Program Overview - SEFSC SFD HMS Electronic Archival Tagging Program

Program Objectives and Achievements

The SEFSC's highly migratory species electronic tagging program enables the acquisition of high resolution data on habitat preferences, movements and other behaviors, as well as post-release mortality; such data could not be obtained by other means such as conventional tagging or the examination of fishery-dependent data. This is accomplished through the use of pop-up satellite archival tags (PSATs) which record ambient environmental data (pressure - *used to estimate depth,* temperature, and light levels - *used to estimate local noon and thereby estimate geolocation*) at an adjustable sampling interval ranging from 10-60 seconds. At the end of a programmed length of time, or after detaching prematurely, each PSAT floats to the surface and transmits the acquired data in summary form to the Advanced Research and Global Observation Satellite (ARGOS) system. If the tag is physically recovered, the complete, high resolution data set can be retrieved and the tag refurbished for redeployment.

The SEFSC has used such advanced tagging technology since 1996, most recently using Wildlife Computers Mk-10 PAT tags. The data acquired can improve stock assessments; for example, by helping to define stock structure and exchange rates, improving the interpretation of fishery trends and catch rate series by characterizing how movements and habitat preferences can affect catchability, enabling estimates of post-release mortality, and providing critical parameters for the integration of other ecosystem considerations. The SEFSC has been able to obtain data on a variety of topics, such as vertical and horizontal movements and how they vary overthe course of a day, temperature and depth preferences, habitat utilization, migration routes, localized and ocean scale behavior (both long term and short term monitoring) for the following target species: Blue marlin, white marlin, sailfish, swordfish, bluefin tuna, and yellowfin tuna. The acquired data have also been used to evaluate potential exposures of tuna to Deep Water Horizon (DWH) related contaminants and the potential effectiveness of fishery closures in mitigating public risk, post-release survival, issues of stock structure, behavioral issues relative to adjustment to tagging, diving speeds, transboundary movements among numerous countries, insights into feeding behavior based on diving activity, and potential impacts on pelagic predators from expanding oxygen minimum zones (OMZs), including a progressive increase in catchability of these predators over time due to OMZ based habitat compression to the surface mixed layer. These basic topics are reflected in numerous peer-reviewed papers (see **Appendix 1**).

Approaches to Tag Deployment

Although currently there are funded research projects to estimate the post-release survival rate of bluefin tuna captured on longline gear in the Gulf of Mexico, and (in response to DWH) to characterize yellowfin tuna distribution and movements in the Gulf of Mexico, there has been no ongoing, dedicated funding for PSAT acquisition and deployment. Due to the expensive cost of electronic tags, as well as difficulty to obtain platform vessels for deployment of the tags, the SEFSC developed collaborations with multiple entities, thereby establishing the "Adopt A Billfish" Program in 2002. Major collaborators within the Adopt-a-Billfish Program include: The Billfish Foundation; Presidential Challenge of billfish tournaments in central America; the

University of Miami's Rosenstiel School of Marine and Atmospheric Science, Bermuda Department of Fisheries, and the International Gamefish Association, The program was approved by NOAA Counsel and has been the backbone for funding the acquisition of tags and arranging tagging platforms for deployments of over 250 PSATs on billfish to date (98 sailfish, 80 blue marlin, 49 white marlin, 2 black marlin, 2 longbill spearfish, 1 roundscale spearfish, and 23 swordfish), with SEFSC SFD HMS Branch staff conducting the deployments, data acquisition and analysis. Unfortunately, there is no such program to support the ongoing acquisition and deployment of tags by the SEFSC on other HMS, such as tunas.

The HMS Branch has developed various PSAT tagging protocols, such as in water tagging procedures at boat-side and procedures for transferring fish from catching vessels to tagging vessels, and is continually improving on designs of tethers and biologically compatible tag anchors These are documented in peer review papers (see **Appendix 1**) and further detailed in **Appendices 2-4**.

