



A Management Framework for Upscaling Reef Restoration in the State of Hawai'i

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Hawai'i Coral Reef Initiative
September 2022

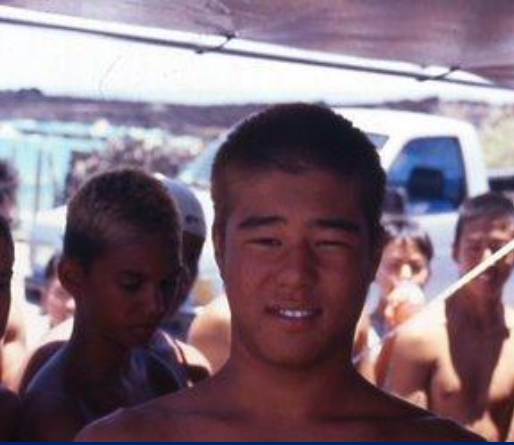


Hawaiian Ecosystems are Unique

- ▶ Highly isolated, colder water, large swell events
- ▶ Low species diversity compared to the wider Indo-Pacific
- ▶ Slower growth rates of the same species (Minton 2013)
- ▶ High levels of endemism

These resources are **irreplaceable**



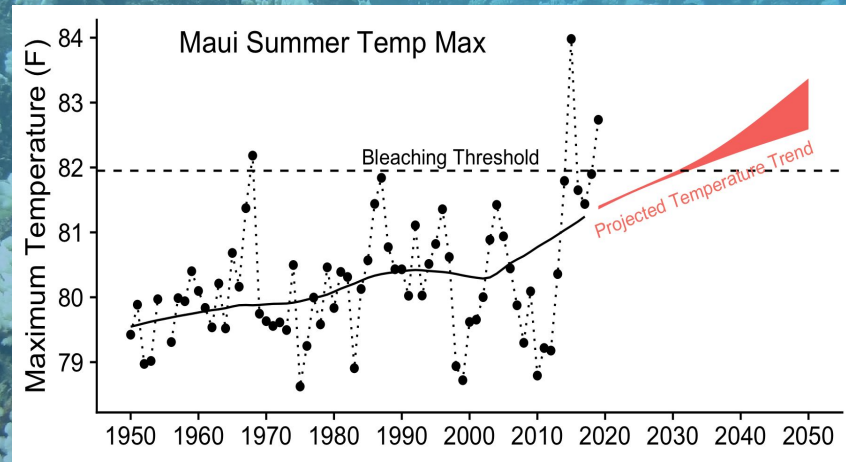


CORAL REEFS ARE IMPORTANT



Threats to Hawaiian Reefs

- ▶ Bleaching Events
- ▶ Overfishing
- ▶ Sedimentation
- ▶ Aquatic Invasive Species (AIS)
- ▶ Nutrient Pollution
 - ▶ Sewage and stormwater runoff

