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Liana N. Heberer[1, 2], James A. Wraith [3], Suzanne Kohin[3], Yuhong Gu[2, 4], Nicole Nasby-Lucas[1, 2], and Heidi Dewar[2]

[1] Institute of Marine Sciences, University of California Santa Cruz, 1156 High Street, Santa Cruz, CA 95064
[2] NOAA Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037
[3]Previous address: NOAA Southwest Fisheries Science Center, 8901 La Jolla Shores Drive, La Jolla, CA 92037
[4] Environmental Assessment Services, LLC, 350 Hills St. Ste. 112, Richland, WA 99354

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U.S. Department of Commerce
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Abstract

The Southwest Fisheries Science Center (SWFSC) Cooperative Billfish Tagging Program (CBTP) is a conventional mark-recapture research venture between National Oceanic and Atmospheric Administration (NOAA) scientists and the global recreational and commercial fishing community, with efforts focused in the Pacific Ocean. The CBTP has provided conventional analog tags to anglers around the world to tag billfish and other large pelagic species to collect distribution, abundance, movement, and morphometric data valuable in quantifying life history parameters used in management. The CBTP comprises the Billfish Tagging Program, the International Billfish Angler Survey, and outreach and reporting. All three components require year-round operations to distribute tagging equipment, deliver and receive surveys, and process, store, and manage data. This document details the technical aspects of the CBTP as it operates in 2021, including equipment acquisition, database structure, and operational design and execution. Given the CBTP protocols could serve as a template for current or future conventional mark-recapture programs, recommendations are also provided to improve upon current protocols. This document serves as the official reference for the program and provides detailed metadata for the historical dataset available to the public.

Introduction

The Cooperative Billfish Tagging Program (CBTP) is a conventional mark-recapture tagging program operating out of the National Oceanic and Atmospheric Administration (NOAA) Southwest Fisheries Science Center (SWFSC) in La Jolla, California. The CBTP was founded in 1963 at the U.S. Fish and Wildlife Service Pacific Marine Game Fish Research Center, Tiburon Marine Laboratory in California, as the Pacific extension of the Cooperative Game Fish Tagging Program at the Woods Hole Oceanographic Institute in Massachusetts. The Cooperative Game Fish Tagging Program was established in 1954 by Frank J. Mather III, who initiated the conventional tagging program on the idea that the large base of marine anglers already catching and releasing pelagic species on the U.S. East Coast would provide an effective, alternative way to tag more species for scientific research than would traditional fisheries-independent methods. The establishment of the CBTP on the Pacific Coast was assisted by the International Game Fish Association and the Department of Fisheries, Mexico (Squire 1974b, Squire and Nielsen, 1983). In 1969-1970, the Tiburon Laboratory and tagging program were transferred to the SWFSC La Jolla Laboratory, where it has remained since (Squire, 1974a).

The goal of the CBTP is to collect valuable life history data on billfish and other large pelagics by cooperating with the large existing global community already engaged in ethical catch-and-release fishing. The CBTP provides conventional tags to cooperative commercial anglers, fishing clubs, and recreational anglers who voluntarily tag and recapture billfish and report back the fishing and biological information. Paired tag release and tag recovery events provides insights in quantifying movements, distribution, and growth over the animal's time at liberty. If sufficient tags are returned, abundance information may be inferred. The CBTP also conducts an annual angler survey to quantify recreational fishing effort and catch around the world.

To date, the CBTP has tagged over 60,000 billfish, received over 600 tag recaptures, contributed to numerous scientific publications, and created one of the longest time series of recreational angler effort and catch in the Pacific Ocean. It is considered one of the world's prominent recreational conventional tagging programs among other government and for-profit programs such as the NMFS Cooperative Tagging Center (formerly the Cooperative Gamefish Tagging Program) in the Atlantic Ocean, the Australian Cooperative Tagging Program in the Pacific and Indian Oceans, the New Zealand Cooperative Game Fish Tagging Program in the Pacific Ocean, and The Billfish Foundation's (TBF) tagging program in the Atlantic, Pacific and Indian Oceans (Ortiz et al., 2003).

