Forever Costa Rica Measures Workshop

March 16 – 18, 2010

Santo Domingo de Heredia, Costa Rica

Technical Report[1]

Contents

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1. Meeting Goals

Develop a monitoring program that will identify whether:

1. The MPA system is functional and conserving system-wide biodiversity
    - related to a national strategy of increasing representativeness
    - will require comparison across protected sites as well as with unprotected areas

2. The protected areas are effective in conserving the local biodiversity
    - local effectiveness measures should capture individual protected area objectives
    - needs to accommodate the different biodiversity and threats of the areas

2. Results

2.1 Conservation targets for monitoring

To test the hypothesis on ecosystem health at system and individual MPAs key biodiversity targets were selected:

- Reefs (coral and rocky)
- Mangroves
- Seagrass beds
- Fishery species (not many, still to be defined)
- Sea turtle nesting beaches
- Estuaries
- Sea bird rookery, congregation, and foraging sites
- Marine mammals

2.2 Objectives for Conservation Targets

The workshop focused on developing impact indicators for the FCR project. Since specific objectives for the conservations targets had not already been developed by the FCR team, a general objective and specific objectives for each conservation target were identified.

Overall Objective

Within 5[2] years of implemented management of individual MPAs, indicators of ecosystem health are maintained or improved due to MPA management actions.

Table 1 and 2 show the proposed objectives for each conservation target.

Box 1.

Tier 1: Essential monitoring necessary to address Goal 1 (above): whether MPA designation results in improved viability of key coastal systems and species. This monitoring should be the highest priority for the FCR program.

Tier 2: Additional monitoring that further strengthens assessment of Goal 1 and addresses Goal 2 (above): whether protected areas are effective in conserving the local biodiversity. This monitoring is highly recommended and should be implemented if resources are available.

[2] Time frame may be expanded to 10 years.

Table 1. Conservation targets and objective proposed for Tier 1 monitoring.

Target	Objective- indicators
Overall MPA system	For 5 strata of the Costa Rican coastline (see Table 4), the target communities or species (listed in this table) show stable or positive change in the MPA sites across zones with different levels of protection relative to unprotected sites.
Key Fishery species (not many, still to be defined)	Populations of key fishery species are stable or increasing, indicated by biomass and proportion of large individuals, in the MPA sites across zones with different levels of protection relative to unprotected sites.
Coral Reef	All key indicators of coral reef resilience [coral recruitment, water quality, macro-algae: coral cover ratio, and biomass and size structure of key functional groups of fish and invertebrates*] and populations of key fishery species show stable or positive change in the MPA across zones with different levels of protection relative to unprotected sites. *all species included, but analysis is on change by functional group Qualitative: Dive operations trained to identify and report on presence of invasive species and disturbance events
Rocky Reef	All key indicators of rocky reef resilience [water quality, macroalgae cover, and biomass and size structure of key functional groups of fish and invertebrates (including octocorals)*] and populations of key fishery species show stable or positive change in the MPA across zones with different levels of protection relative to unprotected sites. *all species included, but analysis is on change by functional group Qualitative: Dive operations trained to identify and report on presence of invasive species and disturbance events

Mangrove	All key indicators of mangrove system resilience [area of mangrove, water quality, and biomass and size structure of key functional groups of fish and invertebrates *] and populations of key fishery species show stable or positive change in the MPA across zones with different levels of protection relative to unprotected sites. *all species included, but analysis is on change by functional group
Sea Turtle Nesting Beaches	Research objective: Analyze the 35 years of sea turtle data to identify trends and whether comparable nesting sites exist inside and outside proposed MPAs. If comparable sites exist: Sea turtle nesting and hatchling success shows stable or positive change in the MPA sites relative to unprotected sites. If comparable sites do not exist: Sea turtle nesting and hatchling success shows stable or positive change in the MPA sites. Note: May need to host a workshop to gather the groups collecting these data to facilitate collaborative action; other strategies associated with turtle nesting would be to reduce light and noise pollution adjacent to beach.

Table 2. Target and objectives proposed for Tier 2 monitoring.

Target	Objective - indicators
Seagrass	For sites 33 and 34, key indicators of seagrass system resilience [cover, water quality, and biomass and size structure of key functional groups of fish and invertebrates *] and populations of key fishery species show stable or positive change across zones with different levels of protection relative to unprotected sites between 2010 and 2020. *all species included, but analysis is on change by functional group; see IUCN guidance and Caribbean methodology
Estuaries	Key indicators of estuary systems [area, water quality, and biomass and size structure of key functional groups of fish and invertebrates * and populations of key fishery species] show stable or positive change across zones with different levels of protection relative to unprotected sites between 2010 and 2020. *all species included, but analysis is on change by functional group; evaluate whether additional indicators are necessary
Fisheries effort (priority species to be determined)	If a collaborative effort between SINAC and INCOPESCA can be developed so that commercial and sport fishery data are shared and can be consistently collected: Commercial, artisanal, and sport fishing catch per unit effort of priority species remains stable across Costa Rica. Number of applications for licenses for fishing inside the MPAs and number of boats present correspond to MPA zoning specifications (quantifies demand and compliance).

