



Management Options for the Western Pacific Gold Coral Fishery



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Introduction and Background

Past research on gold coral indicated that the linear growth rate of gold coral is approximately 6.6 centimeters per year, suggesting a relatively young age for large trees. These estimates were based on the assumption that growth rings are laid down annually as in other precious corals such as black coral and pink coral (*Corallium rubrum* and *C. secundum*). In 2006, Roark et al. conducted research on the aging of gold corals using radiometric dating on three samples collected from the Makapuu Bed and off of the island of Hawaii found that gold coral may grow at a much slower rate of 14-40 micrometers per year aging those samples at 450-2,740 years old (Roark et al. 2006). Research conducted on *Gerardia* species in the Atlantic have estimated the age of large gold coral trees to be 1,800 years old (Druffel et al. 1995). Even using amino acid techniques for dating the specimen, researchers found that the maximum life span of the gold coral specimen to be approximately 250 years (Goodfriend 1997). Gold coral colonies in Hawaii were also measured for linear growth within a 9 year period showed a lack of appreciable change (Parrish and Roark 2009). This could indicate that gold coral growth is much slower than even radiocarbon data may indicate.

The Western Pacific Region’s gold coral fishery is currently dormant, although research on gold coral remains somewhat active. Recent research has called into question current assumptions about the correlation between linear and axial growth rates of gold coral. Based on recommendations from fishery scientists, the Council recommended, and the National Marine Fisheries Service (NMFS) implemented, a five-year moratorium on the harvest of gold coral in the Western Pacific region. Having initially been set in 2008 for five years, the current moratorium is set to expire in 2023 and Annual Catch Limits (ACLs) have been developed for all management unit species in the Western Pacific region, except gold coral due to the moratorium. Since the start of the moratorium, no further research has been done on the growth of gold coral and there are no plans for research in the immediate future.

Historical Management Overview

The Fishery Management Plan (FMP) for the Precious Corals Fisheries of the Western Pacific Region was implemented in September 1983 (48 FR 39229). It established the plan’s management unit species (Table 1) and management area (Figure 1), and it also classified several known beds (Table 2).

Table 1: Precious Corals Management Unit Species

Common name	Scientific name
Pink coral (also known as red coral)	<i>Corallium secundum</i>
Pink coral (also known as red coral)	* <i>Corallium regale</i>
Pink coral (also known as red coral)	<i>Corallium laauense</i>
Gold coral	<i>Gerardia</i> spp.
Gold coral	<i>Callogorgia gilberti</i>
Gold coral	<i>Narella</i> spp.
Gold coral	<i>Calyptrophora</i> spp.
Bamboo coral	<i>Lepidisis olapa</i>

Bamboo coral
 Black coral
 Black coral
 Black coral

Acanella spp.
Antipathes dichotoma
Antipathes grandis
Antipathes ulex

* *Corallium regale* has been recently identified by taxonomic experts as *Corallium laauense*