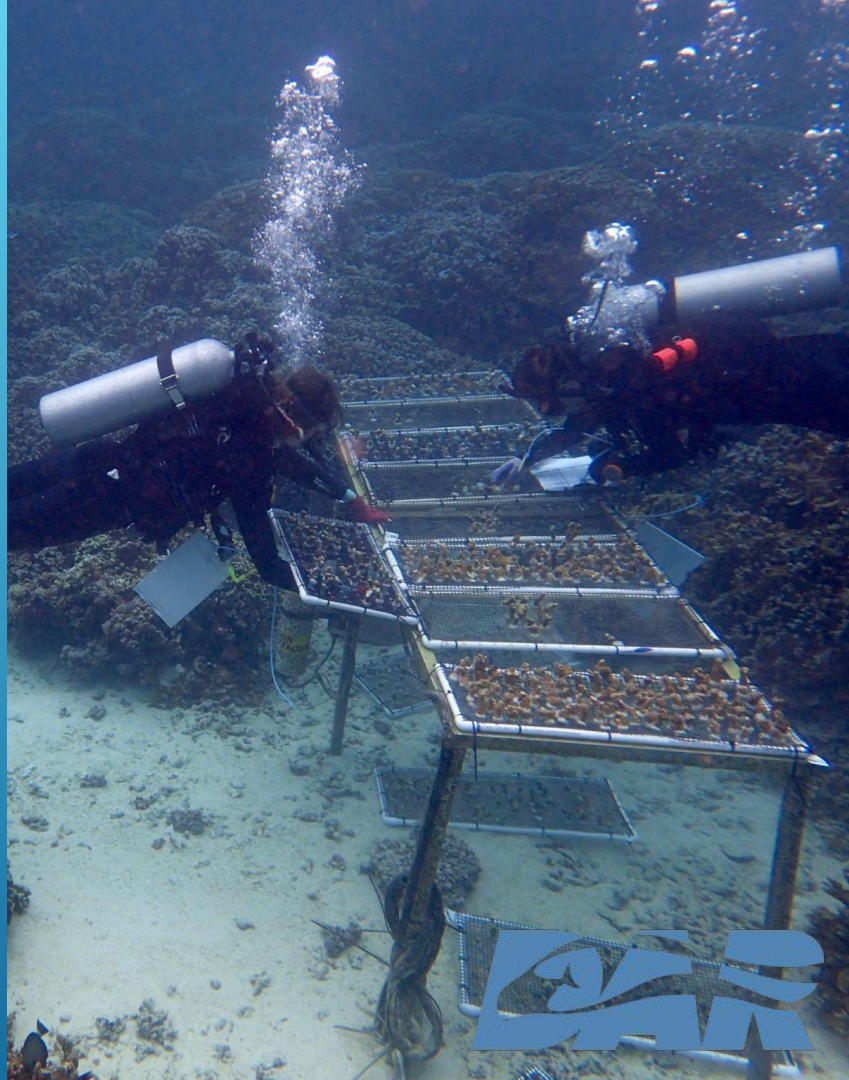


(DAR 2018)



Coral Restoration in Hawai'i

- ▶ Increased interest from researchers, community members, Federal and State agencies
- ▶ Current permitting system lacks capacity to meet the growing need and interest



SOLUTION:

Create a
permitting
framework for
coral restoration

GOAL:

A transparent and efficient
way to evaluate coral
restoration permit
applications that supports
responsible restoration
without limiting innovation



Project Mechanics

Coral Reef Restoration Monitoring Guide

Methods to evaluate restoration success from local to ecosystem scales

DOI-10.26252/doi-10.26252



Hawaii Division of Aquatic Resources Coral Restoration Implementation Guide

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"It is the regulatory community, with the advice and assistance of any and all interested parties, who must determine the appropriate balance between vital research and... we, not those who perform the research" (Hagene 2008).

ing represents the Hawaii Division of Aquatic Resources (DAR) guidance for and implementation requirements for proposed coral restoration projects to Hawaiian waters. It includes discussions and concerns regarding sourcing, holding, growing, and outplanting of Hawaiian corals, modifying benthic out monitoring of restoration sites based on previously established protocols at 1 Coral Restoration Nursery, and the Division's established coral permitting procedures. Of particular importance, anyone who proposes to conduct restoration

DLNR DAR Frequently Asked Questions regarding Coral Species and Restoration

Am I allowed to collect coral for personal/home use?
No. In Hawaii, it is unlawful to take, break or damage, any stony coral mushroom coral (HAR 15-95-70), except as otherwise authorized by the Permit for scientific, educational, management, or propagation purposes.

Am I allowed to collect coral to sell?
No. It is unlawful to sell or offer for sale any stony coral, except that any fragments imported for the manufacture and sale of coral jewelry, or due through legal diving operations in Hawaii, may be sold (HAR 15-95-70) is required.

Can I collect dead coral, coral rubble, or live rock?
No. Taking of sand, dead coral, and coral rubble is prohibited statewide and 200A-44. Taking of live rock is prohibited by HAR 15-95-71, except by law by a Special Activity Permit for scientific, educational, management purposes (HAR 15-95-4). Live rock is defined as any natural hard substrate is visibly attached or affixed. Virtually every hard substrate in nearshore is visibly attached to it.