Sea bird rookery, congregation, and foraging sites (species to be determined, use existing monitoring projects, no new funding)	Sea bird rookery size and fledging success* shows stable or positive change in the MPA sites. *Indicators to be refined through understanding of current monitoring efforts.
Marine mammals, Crocodiles, Whale sharks, Manta rays?* *species to be determined, use existing monitoring projects, no new funding	Numbers and recruitment* of these species remain stable or increase in protected sites between 2010 and 2020. *Indicators to be refined through understanding of current monitoring efforts.

2.3 Methodological guidance and recommendations

2.3.1 Recommendations for addressing system-wide effects of MPAs:

- Tier 1.

  Omit unique sites; target coral reef, rocky reef, mangrove, turtle nesting beach habitats and fishery species within those habitats. Stratify based on management zoning within MPAs and sample within and outside MPAs. Gather data for as many years before MPAs are established as possible.

- Tier 2.

  Use the full array of coral reef, rocky reef, mangrove, nesting beach sites. Some will be MPAs and some won't. Measure changes at sites over time and relate those to connectivity with MPA sites to understand whether proximity to the MPA influences site quality outside of MPAs.

Include unique sites that are or will be designated as MPAs to identify whether the strategy is effectively conserving targeted species and communities at the local scale. Unique sites will not have clear non-MPA controls for comparison but trends within the sites can be assessed

- Need to develop a map of the major habitat sites, what has already been monitored, what will be monitored inside and outside of MPAs (completed for coral reefs at the workshop, see below)

2.3.2 Data analysis

Ideally, where control sites exist: Use Before-After-Control-Impact (BACI), to be analyzed using a 2 sample t-test on the average difference in the monitored variable between MPA and non-MPA sites (including differently zoned areas within MPAs) before and after the implementation of the MPA with permanent sample units (Osenberg et al. 2006[3]). Otherwise, analyze whether the slope of the trend (log n over time) within MPAs is higher than slope for n outside of MPAs. This could also be assessed through the log of the difference of n inside and outside MPA over time. Assessment is by family or by species. Comparing effectiveness of zones with different levels of protection should be assessed similarly to the in/out MPA comparison.

When no control site exists, before/after data of trends within sites will have to be used.

2.3.3 Recommended indicators

- Organize targets in 3 categories: habitats, fisheries, rare and threatened species (see Table 3).

- Measure biophysical parameters that will be helpful to select paired sites outside of MPAs:

[3] Osenberg, C.W., B.M. Bolker, J.S. White, C. St. Mary, and J.S. Shima. 2006. Statistical issues and study design in ecological restorations: lessons learned from marine reserves. Pages 280-302 *in: Foundations of Restoration Ecology*, DA Falk, MA Palmer, and JB Zedler, eds. Island Press.

- Depth
- Substrate composition
- Structural heterogeneity
- Salinity
- Oxygen
- Localized upwelling conditions
- Wave exposure

Table 3. Recommended indicators by each conservation target.

HABITATS		
TARGET	**INDICATOR**	
REEFS	Benthic composition	% Cover by species
		% Coral cover affected by bleaching or diseases
		Coral size structure (particularly recruitment)
	Invasive species (Lion Fish)	Density
		Biomass
	Functional Guilds (fish and others), particularly high level predators and herbivores and the commercial fisheries species	Density
		Biomass
		Richness
	Reef area	
	Water Quality	
MANGROVES	% Cover	
	Size structure (including recruitment)	
	Functional Guilds (fish and others), particularly high level predators and herbivores and the commercial fisheries species	Density
		Biomass
		Richness

SEAGRASS	% Cover	
	Density	
	Richness	
	Water Quality	
	Functional Guilds (fish and others), particularly high level predators and herbivores and the commercial fisheries species	Density
		Biomass
		Richness
ESTUARIES	Functional Guilds (fish and others), particularly high level predators and herbivores and the commercial fisheries species	Density
		Biomass
		Richness
	Water Quality	
SEA TURTLE NESTING BEACHES	Light and noise pollution – **Tier 2**	
	Area of coastal development on and adjacent to beach – **Tier 2**	
	See indicators for sea turtles	

FISHES AND FISHERIES	
TARGET	**INDICATOR**
Commercial Fisheries species (Fabian/Gustavo to provide list of fish and invertebrates)	Density
	Size structure
	Biomass
Fisheries (Trawling, Traditional long line) See indicators for commercial fisheries species and habitats also	Effort (CPUE)
	Distribution and abundance
	Participation

RARE AND THREATHENED SPECIES		
TARGET	**INDICATOR**	
Sea turtles	Population dynamics: number, location, seasonal patterns, size structure. See indicators for turtle nesting beaches also.	Note: review and use indicators in existing monitoring programs
Marine Mammals		
Sharks		
Sea Birds		
Crocodiles		
Manta rays?		