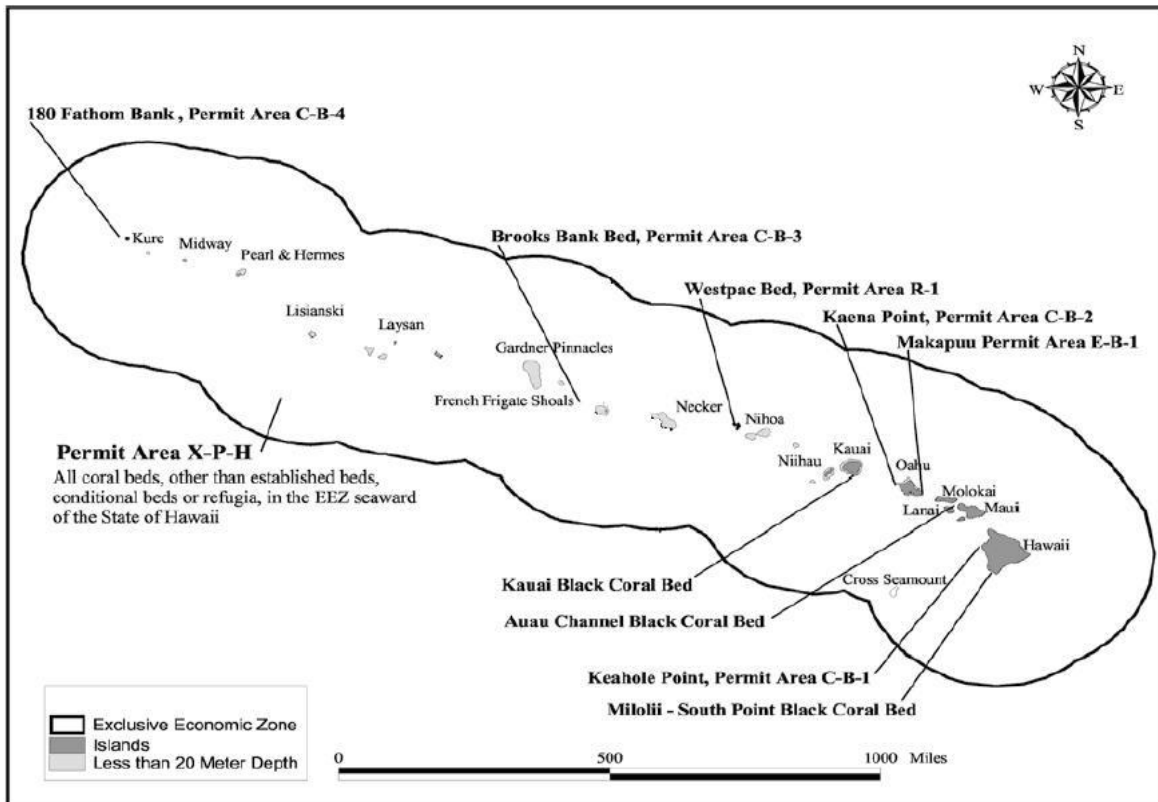


Figure 1: Map of Hawaii Precious Coral Beds

Table 2: Current Western Pacific Region Precious Coral Beds and Harvest Quotas for Gold Coral

Name of Bed	Type of Bed	Harvest Quota	Quota Duration
Makapuu Bed (MHI)	Established	Gold 0 kg	2 years
Keahole Point (MHI)	Conditional	Gold 20 kg	1 year
Kaena Point (MHI)	Conditional	Gold 20 kg	1 year

Name of Bed	Type of Bed	Harvest Quota	Quota Duration
Brooks Bank (NWHI)	Conditional	Gold 133 kg	1 year
180 Fathom Bank (NWHI)	Conditional	Gold 67 kg	1 year
Westpac Bed (NWHI)	Refugium	Zero (0 kg)	N/A
Other EEZ waters around Hawaii, American Samoa, Guam, CNMI, PRIA	Exploratory	1,000 kg per area, all species combined (except black corals)	1 year

Note: “Established Beds” are areas for which a MSY can be estimated based on bed-specific scientific data; “Conditional Beds” are those areas for which MSY estimates have been made based on their size relative to similar Established Beds; all other EEZ waters of the Western Pacific Region are termed “Exploratory Areas,” and are managed under area quotas. “Refugia” are beds with no harvest allowed.

Purpose and Need

Past research has revealed that the current growth rate estimates in the fishery ecosystem plan (FEP) may be overly generous. Radiocarbon dating of three gold coral samples from Hawaii has estimated that gold coral has an axial growth rate of 14-40 micrometers per year (Roark et al. 2006), which is similar to results from radiocarbon dating of gold corals in the Atlantic (Druffel et al. 1995). Currently, the FEP gold coral management is based on a gold coral growth rate of approximately 6.6 cm/yr from numerous gold coral samples. On September 12, 2008, a moratorium was placed on the harvesting of gold corals to provide scientists time to reassess the current gold coral estimates to determine if they are adequate to prevent overfishing.

Since the amendment was put into place, there have been two studies conducted that looked the current gold coral estimates and growth. Parrish and Roarke (2009) marked and measured 48 gold coral colonies at six different sites across the Hawaiian Archipelago and found no discernible growth. They estimated gold coral growth was slower than estimates produced through previous linear measurements. While this one study does provide additional information, studies looking at the gold coral growth over a period longer than 1-9 years may need to be done to confirm these results. In 2019, Putts et al. compared the coral communities on different age lava flows and found that gold coral are slow growing only established on the older substrates. Therefore, the need continues to provide time for the gold coral estimates to be reassessed, as well as incorporate this information into a better assessment of the stocks and the development of a proper Annual Catch Limit (ACL). This provided the impetus to extend the moratorium another five years until June

30, 2028.

The purpose of this action is to provide time for the Council to continue to consider a long-term management strategy for gold coral to ensure the sustainability of the gold coral fishery in the Western Pacific region. This long-term strategy is needed to prevent the renewal of a fishery under regulations that may not be sufficient to prevent overfishing. The Council and NMFS have yet to prepare an ACL or other management strategy for the fishery that is appropriate given the recent changes in the science on gold coral growth.