Data acquisition, processing and quality control

Pop-up satellite archival tag technology has proven an effective fishery independent method for monitoring movement and habitat use by large pelagic fishes. Our program has used Wildlife Computers Pop-up archival transmitting (PAT) tags which record ambient environmental data (pressure (depth), temperature, and irradiance used to estimate geolocation) at an adjustable sampling interval ranging from 10-60 seconds. While the tag archives each data record and can be accessed if the tag is physically recovered, battery constraints require that the satellite transmitted data be compressed into user defined summations ranging from 1-24 hours. On a user defined date, the tag detaches from the fish, floats to the surface and begins transmitting the data summations via the ARGOS satellite system. The raw data is downloaded from the ARGOS data website (http://www.ARGOS-system.org/) and is processed using Wildlife Computers Data Analysis Programs (WC-DAP) software. WC-DAP outputs several useful files for determining habitat utilization. Time at depth (TAD) and time at temperature (TAT) provide the percentage of time spent in 14 predefined user bins for each summarized histogram. WC-DAP also generates a "pressure-depth-temperature" (PDT) file which provides summary data in which the depths and temperatures encountered by the tag are split into eight approximately equally-sized bins, as well as providing minimum and maximum depth and temperature for each 8-hr binning period.

Wildlife Computers Global Position Estimator (WC-GPE2) software is used to process the light level data to create daily geolocation estimates. Aqua-MOdIS sea surface temperature (SST) data are obtained from NASA (http://oceancolor.gsfc.nasa.gov/cgi/level3.pl) and a SST-corrected Kalman filter is then applied to the light-level-derived locations to improve geolocation estimates. Filtered tracks are then plotted using ArcGIS 10 and are overlaid on various layers of remotely sensed environmental data including Dissolved oxygen, SST, currents, and chlorophyll concentration. The Wildlife Computers software also generates a file that is compatible with IGOR Pro, which is a visualization software package capable of generating interpolated depth and temperature figures.

While the transmitted data is valuable, physically recovered tags have the entire archive of all collected data. The recovered tag data has a high enough resolution to calculate dive speeds and identify spawning and feeding behaviors. Because the data archived on these tags is so valuable we offer a $500 reward for the recovery of these tags to ensure a 100% reporting rate. In addition to the archived data, the recovered tags can be rebuilt and reused for a substantially

lower cost, saving $2,700 over the cost of purchasing a new tag.

The majority of our tag recoveries have been found washed up on shorelines, but we have also had success in proactively recovering finding tags on shore or which were still floating on the sea surface. When possible, we have gone out with a directional receiver to aid in the location and recovery of tags. In multiple instances where we could not travel to the tag vicinity ourselves, we successfully guided scientists or fisherman to the tag using ARGOS location messages. To date we have recovered 46 tags from 6 different species (16 yellowfin tuna, 10 sailfish, 8 bluefin tuna, 7 blue marlin, 3 white marlin, 2 swordfish), providing data on temperature, depth and light levels recorded as frequently as every 10 seconds for the duration of the deployment.

Appendix 1

Selected peer reviewed papers using data acquired through the program*:

* NOTE: SEFSC SFD HMS Branch scientists have collaborated on multiple other publications, not listed here, using data acquired though other programs.

[1] LERNER, J.D., D.W. Kerstetter, E. D. Prince, L. McManus, E. Orbesen, A. Mariano, D. Snodgrass, and G.L. Thomas. 2013. Swordfish, *Xiphias gladius,* vertical distribution and habitat use in relation to diel and lunar cycles in the western North Atlantic. *Transactions of the American Fisheries Society*. 142:1, 95-104.

[2] STRAMMA, L. *, PRINCE, E.D.,* [+], SCHMIDTKO, S.*, J. Juo, J. P. Hoolihan, M. Vesbeck, D. W.R. Wallace, P. Brandt, and A. Kortzinger. 2012. Expansion of oxygen minimum zones may reduce valuable habitat for tropical pelagic fishes. *Nature Climate Change*, 2:1, 33-

[3] DEWAR, H., E.D. Prince, M. K. Musyl, R.W. Brill, C. Sepulveda, J. Lou, D. Foley, E. S. Orbesen, M. L. Domeier, N. N.-Lucas, D. Snodgrass, R. M. Laurs, B. A. Block and L. M. McNaughton. 2011. Movements and Behaviors of swordfish in the Atlantic and Pacific Oceans examined using pop-up satellite tags. *Fisheries Oceanography.* 20:3, 219-241.