2.3.4 Guidance on sampling methods and protocols

- Where possible, use established protocols (AGRRA (http://www.agrra.org/), CariCoMP (http://www.unesco.org/csi/act/caricomp/summary14.htm), SeagrassWatch - http://www.seagrasswatch.org/home.html, SeagrassNet- http://www.seagrassnet.org/). The UCR monitoring is already consistent with AGRRA and CariCoMP, so there was no need to detail the protocols at the workshop.
- Remain consistent with existing methodology if long-term datasets exist and meet objective
- Often better to do fewer within-site transects and more sites
- Stratified random sampling – stratify on: long shore direction, depth and geomorphology as relevant; MPA zone, and within or outside the MPA
- The reduced effort and cost to do qualitative rather than quantitative assessment is generally insufficient to warrant qualitative data collection – however, there are methods for MantaTow (http://www.aims.gov.au/docs/research/monitoring/reef/reef-monitoring.html), which is a rapid estimation of cover of different indicators (see GBR long-term monitoring program), for identifying large-scale changes. This approach is likely not possible for FCR because it high visibility, which is not present in many coastal sites.

2.3.5 Aggregation of data for overall score by MPA or across MPAs

- The Great Barrier Reef Program has a method with weighted scorings for assessing resilience (http://www.epa.gov/owow/oceans/coral/documents/charting.pdf)
- Caribbean Challenge is developing 10-15 critical indicators (e.g., coral recruitment) that are un-weighted; have to have good scores for a site to score highly – could develop similar approach here (good, fair, poor). Any one poor indicator score results in a site score of poor. Need >50% good to be good.
- Could be integrated into the FCR MPA management scorecard under development (Caribbean Challenge does this)
- California is also developing an approach, but is not far along
- Graphics for displaying score results are further along than the scoring systems themselves (don't reinvent this)
- Good way to summarize and communicate but less informative and should not be substituted for data summary for really understanding strategy effectiveness

2.3.6 Implementation

- The University of Costa Rica already has extensive monitoring underway, particularly on coral and rocky reefs but also on other communities. Sea turtle nesting success, marine mammals, and other species are also monitored by other groups. Some of the implementation of this monitoring plan will be possible through coordination with these groups to focus monitoring on the sites identified and to share data.
- Additional funding will be required to fully implement even the Tier 1 measures.
- It is highly recommended that a "Monitoring Implementation Plan" be developed that includes specific monitoring objectives, indicators, protocols, data analysis and interpretation. The Plan should include a specific strategy on how the monitoring results will inform FCR project staff, government staff and other key audiences. The FCR team will work with Dr. Odalisca Breedy, who has been contracted by the project, to develop this Plan.

2.3.7. Other general recommendations

- Actual MPA boundaries should be designed to meet IUCN criteria for resilient MPAs.
- Where possible, incorporate site specific threat abatement components into designation of MPAs (e.g., restrict ecotourism and other activities in humpback whale calving sites during calving season).
- Inventory sites opportunistically. Try to get NOAA to place some colonization samplers (multi-level structures on which larvae settle and develop) in some of the Costa Rican sites.
- Develop additional capacity to opportunistically monitor following episodic, large-scale disturbances.

2.4. Monitoring sampling sites

For Tier 1, to assess the overall objective for the MPA system, the following monitoring sampling sites using a BACI approach were proposed. Note that the indicators suggested are in Table 3.

The Pacific and Caribbean coasts were stratified according to biophysical factors. The group decided to divide each coast for sampling purposes into 2-3 mega-regions (Table 1). Within each region and habitat 3 study sites should be selected according to the following BACI criteria:

1) **"NP"**: historically protected (Protected Area)

2) **"Control"**: Unprotected

3) **"MPA"**: Currently unprotected, but to be protected under the new MPA designation

Figure 1 was used as a general framework for selecting sampling points.

Table 4. Sampling sites for accomplishing the overall objective of evaluating the effectiveness of the overall MPA system and of individual MPAs proposed by the FCR project. Note that: 1) "NP": historically protected 2) "Control": Unprotected 3) "MPA": Unprotected, but to be protected.

Conservation Target	Pacific Coast			Caribbean Coast	
	North	Central	South	North	South
Reefs	Santa Elena (MPA) Bahia Salinas (Control) Santa Rosa (NP)	No new MPAS	To be determined within Golfo Dulce (use Figure 1 as reference)	-	Gandoca (NP) Uvita / Limon / Puerto Viejo (Control) No MPA
Mangroves	Chira-Tempisque (Control)	Manuel Antonio / Marino Ballena (NP) Dominical (Control) To be determined (MPA).	To be determined within Golfo Dulce	-	Gandoca (NP) Moin (Control) There are no mangroves outside of NP
Sea grass	-	-	-	-	Gandoca (NP) There are no mangroves outside of NP

Sea Turtle Nesting Beaches	**-**	**-**	**-**	**Tortuguero (NP)** **Barra Colorado (MPA)** **Matina o Playa Norte (Control)**	**Gandoca (NP)** **Playa Negra (Control)**
Key Fishery species	**Santa Elena (MPA)** **Bahia Salinas (Control)** **Santa Rosa (NP)**	**Manuel Antonio / Marino Ballena (NP)** **Dominical (Control)** **To be determined (MPA).**	**To be determined within Golfo Dulce**	**Tortuguero (NP)** **Barra Colorado (MPA)** **Matina o Playa Norte (Control)**	**Gandoca (NP)** **Uvita / Limon / Puerto Viejo (Control)** **No MPA**

It is important to note that these sites will be used for testing the effectiveness of the MPA at system and site specific levels. For the monitoring program that is being developed by CIMAR-UCR and TNC, the same proposed sites will be used only where a MPA already exists. Therefore, more sites should be added in order to evaluate the biodiversity status of the existing MPAs. It is recommended that this proposal concentrate its monitoring strategy on the targets discussed during the workshop.

