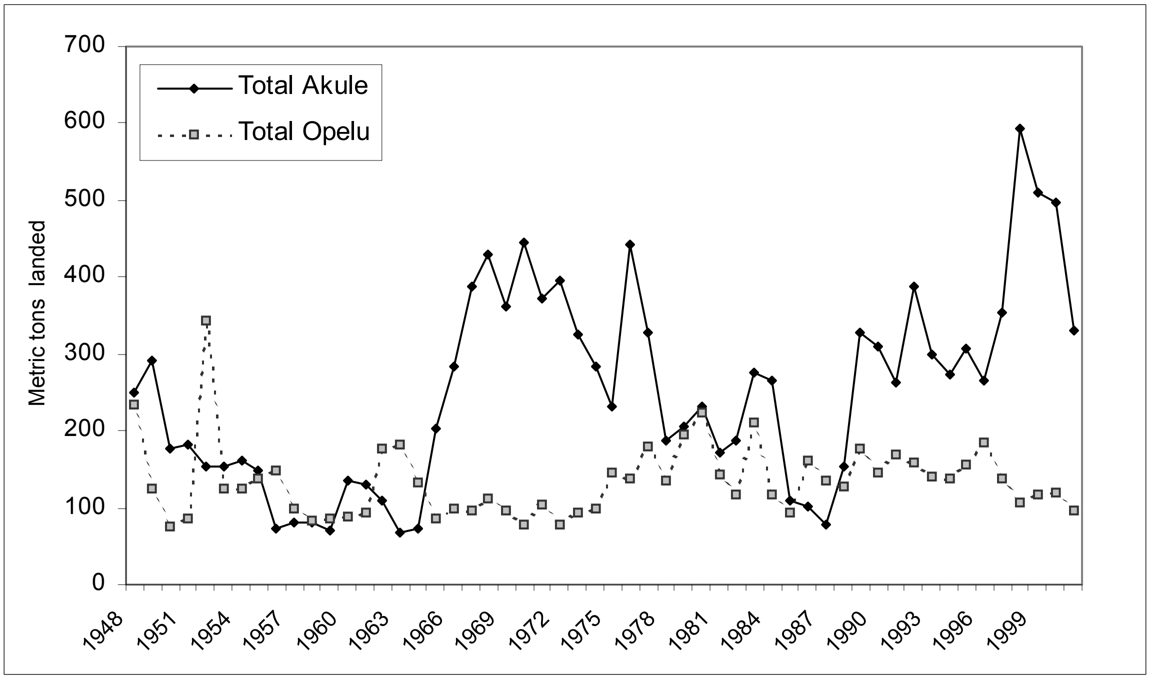

Figure 1. Total commercial catch of akule and ‘ōpelu (net and handline methods), 1948-2001 (HDAR unpublished data).

The historical population abundance of akule and ‘ōpelu is unknown. Abundance in recent years was assessed by Weng and Sibert (2000) using landings and effort data as recorded by HDAR, as well as previously published estimates of population growth rate (r) (Yamaguchi 1953; Kawamoto 1973). The researchers incorporated this data, as well as physical and ecological variables (such as precipitation, ocean temperature, etc.), into two dynamic models, one with a constant carrying capacity (scalar-*k*), and one with a time-varying carrying capacity (vector-*k*).

Akule

With respect to akule, the authors concluded that "under the *scalar-k* model, the akule population has undergone moderate exploitation, and that the biomass is approaching B_{MSY}, but remains about 20% above it. The *vector-k* model indicates that the akule has undergone light exploitation, and that the biomass has remained about 80% greater than B_{MSY} through the time series" (p. 74; Weng and Sibert 2000). Based on this information, it would appear that the level of fishing during the time of observation (1966-1997) is sustainable. Catches from 1998 to 2000, however, reached record levels (Fig. 1), and there is no information relating these high volume landings to the current status of the akule stock.

'Ōpelu

For 'ōpelu, the authors concluded "the *scalar-k* model indicates the 'ōpelu has undergone light to moderate exploitation, and that the biomass has declined gradually but remains about 40% greater than B_{MSY}, while the *vector-k* model showed a range of scenarios from 40% to 75% greater than B_{MSY}" (p. 75; Weng and Sibert 2000).

Another way to assess stock abundance is through catch per unit effort (CPUE). In their study of akule and 'ōpelu, Weng and Sibert (2000) used fishing days as a measure of effort, as fishers generally take one trip per day. CPUE is obtained by dividing the catch by the number of fishing days per year. For akule, CPUE has varied considerably over the years from 1966 to 1997 (Fig.2), but overall the akule stock has remained relatively stable (1966 abundance ~ 1997 abundance). Hence, abundance may be more closely related to environmental conditions than to the action of fishers.