Description of the Options

The following options are under consideration:

Option 1: No action

Option 1 would allow the moratorium on the harvest of gold coral to expire on June 30, 2023. The Council would then need to specify an Annual Catch Limit (ACL) for Gold Coral based on the existing scientific information available. While research is available on growth, MSY values have not been calculated and thus the only available value would be that given in the original Precious Corals FMP.

Option 2: Extend moratorium

Option 2 would extend the moratorium on the harvest of gold coral in the Western Pacific an additional five years (until June 30, 2028). The extension of the moratorium would provide time for other management options, such as ACLs or Ecosystem Components to be considered and implemented by the Council.

Option 3: Prohibit the take of gold coral

Option 3 would implement an indefinite ban on the taking of gold coral in the Western Pacific region. The Council would take action to amend its FEPs to prohibit the take of gold coral and an ACL would need to be developed prior to July 1, 2023. The species would continue to be monitored as a Management Unit Species (MUS).

Analysis of the Options

Option 1-No action

Under this Option, a potential risk of overfishing gold coral would remain as new scientific information regarding the growth rates of gold coral has brought the sustainability of the region's existing quotas under question. Under this option, any future harvests of gold coral would require the designation of an ACL.

A calculation of a potential ACL would need to be completed by July 1, 2023 to be in compliance with the Magnuson Stevens Fishery Conservation and Management Act requirements. The ACL would require the re-estimation of MSY for gold coral would need to be completed and provided

to the Council for consideration prior to that date. The Council would also need to complete its P* and Social Ecological Economic and Management (SEEM) process, as with other ACL designations; the Scientific and Statistical Committee (SSC) would need to set the Allowable Biological Catch (ABC) as well before the Council could select an ACL.

Council staff's cursory calculation of MSY based on the potential ranges of Natural Mortality calculated based on the most recent information on gold coral, estimate MSY at 8.06 – 20.9 kg/year at the Makapu'u Bed. This range would provide a value of \$800-\$16,122 at the current market price. The staff's calculations can be found in Appendix A. The recalculation of the MSY for each of the Beds would need to be conducted and provided to the Council for consideration as well.

There is currently no fishing for gold coral due to the moratorium and there has been no requests from fishers to access this fishery. Historically, there have been no reports of landings in the Western Pacific region as well (WPRFMC 2021). Expiration of the moratorium is unlikely to yield interest in harvest due to the depths and allowable gears that are involved in the fishery. An analysis of MSY (Appendix A) notes that a calculated ACL based on a recalculated MSY would see the harvest costs associated with the fishery likely higher than any potential revenue for gold coral. This would dissuade any potential harvest or interest in the fishery. With an absence of interest, the likelihood of impacts to habitat and protected species is likely absent as well.

Option 2-Extend moratorium

As compared to the no action option, under this option the potential risk of overfishing gold corals would be removed for five years while further research into their growth rates is conducted. This would ensure that harvests of gold coral are sustainable and that overfishing does not occur. The moratorium would also provide a buffer against harvest whilst scientists and managers develop additional management strategies.

An ACL would not need to be developed until at least July 1, 2028, in which time the Council can work with the NMFS Pacific Islands Fisheries Science Center and the SSC to calculate MSYs for the gold coral fishery. The Council would also have additional time to go through the existing P* and SEEM process to propose an ABC to the SSC and a corresponding ACL to the Council.

The Council may also consider other measures that it considers appropriate to manage the gold coral fishery and revise its FEPs accordingly. Gold coral could be removed from the Precious Coral Management Unit Species (PCMUS) list and included as an Ecosystem Component Species (ECS). This would remove the need for conservation and management measures but continue to be monitored through the Council's annual reports. However, an ECS designation may not provide adequate protection without the associated gear and area restrictions currently on the PCMUS. The Council could also remove gold coral from the PCMUS altogether as a fishery for this species does not currently exist. However, the Council would also need to add it back to the PCMUS should a need arise in the future. This would also remove any potential protections afforded as a current PCMUS. The process for amendments is rather lengthy and the moratorium could provide the additional time needed for passing an amendment while protecting the gold coral stock from

potential fishing impacts.

Option 3-Prohibit the take of gold coral

Target Species

As compared to the no action option, under this option the potential risk of overfishing gold corals would be removed permanently. The Council would need to take action to prohibit gold coral fishing through the FEP amendment process. Gold coral would remain an MUS for purposes of monitoring but no harvest would be allowed. The process for amendments is rather lengthy and an ACL would need to be established while the amendment is being completed/processed.

