

PART I. ORAL AND VIDEO PRESENTATIONS

MEAGER STRUCTURING OF mtDNA D-LOOP SEQUENCES AMONG EASTERN PACIFIC OLIVE RIDLEY ROOKERIES: EVIDENCE OF SIGNIFICANT INTER-ROOKERY GENETIC EXCHANGE?

¹F. Alberto Abreu-Grobois, ¹Raquel Briseño-Dueñas, ²René Márquez-Millán, ³Anny Chávez, and ⁴Brian Bowen

¹ Banco de Información sobre Tortugas Marinas (BITMAR), Estación Mazatlán, Instituto de Ciencias del Mar y Limnología (UNAM), Apartado Postal 811, Mazatlán, Sinaloa 82000, México

²Centro Regional de Investigación Pesquera- Manzanillo, Instituto Nacional de la Pesca, SEMARNAP, Apartado Postal 591, Manzanillo, Colima 28200, México

³Universidad de Costa Rica, Apartado Postal 18-3019, San Pablo, Heredia, Costa Rica

⁴BEECS Genetic Analysis Core, 12085 Research Drive, Alachua, FL 32615, U.S.A.

The population structure of the olive ridley (*Lepidochelys olivacea*) sea turtle in the Eastern Pacific (EP) was analyzed from mtDNA d-loop sequences of Mexican, Costa Rican and Australian rookeries. Whereas mtDNA studies in other sea turtles have found highly structured distributions of molecular markers among nesting populations (indicative of demographic independence), the scanty genetic differentiation found between EP olive ridley rookeries (>98% of the genetic variance occurs within populations, fixation index=0.014) coupled with genetic diversity levels similar to other species ($h=0.465-0.684$) can best be explained by the existence of significant genetic exchange between rookeries. This hypothesis is corroborated by reciprocal tag returns from nesters between rookeries within México and between México and other EP countries.

ANALYSIS OF THE INCIDENTAL CAPTURE AND MORTALITY OF SEA TURTLES IN THE SHRIMP FLEET OF PACIFIC COSTA RICA

Randall M. Arauz¹, Roberto Vargas², Isabel Naranjo², and Carlos Gamboa²

¹Associate Researcher, School of Biology, University of Costa Rica/Sea Turtle Restoration Project, Earth Island Institute, 1203-1100 Tibas, San Jose, Costa Rica

²TED Project, School of Biology, University of Costa Rica, San Jose, Costa Rica

Section 609, Public Law (P.L.) 101-162, imposes and embargo on shrimp imports into the United States by nations not meeting or exceeding U.S. standards of sea turtle protection. Henwood, Stuntz and Thompson (unpubl), provide gross estimates of turtle catch and mortality by foreign nations based on metric tons of shrimp exported, assuming turtle catch rates comparable to those in U.S. waters, although the authors recognize that it is questionable whether mortality rates in US waters can be applied to foreign nations. Verifiable estimates of present CPUE and mortality rates must be provided by each country exporting shrimp into the US in order to ascertain the level of protection provided by the regulations implemented.

The principal objective of this paper is to describe the Costa Rican shrimp fishery and provide reliable estimates of turtle catch and mortality rates in these waters.

DESCRIPTION OF THE SHRIMP FLEET OF PACIFIC COSTA RICA

Fifty five vessels operate along the Pacific coast of Costa Rica. Wooden or steel hull Florida type vessels are used, with an average hull length of 60 to 85 ft. A single flat or two seam balloon net with a headrope length from 65 to 80 ft is pulled from each outrigger. Target species include white shrimp (*Peneaus occidentalis*, *P. stylirostris*, *P. vanamei*) and small shrimp (*Trachypenaeus* sp. and *Xiphopenaeus* sp.) in shallow waters (9 to 40 m), pink (*P. brevirostris*) and brown (*P. californiensis*) in deep waters (65 to 85 m), and fidel and camello (*Solenosera* sp and *Heterocarpus* sp.) in the deepest waters (100 to 300 m). Seventeen of the fifty five vessels are licensed to fish only for fidel and camello shrimp.

METHODOLOGY

An observer program was implemented during four separate projects (Arauz, R.M., 1994; Arauz *et al.*, 1997a; Arauz *et al.*, 1997b; Gamboa, 1993), including a research thesis by Rice, R.E. (1973). During each project, the dates, location, number of tows, hours of fishing, headrope length of the nets and number of turtles captured was recorded. Each turtle captured was identified, and the general condition recorded (alive or dead). The CPUE for each zone was estimated by dividing the number of turtles captured by the amount of hours fishing. Because the turtle catch per unit of effort (CPUE) is a direct function of net size and length of tow, all CPUEs were normalized to a 30.5m (100ft) headrope length and one hour tows. Furthermore, turtle catch and mortality rates were maintained in separate blocks, according to the fishing zone (geographic area, target species and depth):

- 1) Gulf of Nicoya white shrimp fishery. Average depth from 9 to 27 meters.
- 2) South Pacific white shrimp fishery. Average depth from 9 to 40 meters.
- 3) Golfo Dulce white shrimp fishery. Average depth from 9 to 15 meters.
- 4) North Pacific pink shrimp fishery. Average depth from 65 to 85 meters.
- 5) South Pacific pink shrimp fishery. Average depth from 65 to 85 meters.
- 6) Deep fidel and camello shrimp fishery. Average depth from 100 to 300 meters.