The CBTP has been a pillar in citizen science and recreational angler outreach for NOAA Fisheries, particularly for pelagic species that represent an economic asset, drive sportfishing tourism on the U.S. West Coast, and contribute to highly migratory species research across the Pacific. Many anglers have participated in the CBTP for more than 30 years, tagging hundreds of billfish in the name of conservation and research and passing the practice on to future generations. The major billfish species targeted by CBTP constituents are the Indo-Pacific blue marlin *(Makaira mazara),* striped marlin (*Kajikia audax*), Indo-Pacific sailfish (*Istiophorus platypterus*), black marlin (*Istiompax indica*), shortbill spearfish (*Tetrapturus angustirostris*), and broadbill swordfish (*Xiphias gladius).* The top three tagging areas are the main Hawaiian

Islands, Mexico, and Southern California, with dedicated captains and anglers in all locations tagging a variety of species nearly year-round.

The CBTP comprises three main components—the Billfish Tagging Program, the International Billfish Angler Survey, and outreach and reporting—with separate but related operations targeting the same angler audience. The CBTP collects two distinct datasets: 1) a tagging dataset through mark-recapture tagging operations of the Billfish Tagging Program, and 2) a recreational catch and effort index through the International Billfish Angler Survey. In the process of this data collection, the CBTP serves as a scientific outreach channel to the recreational billfish fishing community.

The most notable outreach product is the annual *Billfish Newsletter*, which summarizes annual tagging and survey results to participating constituents and the larger public. The *Billfish Newsletter* is a major outreach tool of the SWFSC, reaching thousands of community members in several different countries. The three components of the CBTP operate through various digital (email and website) and hardcopy (traditional mail) correspondence to domestic and international constituents throughout the calendar year. Operations between the three program components are somewhat fluid and have been handled by one or two dedicated staff since the inception of the CBTP. The bulk of effort is in manually processing tagging, recapture, and survey data to populate the Billfish Database.

This report describes the technical program operations and database of the CBTP as it currently operates in 2021 and serves as the official reference for the public dataset extending back to 1963. While some operations of the CBTP have changed since then, albeit minimal, this document is not intended to cover a historical review or results of the CBTP. Instead, the technical aspects of equipment acquisition, database structure, and operational design and execution are detailed. In the spirit of scientific collaboration, we hope this document also informs any future conventional mark-recapture research programs and we thus offer recommendations based on the lessons and challenges learned by the CBTP over nearly six decades in operation. Detailed analysis of results from 1963 to 2021 are being summarized by the SWFSC staff in a separate manuscript slated for publication.

1. The Billfish Database

As the most important underlying component of the CBTP, the Billfish Database houses the information from the Billfish Tagging Program (*see section 2*) and the International Billfish Angler Survey (*see Section 3*). Participating constituents understand that all information they submit on tag report cards, angler surveys, and tag recapture forms are voluntary and public data. The structure and function of the Billfish Database serves to streamline the raw data input process, establish essential data relationships, allow for efficient data querying and extraction, and enable security measures for protecting personally identifiable information (PII) of constituents.

1.1 Database structure

The Billfish Database is a Structure Query Language (SQL) based relational database housed at the SWFSC La Jolla laboratory. The database uses Open Database Connectivity (ODBC) to a Microsoft SQLServer Native Client Database Management System managed by the SWFSC Information and Technology Services. It is password protected and accessed by limited CBTP staff through frontend desktop interfaces. Data are normalized using primary keys (PK), attributes that contain non-null and unique values specific to a table. Each PK can be linked to tables which reference it, wherein it is labeled as a foreign key (FK). The use of PK and FK establishes relationships to reduce redundancy within tables while enforcing referential integrity of the joined data, so only values contained in the referenced tables are valid.

The logical design of the Billfish Database is centered on five independent but related entity sets: 1) Constituents, 2) Tags, 3) Tagged Billfish, 4) Recaptured Billfish, and 5) Billfish Catch and Effort from the Angler Survey (Figure 1). Tagged and Recaptured Billfish are separate entities given that tagging information may not be reported for fish that are later recaptured. The attributes of each set are related to attributes in other tables as illustrated in the Entity-Relationship diagram in Figure 1.