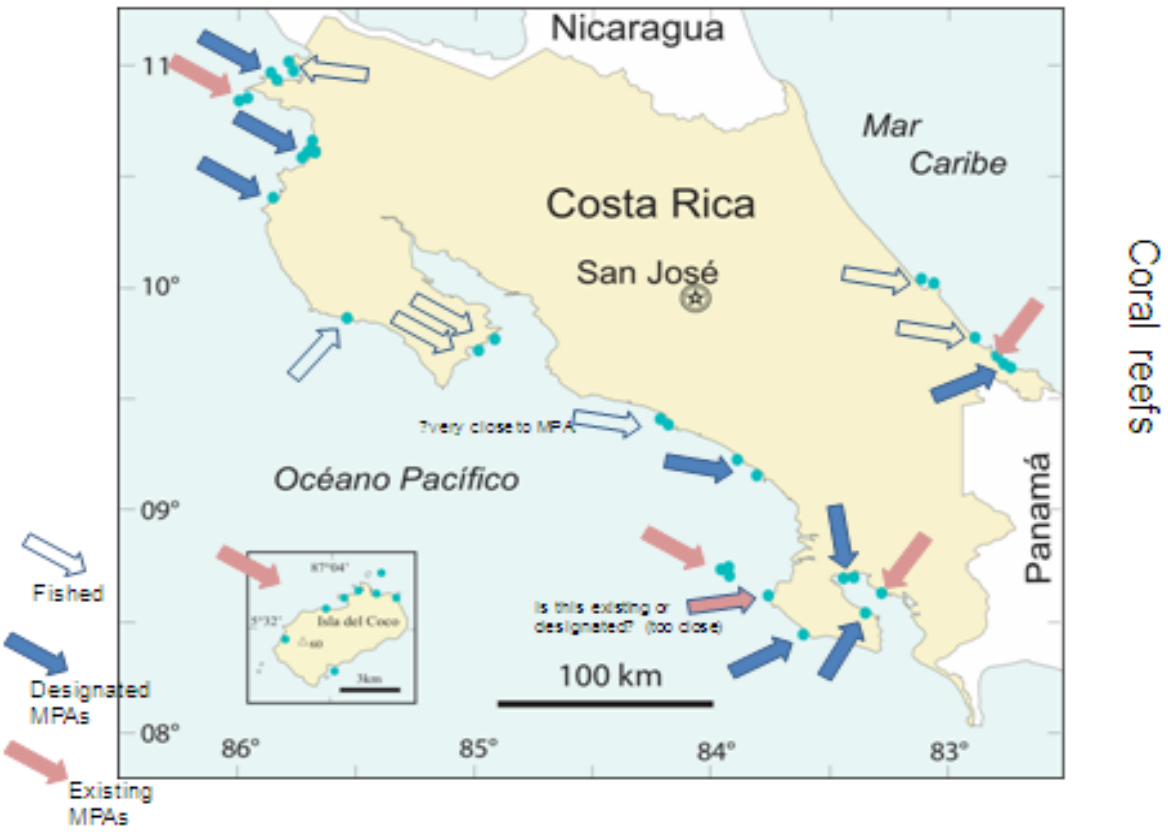
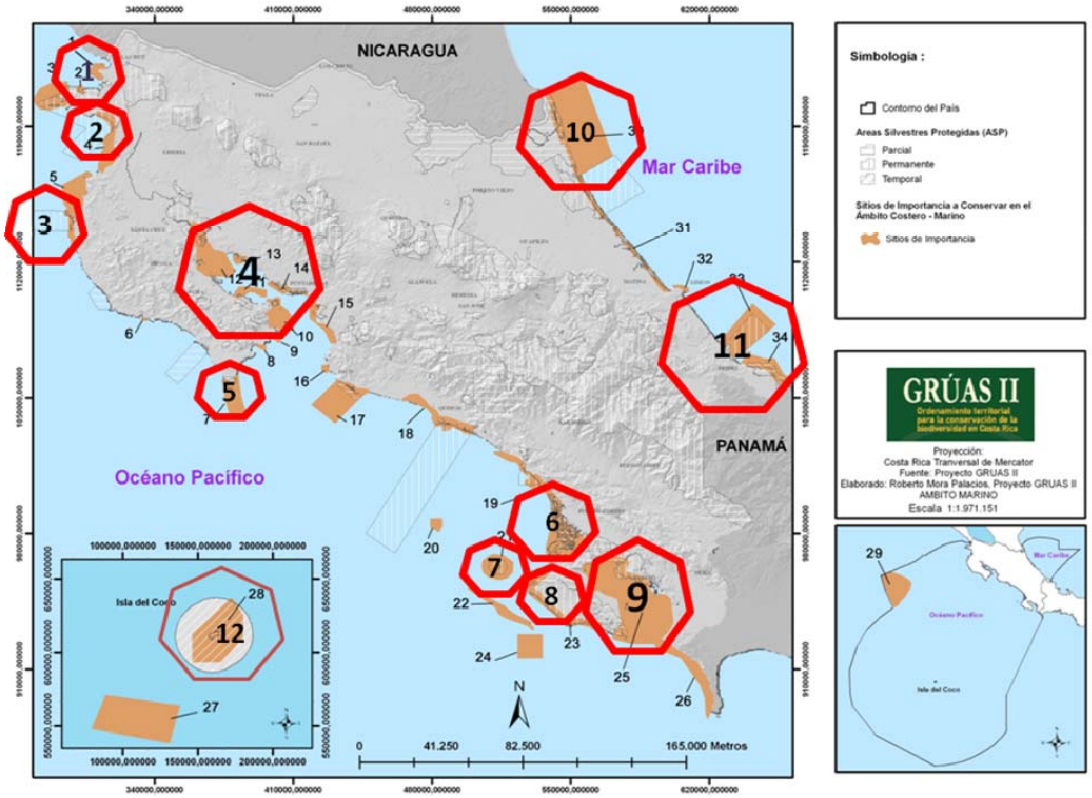