An ACL would need to be developed by July 1, 2023. During the time between final action and the moratorium expiration, the Council would need to work with the NMFS Pacific Islands Fisheries Science Center and its SSC to calculate MSYs for the gold coral fishery. The Council would also need to go through the existing P* and SEEM process to propose an ABC to the SSC and a corresponding ACL to the Council prior to the expiration. This gives a window of March-June 2023 (the next two SSC and Council Meetings) to complete this process. The Council may also use this process to set the ACL and harvest level at zero, which would allow for protection under the FEP as a PCMUS but also prohibit the take without a complete prohibition. The development of an ACL would require the Council to look at re-specification at a shorter interval than the current moratorium.

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APPENDIX A

UNREVIEWED DRAFT-NOT FOR CIRCULATION

Estimating the Maximum Sustainable Yield (MSY) of Gold Coral in the Makapuu Bed, Hawaii based on new estimates of longevity

The MSY and harvest limits for gold coral (*Gerardia* sp.) from the Makapuu Bed, off eastern Oahu established by the Western Pacific Regional Fishery management Council (WPRFMC) were estimated using a simple biomass model (Gulland 1969) and a natural mortality rate of $M = 0.066$. Gulland's model is based on the presumption that with a simple equilibrium production model that $MSY = 0.5.M.B_0$, where B_0 is the unexploited virgin biomass. More recently, Beddington and Cooke (1983) have suggested that Gulland's original model overestimates the MSY and proposed a more conservative model $MSY = 0.4.M.B_0$. When this model is used with a standing stock biomass of 11,800 kg of gold coral for the Makapuu Bed it produces and MSY of about 313 kg (WPRFMC 2009).

The value of M used to generate MSY for gold coral is a proxy, from pink coral (*Corallium secundum*), (see WPRFMC 2009), based on the work of Grigg (1993; 2002). Gold and pink corals were assumed to have similar life history characteristics given that they co-occur on the Makapuu Bed and elsewhere, with lifespans of about 70 years. More recently, Roark et al (2009) and Parrish & Roark (2009) present evidence that gold coral may have a centennial-scale lifespans ranging from 950 to 2,742 years. As such, the MSY estimate for gold coral would be greatly overestimated based on an M value of 0.066.

Re-estimation of gold coral MSY requires a value of M consistent with the newer estimates of maximum longevity for gold corals. Hoenig (1983) has shown that the total mortality rate (Z) of a population is strongly correlated with average maximum lifespan in a population. He presents a simple linear relationship which takes the form:

$$\ln(Z) = 1.44 - 0.982 \ln(t_{max})$$

If it is assumed that the average life span for gold coral lies between 950 and 2,742 years, then this is equivalent to M values of 0.004443 and 0.001707 respectively. When employed in the modified Gulland MSY formulation they produce estimates for the Makapuu Bed of 20.9 kg and 8.06 kg respectively, or about 7% and 3% of the previous MSY estimate.

The centennial-scale lifespan of gold corals has been used as justification of a moratorium on harvests of gold coral by the WPRFMC, implemented since 2008 expiring in five year intervals with the latest in 2023. If it is assumed that the estimates of MSY have some validity, then it is possible, using price data to estimate what resource rent is being forgone by the maintenance of the gold coral moratorium, even though in reality there is no harvesting of any precious corals in Hawaii other than the shallower water black corals. Gold coral prices between November and

December 2012 (<http://www.aliexpress.com/price/gold-coral-price.html>) ranged from about \$45 – 350/lb. Converting the MSY estimates to pounds then this would provide value estimates for an MSY of 20.9 kg of \$2,072 - \$16,122, and for 8.06 kg of \$800 - \$6,217.

A summary of the estimated MSY computed for the centennial scale maximum ages reported for gold corals by Roark et al (2009) and Parrish & Roark (2009) are given in Table 1

Table 1. Summary of the age, natural mortality rates and MSY for gold coral based on centennial scale lifespans

Maximum age (t_{max}) in years	Instantaneous Natural Mortality Rate (M)	MSY (kg)	Value (\$)
950	0.004443	20.9	2,072-16,122
2,742	0.001707	8.06	800-6,217

It is not within the scope of this short note to advise the Council whether it should rescind the moratorium on gold coral harvests, but to provide the Council with information on which to base any future decision making. However, in conclusion, if the MSY estimates for Makapuu bed gold coral are modest at best, harvest costs are likely to outweigh any value of the gold coral resource.

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