Constituents request Tags in a one-to-many entity relationship, meaning each distinct constituent can request many (including zero) distinct tags, but one distinct tag cannot be distributed to many anglers (Figure 1). Constituents also have a one-to-many relationship with Recaptured Billfish, Tagged Billfish, and Billfish Catch and Effort. Each distinct constituent can report many (including zero) distinct tagged billfish, many (including zero) distinct recaptured billfish, and many (including zero) angler survey data at distinct locations per year (Figure 1). Tagged Billfish have a one-to-one relationship with Recaptured Billfish, as tagged billfish can be associated with at the most one recaptured billfish, and vice versa. The occurrence of a billfish being recaptured twice (thus disobeying the one-to-one relationship) is significantly lower than the benefits gained by automatic flagging of duplication enforced by the one-to-one relationship. Recaptured billfish may also be associated with zero tagged billfish if the tag release information was never reported, and vice versa.

1.2 Table descriptions

Each entity set (Constituents, Tags, Tagged Billfish, Recaptured Billfish, and Billfish Catch and Effort) is organized into a single table composed of individual attributes. These five entity set tables (see Tables 1-5) are dynamic because they are continually populated with new data values. An additional nine tables are considered static "lookup" tables of unchanging reference for codified constituent, biological, and fishing information (see Tables 6-14). The codified PK of these lookup tables are referenced as FK in the dynamic tables as one-to-many relationships. A record in the dynamic table associates with only one attribute value in the lookup table while each attribute value in the lookup table may be associated with many records in the dynamic table. For example, the *gear_cd* attribute in the "releases" table can only reference one *gear_cd* attribute value in the "gear" table (e.g. rod and reel). However, this attribute value can be referenced by an infinite number of records in the "releases" table. Null values are allowed in the dynamic tables but non-null values must match an existing PK value in the lookup table. Data joins allow for missing values, as information for many released tags is never reported (e.g. *tag_id* in "recover" may not match to any *tag_id* in "releases" (Figure 1).