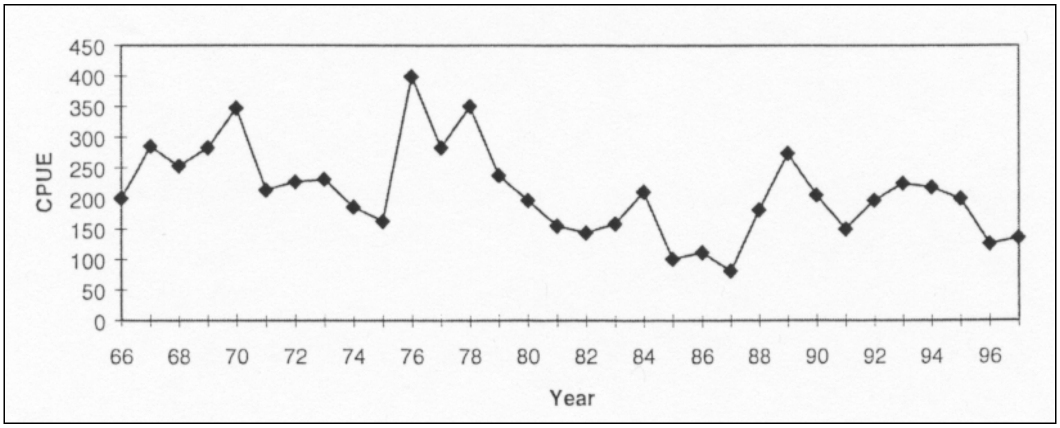

Figure 2. Refined time series of akule CPUE, 1966-1997 (Weng and Sibert 2000).

Effort data for 'ōpelu has been relatively consistent over the last four decades (Fig. 3), indicating that abundance and effort are well matched.

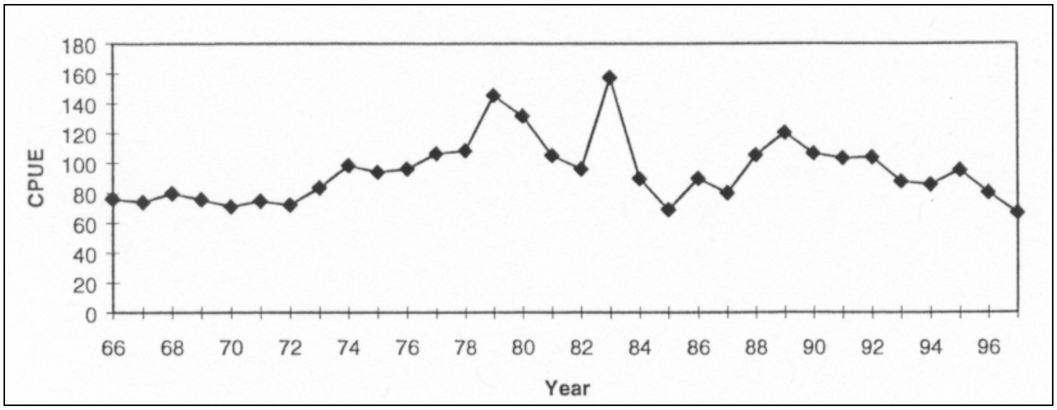

Figure 3. Refined time series of ‘ōpelu CPUE, 1966-1997 (Weng and Sibert 2000).

Sythesis
Data from the most current stock assessment (Weng and Sibert 2000) indicate both akule and ‘ōpelu stocks in the MHI are not overfished. In addition, CPUE data is relatively consistent for both species for the last 40 years, further supporting the conclusions reached in the stock assessment.

Status of Wild Stocks Rank: Poor ☐ Average ☐ **Healthy** ☑

Criterion 3: Nature of Bycatch

Through extensive reviewing of published and gray literature and discussions with fishery managers, no evidence of interactions with endangered or protected species was found in this fishery. In the net fishery, only small mesh, shallow set nets are used, and schools of the target fish are actively selected when the net is pulled in, so even incidental catch may be discarded relatively unharmed. In the handline fishery for ‘ōpelu, benign interactions with bottlenose dolphins (*Tursiops truncatus*) have been observed, where dolphins will remove fish from hooks, without being harmed (Nitta and Henderson 1993).