Figure 1. General framework for selecting sampling points.

3. Appendices

3.1 Map of FCR sites



Priority marine conservation sites in Costa Rica. 1: Descartes; 2: Bahía Santa Elena; 3: Punta Santa Elena; 4: Golfo de Papagayo; 5: Punta Gorda-Punta Pargos; 6: Punta el Indio; 7: Cabo Blanco; 8: Punta Tambor; 9: Curú-Islas Tortugas; 10: Negritos-San Lucas; 11: Caballo-Venado; 12: Chira-Tempisque; 13: Estero Culebra; 14: Aranjuez; 15: Caldera-Tarcoles; 16: Herradura; 17: Punta Judas; 18: Damas-Savegre; 19: Dominical-Sierpe; 20: Plataforma de Coronado; 21: Isla del Caño; 22: Plataforma de Osa; 23: Corcovado; 24: Montañas submarinas de Osa; 25: Golfo Dulce; 26: Punta Burica; 27: Montañas Submarinas de Cocos; 28: Isla del Coco; 29: Domo Termico; 30: Barra del Colorado; 31: Canales de Tortuguero; 32: Uvita; 33: Cahuita; 34: Gandoca. **Sourc**e: SINAC (2008)[4]. **In red: 12 priority sites for the FCR project**.

[4] Sistema Nacional de Áreas de Conservación (SINAC) del Ministerio de Ambiente y Energía (MINAE). 2008. GRUAS II: Propuesta de Ordenamiento Territorial para la conservación de la biodiversidad de

3.2 Habitat targets present by FCR site.

Site #	NAME	CORAL REEFS	MANGROVES	SEAGRASS	ESTUARIES	*NESTING BEACHES
1	Descartes	X				X
2	Bahía Santa Elena	X				
3	Punta Santa Elena	X				
4	Golfo de Papagayo	X	X	X		X
5	Punta Gorda-Punta Pargos	X	X		X	X
6	Punta El Indio	X				
7	Cabo Blanco	X				
8	Punta Tambor	X				
9	Curú-Islas Tortugas	X				
10	Negritos-San Lucas	X				
11	Caballo-Venado				X	
12	Chira-Tempisque		X		X	
13	Estero Culebra		X		X	
14	Aranjuez		X		X	
15	Caldera-Tárcoles		X			X
16	Herradura	X		X		
17	Punta Judas	X				X
18	Damas-Saavegre	X	X			X
19	Dominical-Sierpe	X	X	X	X	X
20	Plataforma de Coronado					
21	Isla del Caño	X				
22	Plataforma de Osa					
23	Corcovado	X				X
24	Montañas submarinas de Osa					
25	Golfo Dulce	X	X		X	X
26	Punta Burica	X				
27	Montañas submarinas de Cocos					

28	Isla del Coco	X				
29	Domo térmico					
30	Barra del Colorado					X
31	Canales de Tortuguero					X
32	Uvita	X				X
33	Cahuita	X		X		X
34	Gandoca	X	X	X		X
35	Ostional	X				X

*Turtle nesting success on beaches use for the MPA SEM depends on analysis of existing data.

3.3 Commercial fishery species in Costa Rica[5]. A small subset of high priority species will be selected for monitoring (see Next Steps).

Fishes		
Coomon spanish name	**Scientific name**	**Family**
Pargo rojo o colorado[1]	*Lutjanus colorado*	**Lutjanidae**
Pargo seda	*Lutjanus peru*	
Pargo negro o dienton	*Lutjanus novemfasciatus*	
Pargo de cola amarilla	*Lutjanus argentiventris*	
Pargo roquero	*Hoplopagrus guntheri*	
Pargo manglero o zaguero	*Lutjanus jordani*	
Pargo Jilguero	*Lutjanus aratus*	
Corvina aguada	*Cynoscion squamipinnis*	**Sciaenidae**
Corvina rayada	*Cynoscion reticulatus*	
Corvina picuda	*Cynosscion phoxocephanus*	
Corvina agria	*Micropogonias altipinnis*	
Corvina plateada	*Lamirus argenteus*	
Corvina ñata rayada	*Larimus acclivis*	
Corvina guavina	*Nebris occidentales*	

[5] Planificación para la conservación y manejo de los recursos pesqueros del Golfo Dulce – Percepción de la comunidad de pescadores artesanales locales. 2007. AsoPez y Centro Ambiental de Osa.