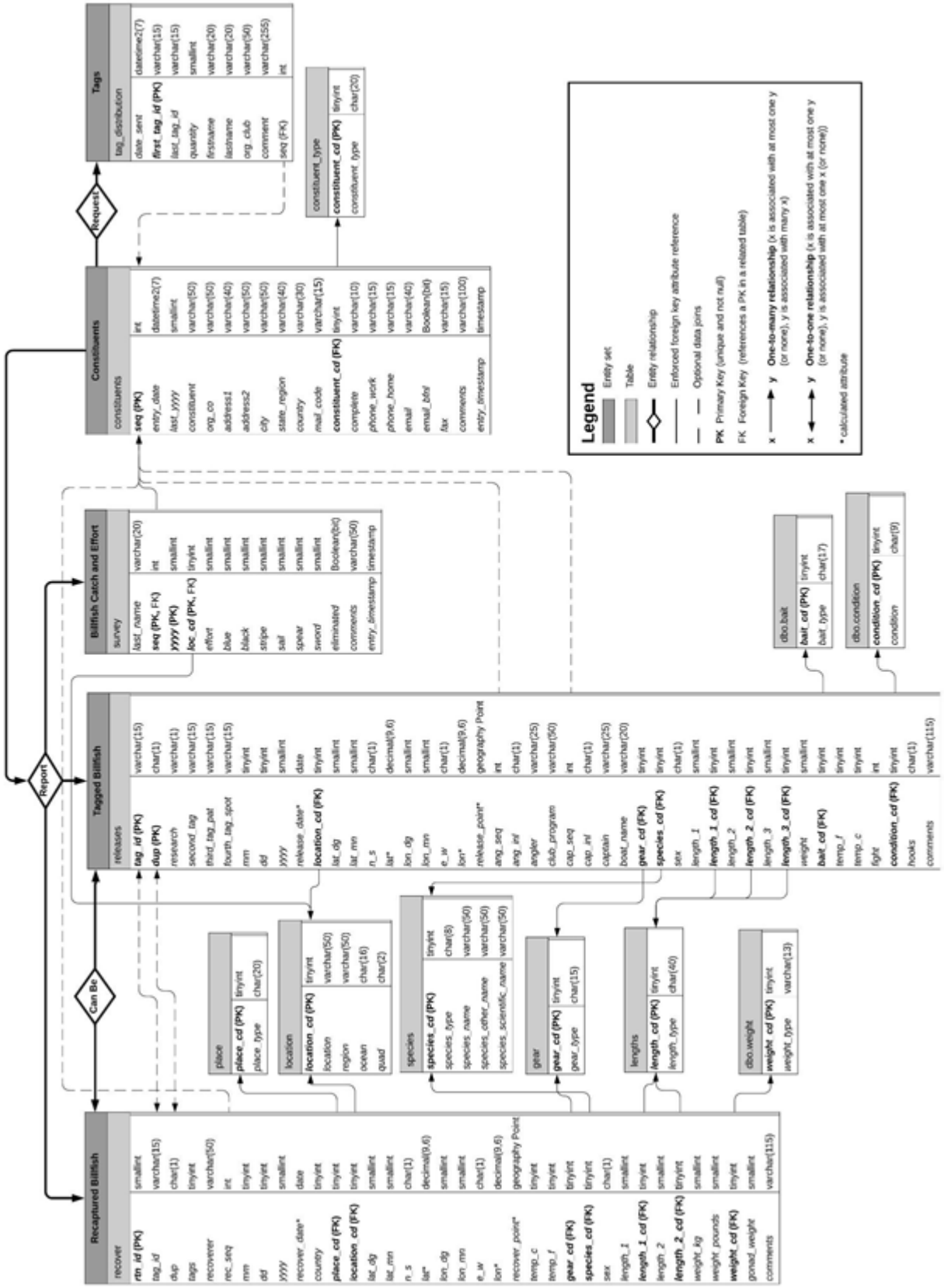


Figure 1. Entity-Relationship Diagram for the Billfish Database. Entity sets are related through the enforced attribute relationships and optional data joins between tables. Refer to Tables 1-14 for detailed descriptions of the tables listed here.

1.2.1 Dynamic tables

"constituents" table

The purpose of the "constituents" table is to create a unique profile for each CBTP constituent based on 20 attributes (Table 1). The PK, *seq*, is a unique numeric sequence representing a distinct constituent and is manually and sequentially assigned. The s*eq* PK is referenced as an FK in the "survey" table and joined to *ang_seq* and *cap_seq* in "releases", *rec_seq* in "recover", and *seq* in "tag_distribution" (Figure 1). A constituent's contact information is voluntarily provided from fields on tag report cards, with name and affiliation considered public information. Personally identifiable information (PII) of constituents is defined as the *constituent* attribute in combination with one or many of the following attributes: *address1, address2, city, state_region, country, mail_code, phone_work*, *phone_home*, *fax*, and/or *email*. This PII is not public information, necessitating password protection for the Billfish Database. The *comments* and *timestamp* attributes are for SWFSC staff purposes.

Table 1. Description of the "constituents" table in the Billfish Database, organizing Constituent attributes. *= personally identifiable information (PII).

Attribute	Data Type (length)	Allow Nulls	Description
seq (PK)	int	N	A unique numeric sequence representing each constituent.
entry_date	datetime2(7)	Y	The date (yyyy-mm-dd) and time (HH:MM:SS) the constituent is added to the database.
last_yyyy	smallint	N	The last year the constituent is active (tagging, reporting, general communications).
constituent	varchar(50)	N	The first and last name of the constituent.
org_co	varchar(50)	Y	The organization to which the constituent belongs, or Captain Of (C/O).
*address1**	varchar(40)	Y	The physical address of the constituent.
*address2**	varchar(50)	Y	The physical address of the constituent, continued.
*city**	varchar(50)	Y	The city of the constituent's physical address.
*state_region**	varchar(40)	Y	The state or region of the constituent's physical address.
*country**	varchar(30)	Y	The country of the constituent's physical address.
*mail_code**	varchar(15)	Y	The mail (zip) code of the constituent's physical address.
constituent_cd (FK)	tinyint	Y	Numeric code for constituent type (see "constituent_type" table).
complete	varchar(10)	N	If the physical address information is complete; N= No, Y= Yes.
*phone_work**	varchar(15)	Y	The constituent's work telephone number.
*phone_home**	varchar(15)	Y	The constituent's home telephone number.
*email**	varchar(40)	Y	The constituent's e-mail address.
email_bfnl	Boolean (bit)	N	Consent to mail Billfish Newsletter. 0= No, 1= Yes.
*fax**	varchar(15)	Y	The constituent's fax number.
comments	varchar(100)	Y	Any relevant comments.
entry_timestamp	timestamp	N	The computer system's timestamp of when data was entered.