What if there is stony coral that need to be removed growing on a that I am maintaining, such as a day use mooring or an underwater

Please contact DAR first to determine the appropriate action to take with Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, HI 96813-3088

Phone: 808.587.0100
Fax: 808.587.0115

Email: DLNR.aquatics@hawaii.gov

Other island contact info here: <https://dlnr.hawaii.gov/for/contact-us/>

What can I do to help coral reefs?

Here are some ideas for ways to protect coral:

- Leave corals in their place
- Observe corals from a safe distance
- Don't litter
- Use biodegradable fishing line
- Be a cautious boater, use mooring buoys and only anchor in sand
- Use reef safe sunscreen, with non-nano zinc and/or titanium dioxide
- Reduce your carbon footprint

A2 Appendices

Appendix 2: Evaluation Tool for Coral Restoration

The Restoration Evaluation Tool is an adaptation of the original Reef Restoration Program Evaluation Tool developed for restoration activities in the Dominican Republic (Lerner et al., 2017). The objective of this tool is to provide metrics of success for evaluating existing and new restoration projects or programs to assess performance and progress towards restoration goals. Metrics provided within this evaluation tool are designed to evaluate the strength and effectiveness of a project while identifying specific metrics which may require adaptive management to improve performance. The tool follows the recovery goals, objectives and criteria outlined with the Recovery Plan for El Estero and the El Estero Corals (NOAA National Marine Fisheries Service, 2015) which may also be applied to additional species which are now listed within the ESA, or have recently suffered dramatic losses in abundance and cover due to severe bleaching and disease events. Specific goals set forth by the Recovery Plan include increasing the abundance of and protecting the genetic diversity of coral populations throughout their geographical range through restoration, outplanting, and active management. Therefore, metrics outlined within this evaluation tool focus on best management practices or results from restoration-based research conducted by scientists in the field of coral propagation and outplanting. The tool should be used to evaluate the current status of restoration techniques, surface problem attributes of production projects and programs, and provide the development of successful strategies to achieve population-based recovery for coral reefs. Upon completion, the Evaluation Tool for Coral Restoration will be available online.

Table A2: Evaluation Tool Criteria by project, scoring criteria, alignment with Restoration Monitoring Guide goal and associated references.

Scoring	Goal	References
1. Outplant criteria		
1. Outplant sites are established based on approved guidelines for Management Factors (CFC Field-based Propagation, Genetics, and Monitoring Working Group)	1. Methods followed published manual/ guidelines for site selection and deployment - 1	1, 2, 3, 4, 5 CFC Field-based Guide, Beams et al., 2016, and Monitoring Guide
2. Outplant sites contain no natural presence of outplanted species (Following Guide for site selection)	2. Outplant sites are present or was historically present - 1	1, 2, 3, 4 CFC Field-based Guide
3. Sites are surveyed for reef community structure and species distribution prior to outplanting	3. Baseline surveys are conducted prior to outplanting - 1	1, 2, 4, 5 CFC Field-based Guide
4. Environmental parameters are measured at outplant sites to determine that site does not represent large change in parameters over short periods of time, consistent measurement of water temperature required, but also include light, current, sedimentation, turbidity	4. Environmental parameters (baseline measurement of water temperature required, are measured) measured - 1	1, 2, 3, 4, 5 Rogers et al., 2001; Spiller et al., 2001; Beams, 2008; Hargrave et al., 2012; Monitoring Guide (Scientific Methods Manual)
5. Restored Reef Area (Diverse RRA) is measured at each outplant site	5. Project area or restored footprint are measured for each outplant site - 1	1, 2, 3, 4 CFC Field-based Guide and Monitoring Guide (Scientific Methods Manual)
6. Restored footprint or area shows no net decrease over time in original project area	6. Restored footprint or area stays the same, or increases over time in original project area - 1	1, 2, 3, 4, 5 Monitoring Guide (Scientific Methods Manual)
7. Outplant sites contain multiple outplanted species	7. Early one species is outplanted - 0.5 1 species - 1 2 species - 1.5 3 species - 2	1, 2, 3, 4, 5 Beams, 2008; Dwyer et al., 2009; Beams, 2010; Hargrave et al., 2012; Monitoring Guide (Scientific Methods Manual)
8. Outplant sites show degree of potential possible genetic diversity for 1 species across sites, similar different genotypes based on physical separation of collection sites	8. 1+ potential genotypes per species are outplanted at each restoration site or 100% genetic species outplanted - 1	1, 2, 3, 4 Beams, 2008; Dwyer et al., 2009; Beams, 2010; Hargrave et al., 2012; Monitoring Guide (Scientific Methods Manual)
9. Outplant sites include genetic diversity of 1 species and 1+ species in abundance (breeding species only)	9. Outplant sites of species display genetic and change between 10% to 100% over time. 5 or more in larger size class and/or no net change in abundance - 1	1, 2, 3, 4, 5 Monitoring Guide (Scientific Methods Manual)
10. Outplant sites are tracked (height, photographed, mapped, marked, etc.) and monitored for 10 years after outplanting for requirements for funding (partnering agency)	10. Outplant sites are monitored for 1 year - 1	1, 2, 3, 4 Monitoring Guide