Nature of Bycatch Rank High ☐ Medium ☐ **Low** ☑

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystem

Scads are caught in coastal waters using a variety of net gears, both contemporary (monofilament) and traditional (cotton/linen). Floating gillnets, crossnet/skirt gillnet, surround nets and ‘ōpelu nets are employed to catch scads (M.K. Lowe. 2003. Personal commun.). These nets are all set in shallow water, are actively attended, and set mostly during daylight hours. There is almost no contact with the seafloor during fishing.

In the nearshore pelagic ecosystem, akule and ‘ōpelu are thought to occupy intermediate niches between macro zooplankton and larger predators such as tunas and billfishes (Weng and Sibert 2000). Over time, therefore, it is possible that significant removal of akule and ‘ōpelu, without ample recruitment of juveniles, may alter trophic relationships in the nearshore pelagic ecosystem. Based on the 2000 stock assessment, however, fishing levels appear to be stable, and probably not significantly altering the nearshore pelagic ecosystem.

Effect of Fishing Practices Rank Severe ☐ Average ☐ **Benign** ☑

Criterion 5: Effectiveness of the Management Regime

The State of Hawaii Division of Aquatic Resources (HDAR) manages coastal akule and ʻōpelu fisheries. To better manage all fishing activities in state waters, the division created a series of Administrative Rules that apply to recreational and commercial fishing. The type, amount, and usage of gear are regulated to manage the take of akule and ʻōpelu inhabiting nearshore areas around the islands. For example, gillnets must have a mesh size greater than or equal to 2¾ inches, may not be left unattended for more than two hours, and may not be left in the water for more than four hours per day (HDAR 2003a). Also, there is a minimum size limit of 22 cm (8.5 inches) for the sale of akule, and no more than 200 lbs per day may be possessed or sold. The use of nets is prohibited from July to October (HDAR 2003a).

It does not appear that ʻōpelu have a minimum size limit, but their catch is restricted by area closures and gear type. In the waters off the coast of South Kona, Hawaii, where the majority of fish are taken, ʻōpelu may only be fished for with hook and line. The use of nets with animal chum is also prohibited in waters off the coast of South Kona, as the presence of blood in the water attracts predators such as *kaku* (barracuda) and *kamanu* (Hawaiian salmon or rainbow runner) that drive the fish into dense schools where they are more vulnerable to overfishing. Respect for fishing *koa* (sacred sites managed and cared for throughout history by native Hawaiians) prompts the state to respect areas of Kona, where the fish are fed, trained and harvested cooperatively by local fishermen who share and barter their catch with local farmers. This traditional management practice has helped maintain resource abundance in these regions for generations (Lowe *in press*). Enforcement of these regulations is conducted through officer patrols, also run by the state.

In 2000, a stock assessment was performed using HDAR's 30-year fisheries database to conduct a spatial analysis of akule and ʻōpelu fisheries (Weng and Sibert 2000). The researchers analyzed a 30-year statewide distribution of catch and effort data to determine the status of akule and ʻōpelu stocks. Since the assessment was based on modeling fishery dependent data only, estimates of abundance are uncertain. The State of Hawaii has only in recent years initiated programs to collect and analyze fishery-independent data, which will eventually enable a more accurate assessment of the stocks.

Synthesis

The management regime in Hawaii has not needed to implement a bycatch reduction plan due to the selective nature of the fisheries for akule and ʻōpelu. There has also been little need to address the effect akule and ʻōpelu fishing has on the surrounding habitat, as the fishing methods used are benign with regard to habitat. The effect of akule and ʻōpelu removals on the overall nearshore pelagic ecosystem has not been addressed.

Effectiveness of Management Rank

Ineffective ☐ Moderately effective ☐ **Highly effective** ☑

Overall Evaluation and Seafood Ranking

Both akule and ‘ōpelu are fast-growing, short-lived fishes, making them inherently resilient to fishing pressure. Both stocks in Hawaiian waters are thought to be moderately exploited, with estimates of biomass 20-80% above B_{MSY}. The methods used to catch akule and ‘ōpelu, including surround net, gillnet, and handline gear, are very selective in the nearshore setting and do not come in contact with the seafloor, so bycatch and habitat effects are minimal. The fisheries are adequately managed and monitored by the State of Hawaii Division of Aquatic Resources (HDAR) through administrative rules and enforcement of regulations. Therefore, these two species of scad are placed in the “Best Choices” category of the Hawaii Seafood Watch® pocket guide.

Overall Seafood Rank:

Big-eye scad (akule) Avoid ☐ Caution ☐ **Best Choices** ☑

Mackerel scad (‘ōpelu) Avoid ☐ Caution ☐ **Best Choices** ☑

Acknowledgements

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