Assumptions:

- 1) The 17 vessels with exclusive fidel licenses do not catch turtles (zone 6).
- 2) Of the other 38 vessels, 19 fish white shrimp and 19 fish pink shrimp.
- 3) The 19 white shrimp vessels are equally distributed in the white shrimp fishing grounds, thus 6.33 vessels operate in each fishing zone (zones 1 to 3).
- 4) The 19 pink shrimp vessels are equally distributed in the pink shrimp fishing grounds, thus 9.5 vessels operate in each pink shrimp fishing zone (zones 4 and 5).
- 5) In Costa Rica the average headrope length of each trawl net is 80 feet.
- 6) White shrimpers do 4 drags a day (4 hours/drag).
- 7) Pink shrimpers do 2 drags a day (5.5 hours/drag).
- 8) All shrimp vessels work an average 21 days of the month, year round.
- 9) CPUE rates do not vary seasonally.

The average CPUE for Costa Rica is estimated by dividing estimated turtle captures for each fishing zone by effort (using the assumptions listed above).

RESULTS

Two hundred eighty one turtles were captured after 2556.5 hours of observation during the four projects. The vast majority are olive ridleys (90.04%), followed by the green turtle (9.6%) and the hawksbill (0.4%). Mortality among olive ridleys is estimated to be 37.55%, and 50% for greens. The only hawksbill captured was alive. Average CPUE sea turtles in the Pacific coast of Costa Rica is estimated to be 0.1019. The annual catch of sea turtles using the assumptions listed earlier result in an estimated 15,631.2 along the Pacific coast of Costa Rica.

Costa Rica has the highest yet recorded average CPUE rate for sea turtles in the world. The olive ridley nests in massive "arribada" fashion in six locations of the tropical eastern Pacific, thus these high rates may be the rule in these waters. The countries of the eastern tropical Pacific must adopt the use of Turtle Excluder Devices (TEDs) in their shrimp fleets if adequate long term protection is to be provided to these populations of threatened sea turtles.

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Table 1. Catch per unit of effort of sea turtles (indiv/hr/30.5m) in the white shrimp fisheries of Pacific Costa Rica, 1997. Rice (1973), Gamboa (1993), Arauz (1994), Arauz *et al.* (1977a,b)^{1,2,3,4,5}.

Vessel	month/year	Hours	# turtles	CPUE/indiv/hr/30.5m
Fishing Zone 1				
Edjorka ²	Sep-92	66.5	0	0
Ana Lourdes ²	Dec-92	49.75	6	0.0804
Pta Guiones ²	Mar-93	58.25	0	0
Ana Lourdes ²	Mar/Apr-93	39.4	0	0
Nautilus ⁴	Aug-95	87.81	28	0.236
Don Beto ⁴	Feb-96	68.05	0	0
Don Manolo ⁴	Mar-96	82.1	0	0
Andi ⁴	Apr-96	22.5	1	0.0317
Ana Lourdes ⁵	Sep-96	101.55	12	0.1819
Capt.Lostalo ⁵	Oct-96	24.08	0	0
Karla G ⁵	Nov-96	42.84	1	0.0231
Total		642.83	48	0.0684
Fishing Zone 2				
Edjorka ²	Apr-93	75.08	13	0.1154
Edjorka ²	Jun-92	54.75	1	0.0122
Maria Pia ⁴	Jun-95	29	4	0.1623
Picaroto ⁴	Jul-95	40.5	3	0.0707
Nautilus ⁴	Aug-95	128.6	41	0.1989
Edjorka ⁴	Oct-95	186.3	8	0.0264
Rio Grande ⁴	Nov-95	164.34	6	0.0243
Maria Aurelia ⁴	Jan-96	134.82	7	0.0344
Andi ⁴	Apr-96	41.75	2	0.0342
Edjorka ⁵	Oct-96	69.41	3	0.1201
Edjorka ⁵	Sep-96	116.5	4	0.0312
Monarca ⁵	Sep-96	54.03	0	0
Capt.Lostalo ⁵	Oct-96	44.56	1	0.032
Karla G ⁵	Nov-96	17.41	2	0.1435
Edjorka ⁵	Nov-96	69.49	0	0
Total		1226.54	95	0.0598
Fishing Zone 3				
Joshua ⁴	May-96	31.6	1	0.0487
Edjorka ⁵	Set-96	83.5	1	0.0074

Total	115.1	2	0.0188
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TABLE 2. Catch per unit of effort (indiv/hr/30.5m) of sea turtles in the pink and fidel shrimp fishery of Costa Rica, 1997.

Vessel	month/year	Hours	# turtles	CPUE/indiv/hr/30.5m
Fishing Zone 4				
Rice ¹	Sep-73	43.2	34	0.5247
Edjorka ²	Sep-92	12	0	0
Karla G ²	Jan-93	81.7	19	0.155
Andi ⁴	Apr-96	29.5	3	0.1453
Total		166.4	56	0.2381
Fishing Zone 5				
Edjorka ²	Jun-92	27.7	4	0.0963
Edjorka ³	Aug-94	69.3	15	0.1443
Karla G ⁴	May-95	127	13	0.09284
Maria Pia ⁴	Jun-95	15.43	2	0.0977
Joshua ⁴	Apr-96	52.75	0	0
Joshua ⁴	May-96	2	0	0
Edjorka ⁵	01/09/1996	19	4	0.13167
Karla G ⁵	Nov-96	22.5	1	0.05
Total		335.68	39	0.0881
Fishing Zone 6				
Joshua ⁴	Apr-96	36.95	0	0
Joshua ⁴	May-96	33	0	0
Total		69.95	0	0

TABLE 3. Analysis of 281 sea turtles captured off the Pacific coast of Costa Rica after 2556.5 hours of commercial shrimp fishing, 1997.

Species	Total	%	Alive	Dead	Unknown	% Mortality
<i>Lepidochelys olivacea</i>	253	90.04	153	92	8	37.55
<i>Chelonia mydas</i>	27	9.6	11	11	5	50
<i>Eretmochelys imbricata</i>	1	0.4	1	-	-	0