[4] HOOLIHAN, J. P., J. Luo, S.E. Campana, J. Fransisco, A. Crespo, G. De Metrio, H. Dewar, M. L. Domeier, L. Howey, M. E. Lutcavage, M. K. Musyl, J. D. Nielson, E. S. Orbesen, E. D. Prince, and J. R. Rooker. 2011. Evaluating irregular post-release behavior of large pelagic fishes deployed with pop-up satellite archival tags. *ICES J. Mar. Sci*. 68:5, 880-889.

[5] HOOLIHAN, J. P., J. Lou, C.P. Goodyear, E. S. Orbesen, and E.D. Prince. 2011. Vertical habitat use of sailfish (*Istiophorus platypterus*) in the Atlantic and eastern Pacific, derived from pop-up satellite archival tag data. *Fisheries Oceanography.* 20:3, 192-205.

[6] PRINCE, E. D., J. Lou, C. P. Goodyear, J. P. Hoolihan, D. Snodgrass, E. S. Orbesen, J. E. Serafy, M. Ortiz, and M. J. Schirripa. 2010. Ocean scale hypoxia-based habitat compression of Atlantic istiophorid billfishes. *Fisheries Oceanography*. 19:6, 448–462.

[7] KERSTETTER, D. W., E. S. Orbesen, D. Snodgrass, and E. D. Prince. 2010. Movements and habitat utilization of two longbill spearfish *Tetrapturus pfluegeri* in the eastern tropical South Atlantic Ocean. *Bulletin of. Marine Science*. 85(2): 173-182.

[8] HOOLIHAN, J.P., J. Luo, D.E. Richardson, D. Snodgrass, E.S. Orbesen, and E.D. Prince. 2009. Vertical movement rate estimates for Atlantic istiophorid billfishes from high resolution pop-up satellite archival data. *Bulletin of Marine Science*. 84:257-264.

[9] RICHARDSON, D.E., R. K. Cowen, E. D. Prince, and S. Sponaugle. 2009. Importance of the Straits of Florida spawning ground to Atlantic sailfish (*Istiophorus platypterus*) and blue marlin (*Makaira nigricans*). *Fisheries Oceanography*. 18(6): 402-418.

[11] GOODYEAR, C.P., J. Luo, E.D. Prince*, J. P. Hoolihan, D. Snodgrass, E. S. Orbesen, J. E. Serafy. 2008. Vertical habitat use of Atlantic blue marlin *Makaira nigricans*: interaction with pelagic longline gear. *Marine Ecology Progress Series*. 365: 233-245.

[12] KERSTETTER, D. W., P.H. Rice, D. Snodgrass and E. D. Prince. 2008. Behavior of an escolar *Lepiodocybium flavobrunneum* in the Windward Passage as determined by pop-up satellite archival tagging. *Gulf and Caribbean Research*. 20: 97-102.

[13] PRINCE, E. D. and C. P. Goodyear. 2007. Consequences of ocean scale hypoxia constrained habitat for tropical pelagic fishes. *Gulf and Caribbean Research*. 19(2): 17-20.

[16] PRINCE, E. D., D. B. Holts, D. G. Snodgrass, E. S. Orbesen, J. Luo, J. E. Serafy, and M. L. Domeier. 2006. Transboundary movement by sailfish (*Istiophorus platypterus*) off the Pacific side of Central America. *Bulletin of Marine Science.* 79(3): 827-838.

[17] PRINCE, E. D., and C. P. Goodyear. 2006. Hypoxia-based habitat compression of tropical pelagic fishes. *Fisheries Oceanography*. 15(6): 451-464.

[18] LUO, Jiangang, E. D. Prince, C. P. Goodyear, B. E. Luckhurst, and J. E. Serafy. 2006. Vertical habitat utilization by large pelagic animals: A quantitative framework and numerical method for use with pop-up satellite tag data. *Fisheries Oceanography*. 15(3): 208-229.