"releases" table

The purpose of the "releases" table is to document the fishing and biological characteristics associated with each tag release, as reported on the tag report cards. The "releases" table contains individual columns for 45 attributes describing tag release (Table 2), eight of which are referenced as FK to lookup tables (Figure 1). The PK to identify tagged billfish is the *tag_id*, which is an alphanumeric value created by the concatenation of the alphanumeric tag identification printed on the body of the actual tag and the duplicate value (e.g. "A091324B"). In some instances the same tag number is reported as being deployed more than once, due to mistakes in tag acquisition and inventorying or if a fish is captured and re-released. To identify these instances, no duplicate is designated as "A", the first duplicate is designated as "B", and the second as "C" (e.g. "A091324B" or "A091324C"). The order in which the tags are input into the database typically determines which are labeled "A" versus "B". This *tag_id* PK is joined to the same attribute in the "recover" table, where it must be an exact match to indicate a mark-recapture event. When tags are deployed as a part of research, any additional tags on the billfish such as satellite tags are also indicated (*second_tag*, *third_tag_pat*, or *fourth_tag_spot* attributes). All attributes in the release table are shown in Table 2.

Table 2. Description of the "releases" table in the Billfish Database, organizing Tagged Billfish attributes. *= calculated attribute.

Attribute	Data Type (length)	Allow Nulls	Description
tag_id (PK)	varchar(15)	N	Alphanumeric tag identifier (as marked on tag card), with indication of duplicate as terminal B or C.
dup	char(1)	N	If the tag was a duplicate. A= no duplicate, B= first duplicate, C= second duplicate.
research	varchar(1)	Y	If the tag was released for or by a research institution. N= No, Y= Yes, Blank= Unanswered.
second_tag	varchar(15)	Y	For research: second tag number.
third_tag_pat	varchar(15)	Y	For research: Pop-off Archival Tag number.
fourth_tag_spot	varchar(15)	Y	For research: Smart Position and Temperature tag number.
mm	tinyint	Y	Calendar month the tag was released.
dd	tinyint	Y	Calendar day the tag was released.
yyyy	smallint	Y	Calendar year the tag was released.
*release_date**	date	Y	Date tag was released (calculated from *mm, dd, yyyy*).
location_cd (FK)	tinyint	Y	Numeric code for colloquial location where tag was released (see "location" table).
lat_dg	smallint	Y	Latitude degrees where tag was released.
lat_mn	smallint	Y	Latitude minutes where tag was released.
n_s	char(1)	Y	Latitude North or South where tag was released.
*lat**	decimal (9,6)*	Y	Latitude decimal degrees where tag was released (calculated from *lat_dg*, *lat_mn*, and *n_s*).
lon_dg	smallint	Y	Longitude degrees where tag was released.
lon_mn	smallint	Y	Longitude minutes where tag was released.
e_w	char(1)	Y	Longitude East or West where tag was released.