Corvina aleta azul	*Paralonchurus petersii*	**Sciaenidae**
Corvina cinchada	*Paralonchurus dumerilii*	
Corvina polla rayada	*Umbrina xanti*	
Cholesca fina	*Bairdiella ensifera*	
Zorra panameña	*Menticirrhus panamensis*	
Robalo	*Centropomus sp.*	**Centropomidae**
Robalito	*Centropomus robalito*	
Gualaje armado	*Centropomus armatus*	
Mano de piedra	*Centropomus unionenses*	
Robalo blanco	*Centropomus viridis*	
Robalo negro	*Centropomus nigrescens*	
Jurel ojon	*Caranx sexfasciatus*	**Carangidae**
Jurel arenero	*Hemicaranx leucurus*	
Jurelillo	*Hemicaranx zelotes*	
Jurel toro	*Caranx caninus*	
Jurel bonito	*Caranx caballus*	
Palometa espejo	*Selene oerstedii*	
Palometa jorobada	*Selene brevoortii*	
Palometa	*Selene peruviana*	
Caballa fina	*Decapterus microsoma*	
Sierra	*Oligoplites altus*	
Pampano rayado	*Trachinotus rhodopus*	
Pampano común	*Trachinotus Kennedy*	

Macarela	*Decapterus sp.*	**Carangidae**
Sardina gallera plateada	*Opishtonema mediastre*	**Clupeidae**
Macabí	*Elop affinis*	**Elopidae**
Barracuda	*Sphyraena sp.*	
Catecismo	*Chaetodipterus spp*	**Ephippidae**
Cuminate	*Bagre panamensis*	**Ariidae**
Cuminate volador	*Bagre pinnimaculatus*	
Cabrilla guardia		**Serranidae**
Cabrilla roja		
Cabrilla mantequilla	*Paralabrax auroguttatus*	
Cabrilla pintada (de roca)	*Diplectrum macropoma*	
Mero	*Ephinephelus sp.*	
Zorro de hebra	*Albula nemoptera*	**Albulidae**
Zorro	*Albula culpes*	
Atún aleta amarilla	*Thunnus albacares*	**Scombridae**
Macarela[3]	*Scomberomorus sierra*	
Macarela caballa	*Scomber japonicus*	
Dorado	*Coryphaena hippurus*	**Coryphaenidae**
Pez Gallo	*Nematisitius pectorales*	**Nematistiidae**
Pez aguja	*Tylosorus sp*	**Belonidae**
Pez vela	*Istiophorus platypterus*	**Istiophoridae**
Pez sierra	*Pristis perotteti*	**Pristidae**
Lisas	*Mugil curema*	**Mugilidae**

Salmonete rosado	*Pseudupeneus grandisquiamis*	**Mullidae**
Conejo	*Caulolatilus spp*	**Malacanthidae**
Pargo blanco	*Diapterus peruvianus*	**Gerrridae**
Roncador	*Anisotremus pacificus*	**Haemulidae**
Roncador fríjol	*Haemulon steindachneri*	
Fríjol	*Anisotremus caesisus*	
Cotongo	*Anisotremus dovii*	
Vieja trompuda	*Haemulon elongatus*	
Vieja jupona	*Pomadasys panamensis*	
Vieja espinosa	*Pomadasys sp.*	
Chancho fisgón	*Pseudobalistes naufragium*	**Balistidae**
Bobo amarillo	*Polydactylus opercularis*	**Polynemidae**
Raya dorada		
Tiburón tigre	*Galeocerdo cuvier*	
Tiburón aleta amarilla		
Tiburón martillo	*Sphyrna lewini*	**Sphyrnidae**
Tiburón punta blanca	*Carcharhinus albimarginatus*	
Tiburón aleta negra	*Carcharhinus ssp.*	**Carcharhinidae**

Molluscs		
Piangua	*Anadara tuberculosa*	**Arcidae**
Chucheca	*Anadara grandis*	
Cambute	*Strombus galeatus*	**Strombidae**
Ostras	*Crasostrea gigas*	
Ostión	*Crassotreas spp.*	
Crustacean		
Camarón blanco	*Solonaeus stylirostris*	**Penneidae**
Camarón café	*Peneaus californiensis*	
Jaibas	*Callinectes spp*	**Portunidae**
Langosta pacifica	*Panulirus spp.*	

3.4 Next Steps

- FCR team will let us all know when the "deal" is complete.
- FCR Team will meet with CR government officials about the workshop results.
- The workshop organizers will develop a report (English) on the workshop by mid-April.
- Participants will review the workshop report.
- FCR team will prepare the report to the CR government on the recommended monitoring plan (Spanish).
- Costa Rican experts will be asked to review the monitoring plan.
- FCR team will develop a proposal for funding this monitoring program.
- SINAC and FCR team will prioritize the commercial fisheries species for monitoring purposes according to the national list (Appendix 3.3.)