[19] PRINCE, E. D., R. K. Cowen, E. S. Orbesen, S. A. Luthy, J. K. Llopiz, D. E. Richardson, and J. E. Serafy. 2005. Movements and spawning of white marlin (*Tetrapturus albidus*) and blue marlin (*Makaira nigricans*) off Punta Cana, Dominican Republic. *Fishery Bulletin*.103: 659-669.

[20] KERSTETTER, D. W., B. E. Luckhurst, E. D. Prince, and J. E. Graves. 2003. Use of pop-up satellite archival tags to demonstrate survival of blue marlin (*Makaira nigricans*) released from pelagic longline gear. *Fishery Bulletin*, 101:939-948.

[22] GRAVES, J. P., B. E. Luckhurst, and E. D. Prince. 2002. An evaluation of pop-up satellite tags to estimate post-release survival of blue marlin (*Makaira nigricans*). *Fishery Bulletin*, 100(1): 134-142.

Appendix 2

General Pop-Up Satellite Archival Tagging Protocols

PSAT TAGGING OBJECTIVE:

To tag as safely as possible while maximizing the effectiveness of the PSAT attachment system through teamwork and good communication.

PREPARATION FOR TAGGING

1. Before leaving the hotel room, verify that you have the tags to be deployed that day, datasheets, tagging tools and emergency equipment. Each tag tube should contain; the PSAT, the PS (conventional) tag with release card and a sealed baggy with a sponge for slime collection and a latex glove to limit contamination during slime capture.
2. On the trip out to the fishing grounds you should make preparations for tagging as well as brief the crew on what is expected of them. ALWAYS handle the tag poles with the utmost of care to eliminate damage to vessel both in the cockpit as well as the interior. Most vessels have very expensive upholstery and such so, puncturing or tearing any of it could cause ill will and affect future tagging opportunities. Start by sliding the cover to extend the stainless steel (SS) applicator pin for the PSAT pole to the appropriate length of the target fish size you most likely will encounter and insert the SS pin for the conventional tagging pole. Use an alcohol wipe to clean the SS applicator tips and place a cork or some sort of protection over the point to limit boat damage.
3. Use alcohol rinse, spray or wipe to clean the PSAT harness where it will be inside the fish's body. Verify that the PSAT is not running. Place a rubber band on the pole for securing the tag itself after turning it on. Store all of the tagging equipment (PAT pole, PS pole (with tag), hook pole, Snooter, measuring tape, sponge/glove) together inside the cabin or other similarly safe location (do not leave in the sun as overheating may cause the PSAT to malfunction). Place the PSAT inside a bubble-wrap bag and place in a secure location for easy access. The PSAT harness has been cleaned with a surgical grade cleanser to remove oils and other foreign materials acquired during rigging. Handle the tag as little as possible to limit further contamination.
4. Prepare the rod for towing fish in the resuscitation procedure and have a nylon cord ready for attachment to the bill for resuscitation if it cannot be done with the snooter.
5. Do a dry run of the entire handling and tagging procedure with the captain and crew before starting to fish. Each person in the cockpit should have an assigned task. Priorities for the trip should be well understood by everyone before the boat leaves the dock. Good communication and teamwork on the boat will help ensure successful tagging. For example, a video crew trying to film the tagging procedure may hinder the process by displacing members of the crew from their required positions in the cockpit.

6. Use fishing gear which is heavy enough to put significant "pressure" on the target billfish to reduce fighting time. If possible use 130 lb test gear for blues and 50 lb test gear for whites and sailfish. The use of lighter tackle will likely require a longer fighting time and may subject the fish to greater physiological stress. If the objective of the tagging is to evaluate post-release survival then the gear and fishing techniques in use in the target fishery should be duplicated as much as possible. However, as stipulated by Goodyear (2002), steps should be made to minimize tagging mortality and to evaluate each type of fishing technique.