*lon**	decimal (9,6)*	Y	Longitude decimal degrees where tag was released (calculated from *lon_dg*, *lon_mn*, and *e_w*).
*release_point**	geography Point*	Y	Geography point where tag was released, referenced to WGS84 (SRID 4326) (calculated from *lat* and *lon).*
ang_seq	int	Y	Angler sequence number (joins "constituents" table).
ang_inl	char(1)	Y	Angler first name initial.
angler	varchar(25)	Y	Angler last name.
club_program	varchar(50)	Y	Angler fishing club name.
cap_seq	int	Y	Captain sequence number (joins "constituents" table).
cap_inl	char(1)	Y	Captain first name initial.
captain	varchar(25)	Y	Captain last name.
boat_name	varchar(20)	Y	Boat name.
gear_cd (FK)	tinyint	N	Numeric code for fishing gear used to catch fish (see "gear" table).
species_cd (FK)	tinyint	N	Numeric code for species tagged (see "species" table).
sex	char(1)	Y	Sex of fish. M= male, F= female, U= unknown.
length_1	smallint	Y	Length measurement of tagged fish at release.
length_1_cd (FK)	tinyint	N	Numeric code for type of length measurement of tagged fish at release (see "lengths" table).
length_2	smallint	Y	Second length measurement of tagged fish at release.
length_2_cd (FK)	tinyint	Y	Numeric code for type of second length measurement of tagged fish at release (see "lengths" table).
length_3	smallint	Y	Third length measurement of tagged fish at release.
lenght_3_cd (FK)	tinyint	Y	Numeric code for type of third length measurement of tagged fish at release (see "lengths" table).
weight	smallint	Y	Weight in pounds of tagged fish at release.
bait_cd (FK)	tinyint	N	Numeric code of fishing bait used to catch fish (see "bait" table).
temp_f	tinyint	Y	Water temperature (Fahrenheit) when fish was tagged.
temp_c	tinyint	Y	Water temperature (Celsius) when fish was tagged.
fight	int	Y	Minutes of fight time between hooking and landing fish.
condition_cd (FK)	tinyint	N	Condition of fish at release (see "condition" table).
hooks	char(1)	Y	If any hooks are on fish at release.
comments	varchar(115)	Y	Any comments relevant to fish tagging and release.

"recover" table

The purpose of the "recover" table is to document the fishing and biological characteristics associated with each tag recovery, which contains some of the same attributes as the Tagged Billfish entity set. Considering many recaptured fish are reported from commercial fisheries where they may be kept for sale or kept by recreational anglers in Hawai'i, the Recaptured Billfish entity set contains biological sampling information only applicable to dead fish. The "recover" table contains 36 attributes describing tag recovery (Table 3), seven of which are referenced as FK to lookup tables (Figure 1). The PK, *rtn_id*, is a unique sequential number automatically assigned to each new recovery record upon entry into the database. The *tag_id* can be joined to the same attribute in the "releases" table, where it must be an exact match to indicate

a mark-recapture event. However, considering the information for many tags released on billfish is never reported despite their recovery on recaptured billfish, these are merely joined instead of *tag_id* serving as a FK. The recovery information in Table 3 is obtained through correspondence with the anglers, either commercial or recreational.

Table 3. Description of the "recover" table in the Billfish Database, organizing Tagged Billfish attributes. *= calculated attribute.

Attribute	Data Type (length)	Allow Nulls	Description
rtn_id (PK)	smallint	N	Numeric return identifier.
tag_id	varchar(15)	N	Alphanumeric tag identifier (as marked on tag card), with indication of duplicate as terminal B or C.
dup	char(1)	Y	If the tag was a duplicate (joins "releases" table). A= no duplicate, B= first duplicate, C= second duplicate.
tags	tinyint	Y	Number of tags recovered from fish.
recoverer	varchar(50)	Y	Name of constituent who recovered tag.
rec_seq	int	N	Sequence number of constituent who recovered tag (joins "constituents" table).
mm	tinyint	Y	Calendar month the tag was recovered.
dd	tinyint	Y	Calendar day the tag was recovered.
yyyy	smallint	Y	Calendar year the tag was recovered.
*recover_date**	date	Y	Date the tag was recovered (calculated from *mm*, *dd*, and *yyyy*).
country	tinyint	Y	Country where tag was recovered.
place_cd (FK)	tinyint	N	Numeric code for place where tag was recovered (see "place" table).
location_cd (FK)	tinyint	Y	Numeric code for location where tag was recovered (see "location" table).
lat_dg	smallint	Y	Latitude degrees where tag was recovered.
lat_mn	smallint	Y	Latitude minutes where tag was recovered.
n_s	char(1)	Y	Latitude North or South where tag was recovered.
*lat**	decimal(9,6)*	Y	Latitude decimal degrees where tag was recovered (calculated from *lat_dg*, *lat_mn*, and *n_s*).
lon_dg	smallint	Y	Longitude degrees where tag was recovered.
lon_mn	smallint	Y	Longitude minutes where tag was recovered.
e_w	char(1)	Y	Longitude East or West where tag was recovered.
*lon**	decimal(9,6)*	Y	Longitude decimal degrees where tag was recovered (calculated from *lon_dg*, *lon_mn*, and *e_w*).
*recover_point**	geography Point*	Y	Geography point where tag was recovered, referenced to WGS84 (SRID 4326) (calculated from *lat* and *lon).*
temp_f	tinyint	Y	Water temperature (Fahrenheit) when fish was recaptured.
temp_c	tinyint	Y	Water temperature (Celsius) when fish was recaptured.
gear_cd (FK)	tinyint	N	Numeric code for fishing gear used to recapture fish (see "gear" table).