Project Structure

Restoration Plan

Permittee	0	Permittee/Scientific Advisor has not recently conducted unpermitted activities such as collecting regulated organisms or resources, using regulated gear, or collecting/conducting activities in corals or coral reef organisms.	Tier 1/2 Meetings	1
Permittee	0	Permittee/Scientific Advisor has submitted a CV that details at least 2 years of relevant experience or graduate level research experience involving corals or coral reef organisms.	Tier 1/2 Meetings	1
Permittee	0	Permittee/Scientific Advisor has justified experience in experimental design for projects pertaining to corals (ex. graduate level research experience or professional experience)	Tier 1/2 Meetings	1
Permittee	0	Permittee/Scientific Advisor has justified experience in implementation of projects involving corals.	Tier 1/2 Meetings	1
Permittee	0	Permittee/Scientific Advisor has justified experience in monitoring of coral	Tier 1/2 Meetings	1
Cultural Advisor	0	Needs criteria: Demonstrated connection to community.	Tier 1/2 Meetings	1
Project Team	0	Team has necessary expertise to conducted proposed activities, or has	Tier 2 Meetings	1
Funding	0	Project demonstrates ability to maintain successful funding through	Tier 2 Meetings	1
Collection Plan	0	Includes photodocumentation of collected coral	DAR FAQ, HCRN	1
Collection Plan	0	Primarily uses corals of opportunity	Tier 1 Meetings,	1
Collection Plan	0	Does not impair overall population genetic diversity at site	Tier 1 Meetings,	1
Collection Plan	0	Targets common species	DAR FAQ, Tier 1	0.75
Collection Plan	0	If collecting from corals attached to substrate, targeted coral colonies	DAR FAQ	0.75
Collection Plan	0	If collecting from corals attached to substrate, and is possible, collection	Tier 2 Meetings	1
Collection Plan	0	Avoids coral spawning periods for targeted species	HCRN Guidelines	1
Collection Plan	0	Includes contingency plan for bleaching moratorium, prioritizing sampling	DAR FAQ, Tier 1	1
Collection Plan	0	When transferring corals outside of collection site, includes a plan to	HCRN Guidelines	1
Collection Plan	0	Avoids sensitive locations	HCRN Guidelines	1
Collection Plan	0	Avoids areas with high prevalence of Aquatic Invasive Species	Tier 1 Meetings,	1
Collection Plan	0	Uses approved methods	Tier 1/2 Meetings	1
Collection Plan	0	Includes justification for the need for potential environmental impact for	Tier 2 Meetings	1
Collection Plan	0	Follows approved locations for proposed method	Tier 1/2 Meetings	1
Collection Plan	0	Includes justification for the need for potential environmental impact for chosen method.	Tier 2 Meetings	1
Collection Plan	0	Conducts baseline assessments of restoration site that includes reef community structure and species	HCRN Guidelines, CRC Evaluation Tool	1
Collection Plan	0	Site has historical presence of target outplanted species at site	HCRN Guidelines,	1
Collection Plan	0	Includes photodocumentation of outplanted coral	DAR FAQ, HCRN	1
Collection Plan	0	Uses environmentally inert materials for adhering corals to reef.	Tier 1/2 Meetings	1
Collection Plan	0	Transport method minimizes stress on coral colonies	Tier 1/2 Meetings	1
Collection Plan	0	Attachment procedure minimizes risk to adjacent habitat.	Tier 1/2 Meetings,	1
Collection Plan	0	Avoids sensitive locations	HCRN Guidelines	1
Collection Plan	0	Avoids areas with high prevalence of Aquatic Invasive Species	Tier 1 Meetings,	1
Collection Plan	0	Tracks reference site for each restoration site	HCRN Guidelines,	1
Collection Plan	0	Tracks control site for each restoration site	CRC Evaluation Tool	1
Collection Plan	0	Tracks individual coral outplants at site	CRC Evaluation Tool	1
Collection Plan	0	Tracks coral populations at site	CRC Evaluation Tool	1
Collection Plan	0	Tracks reef-level metrics	CRC Evaluation Tool	1
Collection Plan	0	Tracks abiotic metrics (water temperature, light, current, sedimentation,	CRC Evaluation Tool	1
Collection Plan	0	Surveys include photodocumentation of outplanted coral	HCRN Guidelines	1
Collection Plan	0	Includes ecological monitoring	Tier 1 Meetings, CRC	1
Collection Plan	0	Surveys include photodocumentation	HCRN Guidelines,	1
Collection Plan	0	Surveys include presence and degree of bleaching	HCRN Guidelines,	1
Collection Plan	0	Surveys include presence and degree of outplant mortality	HCRN Guidelines,	1
Collection Plan	0	Surveys include size of outplant	HCRN Guidelines,	1
Collection Plan	0	Surveys include presence of any known coral disease	HCRN Guidelines,	1
Collection Plan	0	Surveys include signs of predation	HCRN Guidelines,	1
Collection Plan	0	Surveys include signs of competition	HCRN Guidelines,	1