3.5 Agenda for Forever Costa Rica Measures Workshop

March 16 – 18, 2010
Hotel Bougainvillea (http://www.hb.co.cr/)
Santo Domingo de Heredia, Costa Rica

Goals

Develop a monitoring program that will identify whether:

1. The MPA system is functional and conserving system-wide biodiversity
    - related to a national strategy of increasing representativeness
    - will require comparison across protected sites as well as with unprotected areas
2. The protected areas are effective in conserving the local biodiversity
    - local effectiveness measures should capture individual protected area objectives
    - needs to accommodate the different biodiversity and threats of the areas

Specific questions

1) Is the strategy of designating MPAs effectively improving overall marine system viability?
    - Does designation of marine protected areas result in maintained or improved viability of selected indicator species/communities and reduced threats (sedimentation, water quality, commercial fishing) within those protected areas compared to unprotected areas?
    - Does the monitoring data support a conclusion that management of the MPAs is effectively conserving ecological integrity?

2) Is the status of marine system targets and threats improving within and across MPAs?
    - What is the minimum set of indicators that can be monitored and will sufficiently reflect the ecological integrity of the marine system?
    - How will those indicators be monitored and analyzed?
    - Can we summarize multiple indicator data into an overall score of ecological condition or integrity by MPA (to use for the MPA and aggregate into national level)?
    - Where quantitative data cannot be collected on indicators in all locations, are there qualitative criteria that might be used to assess indicator condition?

These questions assume that the Costa Rican government is implementing and managing the MPA network. These components will also be monitored, but do not need to be addressed during the workshop. The workshop focuses on measures of ecological integrity only.

Workshop participants will

1) Review Forever Costa Rica project objectives and proposed indicators
2) Refine, replace, or add indicators necessary to evaluate whether the MPA strategy will have the intended results
3) Suggest methodology, desired precision, and sampling designs for priority indicators that will provide the minimum information required to make management decisions at both the site and MPA levels
4) Incorporate consideration of cost into designs selected
5) Identify likely analysis approach for each monitoring effort and available assistance

<u>March 15</u> – Travelers arrive at Hotel Bougainvillea

<u>March 16</u>

8:30-9:30 Welcome, Introductions, Workshop purpose – *Bernal Herrera*, *Doria Gordon*

930 5-10:45 Review of the FCR strategy, theory of change, objectives, and questions workshop will address – *Zdenka Piskulich, Fabian Sanchez*

10:45-11:00 BREAK (Coffee and Fruit provided)

11:00-11:30 Discussion and clarification **–** *Bernal Herrera*

11:30-12:00 The Conservancy's Strategy Effectiveness Measures approach – *Doria Gordon*

12:00-1:00 LUNCH (Provided)

1:00-1:30 Sampling decisions – *Craig Osenberg*

1:30-2:00 Examples of MPA threat/target measures from elsewhere – *Alison Green*

2:00-2:30 Presentation of system-wide indicators proposed for FCR – *Odalisca Breedy*

2:30-2:45 BREAK (Coffee and snacks provided)

3:00-4:30 Review/confirmation/identification of indicators of: 1) MPA strategy effectiveness and 2) status of targets and threats within and across MPAs in breakout groups. *Groups identify reporters*

4:30-5:00 Reconvene group for review of indicators identified – *Bernal Hererra*

March 17

8:30-11:30 Develop sampling design and potential methodology for primary indicators along theory of change. Separate break-out groups (2) to address threat reduction and target response indicators. – *Groups assign facilitators/reporters (CR participants identify data already being collected that can be used)*

Groups take breaks independently (Coffee and snacks provided).

11:30-12:30 Reconvene group for peer review of identified sampling designs and methodology – *Doria*

12:30-5:00 Field Trip (bag lunch provided)

March 18

8:00-10:30	Refine sampling designs/methodology in breakout groups based on peer review
10:30-11:15	BREAK (Coffee and Fruit provided)
11:15-12:30	Reconvene group for further peer review and discussion of identified sampling designs and methodology – *Doria*
12:30-1:30	LUNCH (Provided)
1:30- 3:00	Breakout into same groups: 1) Identify likely analysis for each sampling design (brief description highlighting any data organization or covariate needs; 2) Identify line items that will help later budget development, other logistical needs to implement the identified monitoring. – *Groups assign new facilitator/reporter*
3:00-3:15	BREAK (Coffee and Fruit provided)
3:15-4:00	Plan next steps for filling information gaps and developing more extensive monitoring protocols - *Bernal*
4:00-5:00	After Action Review of workshop

3.6 Forever Costa Rica Measures Workshop Participants

Odalisca Breedy, Ph.D. is a Senior Scientist at the Research Center on Marine Sciences and Limnology (CIMAR) at the University of Costa Rica. She is expert in coral reefs and has been contracted by the Conservancy to develop indicators for the Costa Rican Marine Protected Areas. odalisca@racsa.co.cr