species_cd (FK)	tinyint	N	Numeric code for recaptured fish species (see "species" table).
sex	char(1)	Y	Sex of recaptured fish. M= Male, F= Female, U= Unknown.
length_1	smallint	Y	Length measurement of fish at recapture.
length_1_cd (FK)	tinyint	N	Numeric code for type of length measurement of fish at recapture (see "lengths" table).
length_2	smallint	Y	Second length measurement of fish at recapture.
length_2_cd (FK)	tinyint	Y	Numeric code for type of second length measurement of fish at recapture (see "lengths" table).
weight_kg	smallint	Y	Weight, in kilograms, of fish at recapture.
weight_pounds	smallint	Y	Weight, in pounds, of fish at recapture.
weight_cd (FK)	tinyint	Y	Numeric code for type of weight measured of fish at recapture (see "weight" table).
gonad_weight	smallint	Y	Weight of gonads.
comments	varchar(115)	Y	Any comments relevant to tag recovery or fish recapture.

"tag_distribution" table

The purpose of the Tags entity set is to inventory the tags distributed to constituents, mostly as reference for SWFSC staff for when a return is reported but release information is missing. The "tag_distribution" table contains nine attributes describing outgoing tag bundles and the receiving constituents (Table 4), one of which is a foreign key to the "constituents" table (Figure 1). The PK, *first_tag_id*, identifies the first tag number in the bundle to ensure no duplicates are sent. Tag attributes include the range of tag numbers sent (*first_tag_id* and *last tag_id*) and number of tags sent (*quantity*), while distribution attributes include the time and date tags were sent (*date_sent*); tag recipient name (*first_name* and *last_name*), affiliation (*org_club*), and sequence number (*seq*, FK referencing "constituents" table)*;* and any comments relevant to tag distribution (*comments*).

Table 4. Description of the "tag_distribution" table in the Billfish Database, organizing Tags attributes.

Attribute	Data Type (length)	Allow Nulls	Description
date_sent	datetime2(7)	Y	Date tags are distributed to constituents.
first_tag_id (PK)	varchar(15)	N	Tag ID of first tag in bundle.
last_tag_id	varchar(15)	Y	Tag ID of last tag in bundle.
quantity	smallint	Y	Quantity of tags being distributed.
first_name	varchar(20)	Y	First name of tag recipient.
last_name	varchar(20)	Y	Last name of tag recipient.
org_club	varchar(50)	Y	Organization or club of tag recipient.
comments	varchar(255)	Y	Any comments relevant to tag distribution.
seq (FK)	int	Y	Sequence number of tag recipient (see "constituents" table).

"survey" table

The survey table contains the results of the International Billfish Angler Survey. Each year, constituents can submit one survey per location, for up to three locations. The "survey" table has a concatenated PK with three attributes (Table 5), two of which are also foreign keys: constituent sequence number (*seq*, FK referencing the "constituents" table), survey year (*year*), and fishing location (*location_cd*, FK referencing the "location" table) (Figure 1). Constituent attributes include whether the survey data is valid as non-captain reporting (*eliminated*). Fishing attributes include the number of days or partial days fished (*effort)* in the survey year regardless of catch, and catch (kept or released, in whole numbers) by species. Additional attributes include any comments relevant to the survey (*comments*) and a data entry timestamp (*entry_timestamp*) for SWFSC staff purposes.

Table 5. Description of the "survey" table in the Billfish Database, organizing Billfish Catch and Effort attributes.