TAGGING PROCEDURE

1. **Good communication** between the wireman, captain and tagger are essential to coordinate the roles of each person in the tagging procedure. Everyone should check the fish for visible injuries (i.e. wounds and bleeding) when the fish comes close to the vessel. The Captain should **steer the vessel in a straight line** going down sea or alternatively going directly into a head sea **at about 1-2 knots**. Any faster will cause a significant drag on the fish, wireman and snooter. Any slower than 1-2 knots will cause the fish's tail to sink and the head to come out of water. This will likely cause the fish to panic (due to lack of water flowing over the gills) and will probably create a struggle for the person holding the snooter. The vessel should be moving forward at all times as billfish are ram-ventilators and need water passing over their gills to get sufficient oxygen. Steering the boat in a straight line will help prevent the billfish from either slamming up against the vessel (thus increasing the chance of breaking the PSAT tag) or drifting away from the side of the vessel which would make tagging more difficult. Alternatively, the captain can steer the boat in a very wide circle to the side of the boat that the fish is on (i.e. wide circle to port if the fish is on the port side). This will move the fish away from the boat and is particularly helpful in keeping the tag, once deployed in the fish, from banging against the side of the boat. When the fish has been brought to the boat, the wireman wires the fish and then determines if the fish is ready to snooter. This is done by considering how long the fish has been fought, if the fish has been actively jumping and expending energy, and examining the fishes color at boatside (is the fish still "lite up). The final **litmus test** to see if the fish is calm enough to snooter is to have the crew touch the bill. If fish is too "green" and struggles significantly, wireman should let go of bill, dump the leader, and the angler should remain in the chair and continue fighting fish until it is calm at boat side.

When feasible, the snooter should be used on every fish, first for safety reasons and also to ensure accurate tag placement and to prevent the tag from being damaged against the hull. In addition, a billfish already snootered can be sampled for muscle tissue (sex determination) and resuscitation can proceed without any handling procedures.

When the bill is grabbed and the fish appears to be under control, attempt to snooter the fish. Wireman can assist in the snootering process by holding the loop of the snooter open and then helping put the loop of snooter over bill and then slide loop along the upper bill until just

anterior of nares. Be careful not to wire lower jaw closed with snooter, as mouth needs to be left open to ventilate gills. The person handling the snooter then pulls the snooter tight on the wire, at the same time holding onto the pvc tube. It is critical to apply pressure by pushing down on the pole thus keeping the head and particularly the bill in the water. The snooter is then passed to crewman to hold during the entire tagging process. If enough crew are available on the vessel, it is best to have a crewman hold the snooter during the entire tagging process because this will prevent inadvertent release of the tension on the snooter. This allows the crewman to focus on keeping the head of the billfish submerged. Once trained, the same crew member should be in charge of holding the snooter on successive fish (this will prevent problems with excessive struggling by the fish).

It is particularly important for the snooter to be deployed at a 90 degree angle to the side of the vessel. This way the snooter **acts as a buffer between the vessel and the fish**, thus helping to protect the PSAT once it is inserted into the fish. In addition, the crewman holding the snooter can bring the fish within range to facilitate the wireman grabbing the tallest dorsal spine to expose the dorsal musculature for tagging. Alternatively, a 3-4 foot long boathook can be used on vessels with a high freeboard (i.e. more than 3 ft. to the water) to lift the dorsal spines up to expose the target area for precise tag placement.

2. After the fish is secured with the snooter, the tagger is handed the tagging pole with PSAT. **Tagger places tagging needle tip on the target area with tag head three inches down from base of dorsal fin under the sixth or seventh dorsal spine.** The tag anchor is inserted into the fish with a **short**, **sharp jab** while the fish's head is maintained submerged during the tagging process. The insertion should be all the way to the stopper on the tagging pole. On billfish less than 50 lbs, we use a 4 inch stainless steel applicator. Longer applicators (up to 12-15 inches) can be used on larger billfish. Angle of entry should be such that the tag anchor does not go through to the other side of the fish. The goal is to have the tagging anchor pass between the pterygiophores and connective tissue to hold the tag securely in place. Always try to insert tag when the flank is exposed out of water for better placement, as there is distortion when attempting to tag a submerged fish. **Remember – marlin/sailfish are fast-swimming fishes which free-jump out of the water as part of their normal behavior, for this reason good tag placement and anchoring is critical.**

3. After PSAT is inserted, conventional (spaghetti) tag should be inserted toward the posterior end of the body (high on the flank, well above the lateral line) such that the end of the PSAT antenna does not touch the anterior part of the conventional tag. A boat hook can be very useful to fend off the fish and to prevent it from banging against the hull.