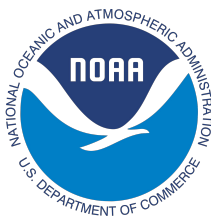
SCIENTIFIC ADVISORY BOARD

TIER 1:

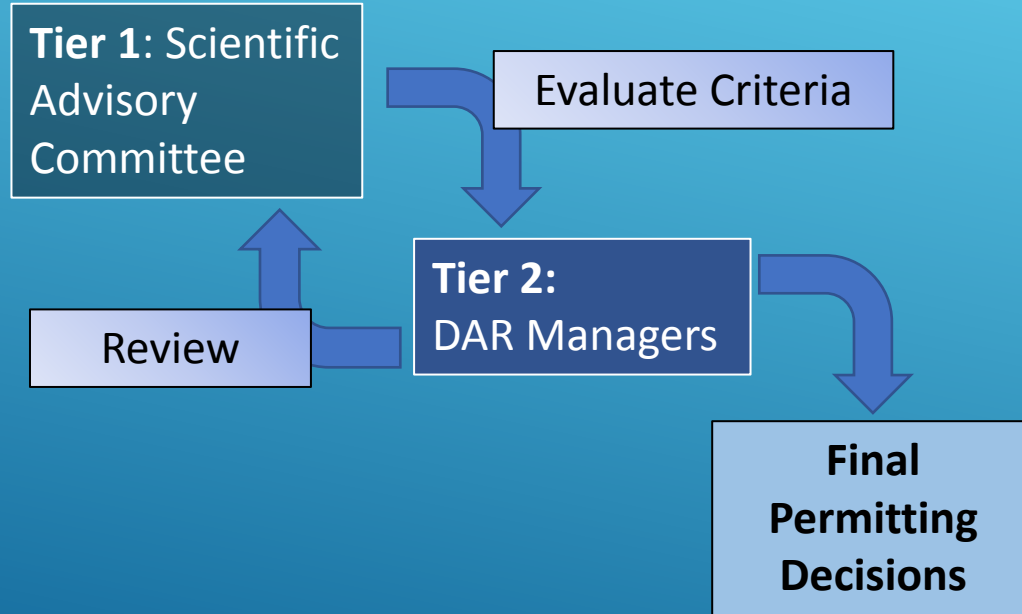
- ▶ University of Hawai'i at Mānoa
- ▶ US Environmental Protection Agency
- ▶ National Oceanic and Atmospheric Administration
- ▶ US Fish and Wildlife Service
- ▶ The Nature Conservancy

