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Preliminary Results: Movements of scalloped hammerhead sharks (*Sphyrna lewini*) tagged in Cocos Island National Park, Costa Rica, 2005.

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Introduction. Cocos Island National Park, is located 550 km Southwest off the Pacific coast of Costa Rica. The underwater world of the national park has become famous due to the presence of large pelagic species such as sharks, rays, tuna and dolphins, highlighting its role as a sanctuary for highly migratory species threatened by fisheries. In spite of a 12 mile "no take" zone established in the waters surrounding Cocos Island, shark populations have continued to decline, in particular the scalloped hammerhead by 71% (Myers et al, 2004). How can conservation be improved? Should the "no take" zone be extended beyond 12 miles? Are these sharks interacting with sharks from the mainland, or with sharks from other oceanic islands of the region? Information on movements of emblematic species such as scalloped hammerheads in Cocos Island, and possible connectivity with other marine protected areas in the region is crucial for the establishment of efficient shark conservation policy.

Methods. 10 scalloped hammerhead sharks were tagged with VEMCO V16 Coded Multi-Purpose Transmitters, from July 25 to September 28 of 2005. Tags were attached directly to the base of the dorsal fin of free swimming sharks exhibiting schooling behavior, by means of a stainless steel tag anchor and a monofilament tether at the end of a pole spear. The use rebreather SCUBA gear was used to minimize the disturbance to

Figure 1. VR2 deployment sites Roca Sucia and Bajo Alcyon, including Isla Manuelita. July – September, 2005

the sharks thus allowing the researcher to get closer to the animals. Two VR2 Automated Receivers, which can identify individual acoustic transmissions from the V16s at a distance of 500 meters were deployed on July 19 and 22 of 2005, at sites known as Roca Sucia (Dirty Rock) (20 m) and Bajo Aclyon (35 m), respectively (Figure 1), where schooling behavior is common. Data was downloaded from the VR2s on December 11 (Roca Sucia) and December 12 (Bajo Alcyon) of 2005.

Table 1. Scalloped hammerhead sharks tagged in Cocos Island, July-September, 2005.

#	Date tagged	site tagged	last record	# days
1	25/07/2005	Alcyon	08/08/2005	14
2	25/07/2005	Alcyon	28/07/2005	3
3	25/07/2005	Alcyon	12/08/2005	18
4	lost	Alcyon		
5	17/08/2005	Dirty Rock	22/08/2005	5
6	25/07/2005	Alcyon		
7	25/07/2005	Alcyon	02/08/2005	8
8	25/07/2005	Alcyon	22/08/2005	28
9	01/09/2005	Manuelita	16/09/2005	15
10	28/09/2005	Manuelita	20/10/2005	22

Results. Two tags were lost under different circumstances (4 and 6). The eight other tags provided information for periods ranging from 3 to 28 days. Five sharks were successfully tagged at Bajo Alcyon on July 25, one shark was tagged at Roca Sucia on August 17, and two were tagged near Isla Manuelita, on September 9 and 28. All eight sharks were recorded at either of the receiver sites (Roca Sucia or Bajo Alcyon) one or two days after tagging date. In general, the sharks presence is first recorded in the morning, from 7:00 am to 8:00 am, each shark staying within range of the VR2 for a period of time ranging from 15 minutes to five hours (receiver hits at least every 3 minutes), a time lapse which will be referred to as a "session" in a particular site. In some cases, sharks may return during the afternoon for a second session which may also last for a period of time ranging from 15 minutes to 5 hours. When afternoon sessions occur, sharks tend to leave range of the VR2s by 4:00 or 5:00 pm, although one shark (7) tended to show up late in the afternoon, 5:30 – 6:00 pm, and didn't leave range until 7:30 - 8:00 pm. The five sharks tagged at Bajo Alcyon didn't report acoustic transmissions at Roca Sucia, nor did the Roca Sucia tagged shark report acoustic transmissions at Bajo Alcyon. However, the two Manuelita tagged sharks did demonstrate more mobility. One of them (10) was recorded at Roca Sucia during 4 different sessions in a 22 day period. The other shark (9) was recorded the day after tagging at Bajo Alcyon, where its presence was recorded during two consecutive sessions in two days. After a period of 6 days without records, the shark was recorded at

Roca Sucia during 4 sessions in a period of 8 days. The day after the last record in Roca Sucia, the shark was recorded at Bajo Alcyon during 4 sessions in 7 days.

Discussion. VEMCO V16 Coded Multi-Purpose Transmitters and VR2 Automated Receivers are effective for studying movements of hammerhead sharks in the waters surrounding Cocos Island. Tagged sharks were recorded within one or two days at VR2 Receiver sites, indicating the stress of the procedure is minimal. Tagged sharks move about the different schooling sites, yet more information is needed to determine if these movements are independent or not from the schooling group. Scalloped hammerhead sharks tagged in Cocos Island exhibit the same uniform behavior of scalloped hammerhead sharks tagged in El Bajo Espíritu Santo, Gulf of California, Mexico, where sharks make their appearance at schooling sites during hours of the morning between 6:00 and 8:00 pm and leave between 4:00 and 7:00 pm (Klimley et al, 2005). At the moment, the fate of all 8 tagged sharks is uncertain. The sharks may be out of range of the VR2s yet still within the waters of Cocos Island, or they may have migrated to other oceanic islands where scalloped hammerhead schooling behavior occurs. A next expedition is planned to Cocos Island in July of 2006, to tag 20 more sharks, deploy two more receivers around the Island. Data from the VR2s will also be downloaded at this time to determine whether the sharks tagged from the previous year are still in the area. Night time movements of sharks will be tracked with a VR 100 Manual Tracking Acoustic Receiver and a VH 110 directional hydrophone, crucial information to justify the expansion of the no take zone beyond 12 miles, as the sharks of Bajo Espíritu Santo travel distances of up to 20 km from their schooling sites to feed on squid in deeper waters (Klimley et al, 2005). Furthermore, close contact has been established with researchers in Malpelo Island (Colombia), who will initiate a tagging project with scalloped hammerhead sharks using similar technology, so as to guarantee an efficient exchange of information if any sharks overlap the study sites.

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