4. After the conventional tag is in place, the muscle plug pole spear is given to the tagger. The muscle plug should only be taken when the flank of the fish is out of the water. The plug should be taken well above the lateral line back toward caudal fin of the fish, away from the PSAT tag and conventional tag. Thus, one of the best places to take muscle tissue is on the opposite side from the PSAT and conventional tags. Make sure that the muscle sampler hits flush on a flat portion of the dorsal musculature instead of a curved portion. This will help ensure the collection of a better muscle plug.

5. The last element in this procedure is to remove the hook(s). Do not keep the head out of water for any lengthy period to remove the hooks. If possible, use a large scale de-hooker to remove hooks. If hooks cannot readily be removed without injuring fish, cut the leader at the hook-eye or as close as possible. Note the appearance of any blood while removing hooks.

RESUSCITATION

After tagging procedure is complete, the condition of the fish must be evaluated to determine if resuscitation is needed. Smaller fish (up to 200 lbs) can generally be resuscitated using the snooter.

Larger fish may need to be towed using the towing rod-reel already prepared (although, if sufficiently exhausted, it may be possible to successfully snooter even an extremely large fish; in fact, this may be the best way to resuscitate a large fish that is very tired). Attach **nylon multi-strand line** to the bill and tie double loop knot around the bill (do not use polypropylene rope as it will slip). Slowly let the marlin back about 75 feet behind the boat while attached to the towing rod. The angel of the line will decrease as the fish regains his senses—usually 20-30 minutes. In fact, in many cases the angle of the leader will be almost in the props, thus indicating the fish is ready to be released. Evaluate condition of fish to assess recovery (behavior, color). When fish exhibits normal orientation and swimming behavior, reel fish back to boat and remove line from bill. Note duration of resuscitation at time of release.

SHARK DISTRACTION TECHNIQUES

In some locations, sharks can be a problem while PSAT tagging billfish. St. Thomas, USVI, and Cairns, Australia, are examples of two such locations. Diversionary tactics can be very useful in distracting the sharks, so that tagging can be completed without interaction with these predators. One method is to pre-rig floats with wire leaders, multiple hooks and baits (e.g. whole mackerel). When a shark is first sighted near the boat, this rig can be thrown overboard where the sharks have been seen. The focus then changes from the marlin at boat-side to the baits in the water and this increases the likelihood of the billfish surviving the tagging event. If sharks remain in the vicinity during resuscitation,this procedure should be extended in duration to move the release location further away from the sharks and allow the tagged marlin to regain full strength for normal swimming behavior.

bleeding and location of bleeding), and behavior of fish (swimming strongly, sinking in water column, actively swam away, belly up, etc).

WHY SNOOTER?

(1) **Safety** -- If properly used, a snooter can minimize the likelihood of a billfish injuring a member of the crew, causing damage to the vessel, as well as prevent the billfish from injuring itself against the boat;

(2) Snooters provide a method to **maintain control** of the billfish at boat-side, even with vessels that have a high free-board. If properly used, a snooter can provide a means to control the billfish while it is along side the boat, thus allowing precise placement of the PSAT tag while the head is held underwater during the tagging process. It also allows the billfish to be manipulated vertically during the tagging process, which is helpful to expose the target area for tag placement and to aid the crew in dislodging the hook;

(3) Provides a method to **prevent** the billfish, once equipped with a PSAT, from **slamming the tag against the side of the boat**, thus disabling the PSAT tag (i.e. acts as a buffer between fish and boat),. Also, **provides a means of fish control for resuscitation after the tagging event is finished**.

2. Note time, position of release (GPS – lat/long), location of hook, injuries to the fish (i.e.

On-Board Tagging Procedures for Tunas (<175 lb):

Preparations for Catch Period/Haulback:

The whole tagging scenario should be discussed with the cockpit or deck crew and tasks assigned to those willing and confident to participate. When it is considered safe, a practice session with similar species or unhealthy target species should be conducted in various sea conditions to gain confidence with all aspects of the process, even including release.
One of each tag programmed for different deployment durations should be kept in a zip-loc type bag big enough to afford ample room for the tag and its antenna. These bags should be kept in a safe location that is easily accessible as the fish is being handled on deck. A bottle of 70% Ethyl alcohol with small holes poked in the seal should be kept with the tags in order to rinse the anchor and applicator prior to attachment to the target animal. Get permission from the captain to place a magnet on something metal that is accessible and secure. Depending on the deck type it might be worthwhile to have knee protection available to those who care to use it. It is also a good idea to tuck the PFD handle inside the vest or change the T-shaped handle to a ball so that it doesn't snag in the net.