TIER 2:

- ▶ Hawai'i Department of Natural Resources Division of Aquatic Resources



Project Mechanics



Plan	Subject Area	Plan	Subject Area
Statement of Purpose	Purpose	Restoration Plan	In-situ Nursery
	Location-Specific Criteria		In-situ Methods
			Transport
			Outplant
			Baseline survey
Administrative Plan	Permittee	Survivorship	Monitoring
			Monitoring timeline
	Project Team		
	Funding		
Restoration Plan	Collection Plan	OR RENEWAL	
	Ex-situ Facility	Renewal	Adherence
			Reporting
			Survivorship
	Ex-situ Methods		

Application Sections

- ▶ **Statement of Purpose**
- ▶ **Administrative plan**
- ▶ **Restoration plan**
 - ▶ AIS Plan
 - ▶ Collection
 - ▶ Propagation Methods
 - ▶ Hurricane and Large Storm Plan
 - ▶ Discharge/Effluent Plan
 - ▶ Monitoring
- ▶ **Renewal**



Statement of Purpose

Reason for Conducting Restoration

- ▶ Congruent with State Plans/Strategies
- ▶ Emergency Restoration
- ▶ Non-emergency Restoration
 - ▶ Identify stressors driving coral degradation at restoration site & how they're mitigated/addressed in proposal

Location-specific Criteria for Collection / Outplanting

- ▶ Sensitive Areas
- ▶ High Prevalence of AIS



Administrative Plan

- ▶ **Permittee Requirements**

- ▶ In good standing (no known unpermitted activities)
- ▶ Experience in experimental design, implementation, and monitoring of projects involving coral reef resources

- ▶ **Project Team**

- ▶ Must be added to permit

- ▶ **Project Funding**

- ▶ Can maintain funding throughout project, including monitoring



Restoration Plan

► **Collection Plan**

- Photodocumentation
- AIS Management
- Criteria based on source material (COO, artificial substrates, natural reef substrate, gametes)
 - Size
 - Species rarity or endemism
 - Spawning period
 - Bleaching event



Restoration Plan (cont)

► Propagation Methods

- Photodocumentation
- AIS Management
- *In-situ* requires Hurricane and Large Storm Plan
- *Ex-situ* requires Discharge and Effluent Plan

Method		<i>In-situ</i>	<i>Ex-situ</i>
Genetic Manipulation	GMO coral	Red	Red
	Selective breeding	Yellow	Green
	Selective collection	Yellow	Green
	Assisted migration	Red	Red
	Cryopreservation	Yellow	Green
	Genetic archiving	Green	Green
	Live samples/aquaculture	Yellow	Green
Environmental Intervention	Bio-rock	Yellow	Green
	Live rock/CCA	Yellow	Green
	Artificial Structures	Yellow	Green
Physiological Intervention	Probiotics	Red	Yellow
	Phage therapy	Red	Red
	Antibiotics	Red	Yellow
	Climatization	Yellow	Green



Restoration Plan (cont)

► Outplanting Plan

- Criteria based on distance from original collection site and propagation method
 - Photodocumentation
 - AIS Management
- Benign outplanting materials

Method		Within 500 m	Island Sector
Physical Restoration	Transplantation	Green	Yellow
	Larval Seeding	Yellow	Yellow
	Outplanting	Yellow	Yellow



Restoration Plan (cont)

► **Monitoring Plan**

- Standardized habitat metrics
 - Temperature
- Standardized coral outplant metrics
 - Species, unique identifier, size, percent mortality, condition score
- Timeline
 - More monitoring in first year than in subsequent years