James Byrne, M.S. is the Conservancy's Marine Science Program Manager for South Florida, based in the Florida Keys Office. James provides managerial, technical and scientific leadership for marine conservation initiatives in south Florida, the Florida Keys and the Caribbean. James is leading the development of strategy effectiveness measures for the Conservancy's Caribbean Challenge. jbyrne@tnc.org

Jennifer Caselle, Ph.D is a Research Biologist at the Marine Science Institute at the University of California Santa Barbara, who has worked extensively in both coral reef and kelp forest ecosystems. Her primary research interests include population dynamics of both tropical and temperate reef fish, dispersal processes of marine organisms, consequences of natural and anthropogenic impacts on populations and the design and evaluation of marine protected areas. caselle@msi.ucsb.edu

Pamela Castillo, MSc. is a lawyer with The Nature Conservancy's Forever Costa Rica Project. She provides general support to project activities. pcastillo@tnc.org

Doria Gordon, Ph.D. is the Director of Conservation Science for the Florida Chapter of the Conservancy and a Courtesy Professor of Biology at the University of Florida. She has established and developed training on monitoring programs and is coordinating this workshop. dgordon@tnc.org

Alison Green, Ph.D. is Senior Marine Scientist with The Nature Conservancy's Asia Pacific Conservation Region and an Adjunct Professor at the Australian Research Council Center of Excellence for Coral Reef Studies. Her areas of expertise include designing, monitoring and measuring success of resilient networks of marine protected areas. agreen@tnc.org

Bernal Herrera, Ph.D. is Science Coordinator for The Nature Conservancy's Northern Andes and Southern Central America Program and is Regional Vice-chair for Mesoamerica for the IUCN Commission for Ecosystem Management. He oversees the Forever Costa Rica Project and is expert on conservation planning and biological corridors. bherrera@tnc.org

Gustavo Induni, M.Sc. is a biologist with expertise in management of protected areas. He is with the Division of Protected Areas of the National System of Conservation Areas of Costa Rica (SINAC). gustavo.induni@sinac.go.cr

Daniela Lizano, Lic. is a biologist focusing in supporting the development and monitoring of conservation area planning and results chains. She works on the Protected Area Strategy for the Conservancy's Northern Andes and Southern Central America Program. dlizano@tnc.org

Helena Molina, Ph. D. is at the Research Center on Marine Sciences and Limnology (CIMAR) at the University of Costa Rica. She is an expert in marine fish monitoring and conservation. hmolina@rsmas.miami.edu

Alvaro Morales, Ph.D. is Professor and the Director of the Research Center on Marine Sciences and Limnology (CIMAR) at the University of Costa Rica. He is an expert in marine biodiversity management and conservation. alvaro.morales@ucr.ac.cr

Craig Osenberg, Ph.D. is a Professor of Biology at the University of Florida. His interests include the application of ecological theory to the design of marine reserves and fisheries management, coral reef ecology, and the design and implementation of environmental assessment studies. osenberg@ufl.edu

Zdenka Piskulish, M.Sc. is an environmental lawyer and expert in conservation policy. She is the Forever Costa Rica Project Director for The Nature Conservancy. zpiskulish@tnc.org

Michael Rotschild, M.Sc.is a Marine Biologist with the Walton Foundation. He has expertise in marine biodiversity conservation and marine conservation policy. mrothschild_2000@yahoo.com

Fabian Sanchez, M.Sc. is a Marine Biologist with The Nature Conservancy's Forever Costa Rica Project. He is an expert in marine biodiversity conservation. fsanchez@tnc.org

3.7 After Action Review Comments from Participants

Positives

- Participation from scientists outside TNC greatly appreciated
- Participants felt they learned a lot
- Well organized venue and meeting
- Good, intense discussions that were very productive
- Good scientific contacts made
- Workshop improved on an already good monitoring system
- Materials sent out before workshop were informative
- Starting the workshop with informative background presentations
- Adaptable meeting agenda
- Good facilitation
- Open-minded, critical discussion (disagreements expressed, but productive result)
- Refreshing to focus on measures and technical issues
- Non-TNC participants felt honored to be invited and learn about TNC culture
- Ground rules
- Facilitators respectful of everyone and different ideas
- Integration of system-wide and site based measures
- Rich knowledge of Costa Rican systems
- Multiple experts with different expertise
- Incorporating climate change into objectives
- Overnight summary of work for next day discussion
- Sufficient time for needed discussion

Negatives

- Some key Costa Rican experts were not present (had been invited)
- Local Costa Rican experts attended intermittently
- Workshop objective insufficiently clear
- Clarify the specific workshop product desired
- Could have made better use of existing materials and knowledge prior to the workshop
    - Existing MPA measures frameworks could have been used as a starting point for a draft structure sent out before the workshop
    - Summarize monitoring data already being collected (with methods)
- Workshop length may have discouraged participation

- Could have included other organizations in Costa Rica that do some monitoring
- Spend first day presenting more data rather than overview information; maybe make that first day entirely presentations
- Hand out copies of all powerpoints to help those who miss some of the workshop
- Arrival of participants late in the workshop resulted in unnecessary repetition /time waste
- Provide a map with both place names and numbers to facilitate communication about specific sites
- Provide greater clarity about planned management actions at MPAs
- Food