The beanbag and net (with no handle connected) should be kept in a secure location that is accessible but out of the way enough to not interfere with fishing operations when not needed. The tagging stick should be stowed in a safe location so that there is NO possibility of being impaled by the applicator tip. The tag stick should have 3-5 short, heavy rubber bands in case the one in use breaks during tagging process. When a fish on the leader has been identified as a probable tagging candidate the preparations on deck should be enacted. One of the team members should wear a watch to keep track of handling time on deck.

Tag Deployment:

1. Identification of a possible tag host.
2. Get the beanbag out into the area adjacent to the hull-side door but out of the way of the leader pile.
3. Get the landing net/cradle out and place it by the beanbag with the lifting lines untangled.
4. Select the proper tag and anchor setup for whatever sized fish is being landed and place it on the tagging stick.
5. Place the tagging stick and tag assembly where is can be easily accessed for magnet toggling to start the tag if the fish is determined to be a proper candidate for deployment.
6. Pull the saltwater washdown hose out onto the deck so that it can be easily maneuvered and not become entangled or kinked on fish or hardware on deck. The most important thing after getting the fish aboard is to insert the saltwater wash-down hose inside the fish's mouth ASAP and keep it in place at every turn as the fish is moved for deployment.
7. When the struggle by the leader handler has settled down the beanbag and net can be brought into the area directly adjacent to the hull-side door.
8. As the fish approaches the vessel attention needs to be paid as to when the next rotation will bring it close to the surface at the hull-side door.

care to have one line person on each lifting line. The rear lifting line should be left somewhat limp to facilitate with drawing the fish into the net. The net handler should keep hold of the net frame as well as the front lifting line. If enough people area available then one more person can handle the front lifting line.

10. Depending on sea condition the lifting team needs to work in unison to lift the fish safely into the boat.

11. The fish should be placed immediately onto the beanbag at the same time as the hose being placed at the head. Allow the hose to create a pool of water so that there is ample contact with the fish's head and gills while the mouth is being opened.

12. Observe the overall condition/health of the fish in order to determine whether it should be used to carry a tag.

13. A wet cloth (t-shirt) should be placed over the eyes as soon as possible.

14. As soon as the mouth has been opened the hose should be inserted so that both gill arches get ample coverage. If using a small diameter hose then rotate from side to side but with a large diameter hose it just needs to be verified that all gill filaments are being sufficiently irrigated. This should be done for at least 4 minutes after the fish is brought aboard to resuscitate the fish.

15. There is no need to rush getting the fish back into the water as long as the hose is watering the gills. This should all take a matter of 20-30 seconds.

16. Get the magnet and activate the tag with the toggle switch/"Reset" location. Wait 30 seconds or so and then swipe the toggle again to verify that the tag is in "Deploy" mode. Verify the tag number being used.

17. The leader can be cut at this time to allow the hook to be removed in the reverse direction in order to cause less damage. Either a straight-line or curved length can be measured at this point.

18. After verifying that the tag is turned on then determine what length of applicator should be used to insert the anchor just past the dorsal midline.

19. Insert the tag from the rear direction just below the base of the second dorsal fin. Make sure that the tag is not allowed to drop hard to the deck or get overly tangled in the net.

20. After ample time has passed for adequate resuscitation then the whole assembly should be rotated so that the head is facing toward the hull-side door taking care to not damage the tag and keeping the hose inserted in the mouth.

21. Make sure that all of the fins, the nose and the tag are not tangled up in the net's mesh. The tag should be held up at this point to make sure that it does not get tangled.

22. When the fish has been determined to be ready for release then a coordinated effort to remove the eye cover and hose, cradle the tag, and shove the fish overboard needs to be accomplished with great care and speed.