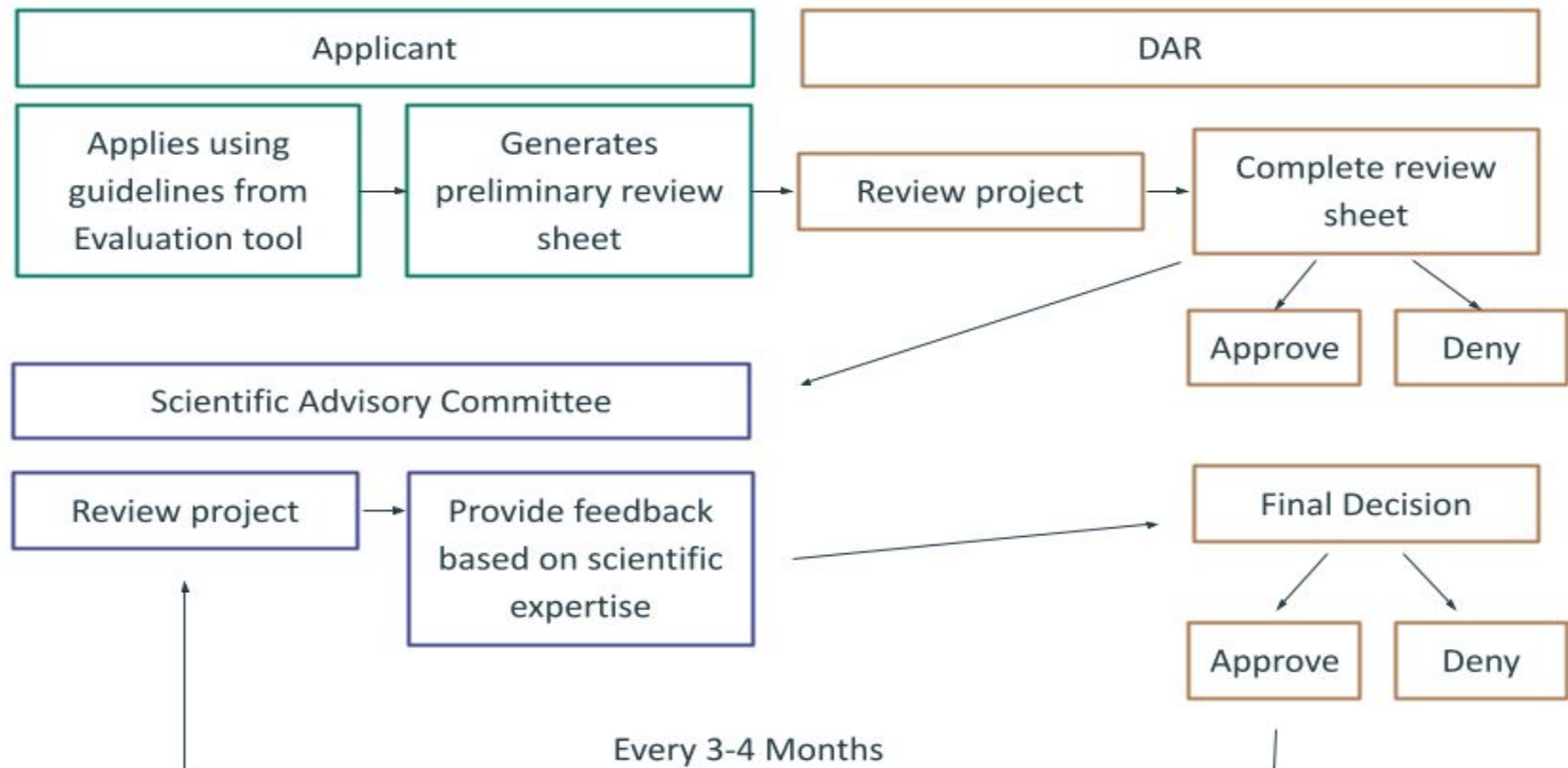


Renewal

- ▶ Annual report detailing activities conducted
- ▶ Estimated and realized survivorship at key timepoints
 - ▶ After quarantine, within nursery, at monitoring time points
 - ▶ Justifies differences between estimated and realized rates



Decision Making



Next Steps

- ▶ Involve trusted community members/applicants
- ▶ Evaluate community involvement
- ▶ Communications strategy



CONCLUSIONS & QUESTIONS

Email us:

**Coral Restoration
Framework**

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Photo: Marvin Chandra, Flickr