23. Make note of the geo-location, time, date, tag number, size (type and increment), handling time and any notes that stand out from the handling procedure.

9. When the fish is at or near the water's surface the net should be lowered into the water taking

Boatside Tagging Procedures for Yellowfin Tunas:

OVERVIEW of Preparations for Catch Period/Haulback:

The whole tagging scenario should be discussed with the captain and deck crew on a few occasions prior to the period of time when a potential candidate is at boatside. When appropriate some tasks can be assigned to those willing and confident enough to participate. When it is considered safe, a practice session with similar species or unhealthy target species should be conducted in various sea conditions to gain confidence with all aspects of the process, even including release. For example, when a shark-bitten tuna is on the leader it can be used to practice tag insertion while in the water. In this situation the carcass can then be brought aboard and be dissected to inspect the anchor effects to give the tagger more confidence in the process.
Each vessel crew is going to be different even on a day to day basis and whether the captain or vessel owner is on deck. Some vessels(ie. Leo B) may only allow easy access to one region of the boatside where tagging can take place. In order to limit the possible loss of harvestable animals that are being handle for tagging some allowance needs to be made to permit gaffing in some locations when permissible. This will limit the number of candidates for deploying the tag but in the long run it is more important to keep the crew happy, especially on slow fishing trips. When a better situation arises then you will receive better cooperation from the crew when you show that you recognize their needs as well.
One of each tag programmed for different deployment durations should be kept in a zip-loc type bag big enough to afford ample room for the tag and its antenna in the red protective sheath. These bags should be kept in a safe location that is easily accessible since some of the target animals come up suddenly, sometimes. A rinse bottle of 70% Ethyl alcohol should be kept with the tags in order to rinse the anchor and applicator prior to attachment to the target animal. Get permission from the captain to place a magnet on something metal that is accessible and secure. This magnet is only to be used to change the mode of the tag as per the instructions included in the paperwork with the tag deployment field data sheets.

The tag stick should be kept in a secure location that is accessible but out of the way enough to not interfere with fishing operations when not needed. The tagging stick should be stowed in a safe location so that there is NO possibility of anyone or anything being impaled by the applicator tip. The tag stick should have 3-5 short, heavy rubber bands in case the one in use breaks during tagging process. When a fish on the leader has been identified as a probable tagging candidate the preparations on deck should be enacted. One of the team members should wear a watch to keep track of catch and release times.

ALWAYS remember that you need to consider the sea and weather conditions before attempting to tag on any given day. When it is too rough, windy or rainy it might be best to err on the side of caution and forego tagging attempts for that day. The safety of the crew AND the fish are too important to risk injury or damage.

Appendix 4

TAG DEPLOYMENT:

1. An appropriate animal to carry a tag is identified.
2. Select the proper tag and anchor setup for whatever sized fish is being landed and place it on the tagging stick.
3. Place the tagging stick and tag assembly where is can be easily accessed if the fish is determined to be a proper candidate for deployment.
4. As the fish approaches the vessel attention needs to be paid as to when the next rotation will bring it close to the surface at the accessible tagging regions of the vessel. This will give you a feel for when you will have the best opportunity for tag insertion.
5. When the fish is at or near the water's surface the appropriate tag should be on the tag stick and in your hand but kept away from the leader or other lines that may be on deck.
6. Observe the overall condition/health of the fish and the location of the hook, with attention paid to damage the hook may have caused, in order to determine whether the fish should be used to carry a tag.
7. Insert the tag from the rear direction just below the base of the second dorsal fin with enough force to break the skin and push the anchor across the dorsal midline.
8. If possible the fish can be resuscitated for as long as possible or until it is determined to be ready for release.
9. Make note of the geo-location, time, date, tag number, size (type and increment), handling time and any notes that stand out from the handling and tagging procedure. No additional information is too little. Write it down if it seems pertinent. If it is determined to not be needed it can always be ignored but forgotten data cannot be accurately recalled.
10. If a tag is not used during a given haulback period then its status should be checked prior to storing the tag for the next opportunity. This is to prolong battery life in case a tag is accidentally turned on by an unknown source (magnet, water, pressure) while on deck.