Attribute	Data Type (length)	Allow Nulls	Description
last_name	varchar(20)	Y	Constituent last name.
seq (PK, FK)	int	N	Constituent sequence number (see "constituents" table).
year (PK)	smallint	N	Calendar year of survey.
location_cd (PK, FK)	tinyint	N	Numeric code for fishing location (see "location" table).
effort	smallint	Y	Number of whole days fished in survey year, regardless of catch.
blue	smallint	Y	Number of Pacific blue marlin released or kept in survey year.
black	smallint	Y	Number of black marlin released or kept in survey year.
stripe	smallint	Y	Number of striped marlin released or kept in survey year.
sail	smallint	Y	Number of sailfish released or kept in survey year.
spear	smallint	Y	Number of spearfish released or kept in survey year.
sword	smallint	Y	Number of broadbill swordfish released or kept in survey year.
eliminated	Boolean (bit)	Y	Is the entry eliminated due to captain reporting? 0= No, 1= Yes.
comments	varchar(50)	Y	Any comments relevant to the survey
entry_timestamp	timestamp	N	The computer system's timestamp at data entry.

1.2.2 Lookup tables

"constituent_type" table

The static "constituent_type" lookup table describes the type of constituents participating in the CBTP (Table 6). The PK, *constituent_cd*, is a numeric code referenced only by the "constituents" table (Figure 1) and is paired with the corresponding *constituent_type* attribute for eight possible values: 1= surveyor, 2= new_tagger, 3= old_tagger, 4= associate, 5= commercial_angler, 6= previous_associate, 7= select, 8= previous_select.

Table 6. Description of the attributes of the "constituent_type" table in the Billfish Database.

Field	Data Type (length)	Allow Nulls	Description
constituent_cd (PK)	tinyint	N	Numeric code for the constituent type.
constituent_type	char(20)	Y	Constituent type.

"bait" table

The static "bait" lookup table describes the type of bait used to catch billfish (Table 7). The PK, *bait_cd*, is a numeric code referenced only by the "release" table (Figure 1) and is paired with the corresponding *bait_type* attribute for six possible values: 0= unknown, 1= live_bait, 2= dead_bait, 3= unidentified_bait, 4= artificial_lure, 5= other, 6= fly.

Table 7. Description of the attributes of "bait" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
bait_cd (PK)	tinyint	N	Numeric code for fishing bait or jig.
bait_type	char(17)	Y	Fishing bait or jig type.

"condition" table

The static "condition" lookup table describes the visual condition the billfish is in at time of release based on the judgement of the constituent (Table 8). The PK, *condition_cd*, is a numeric code referenced only by the "release" table (Figure 1) and is paired with the corresponding *condition* attribute for six possible values: 0= unknown, 1= excellent, 2= good, 3= fair, 4= poor, 5= injured, 6= dead.

Table 8. Description of the attributes of the "condition" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
condition_cd (PK)	tinyint	N	Numeric code for fish condition.
condition	char(9)	Y	Fish condition based on visual assessment.

"gear" table

The static "gear" lookup table describes the fishing gear used to catch the billfish (Table 9). The PK, *gear_cd*, is a numeric code referenced by the "release" and "recover" tables (Figure 1) and is paired with the corresponding *gear_type* attribute for 11 possible values: 1= baitboat, 2= purse_seine, 3= troll, 4= rod_reel, 5= harpoon, 6= longline, 7= handline, 8= gillnet, 9= unknown, 10= halibut_trawler, 11= free_tag.

Table 9. Description of the attributes of the "gear" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
gear_cd (PK)	Tinyint	N	Numeric code for fishing gear type.
gear_type	char(15)	Y	Fishing gear type.

"lengths" table

The static "lengths" lookup table describes the measurement type reported by the angler (Table 10). The PK, *length_cd*, is a numeric code referenced by the "release" and "recover" tables (Figure 1) and is paired with the corresponding *length_type* attribute for 19 possible values: 0= no_value_reported, 11= cm_unknown, 12= cm_eye_to_tail_fork_billfish_only, 13= cm_bill_to_tail_fork_swordfish_only, 14= cm_cleithrum_to_tail_fork, 15= cm_lower_jaw_or_lip_to_tail_fork, 16= cm_snout_to_tail_tip_nonbillfish_only, 17= cm_snout_to_tail_fork_nonbillfish_only, 18= cm_tip_of_bill_to_tail_tip_billfish_only, 19= cm_dorsal_fin_to_dorsal_fin, 21= in_unknown, 22= in_eye_to_tail_fork_billfish_only, 23= in_bill_to_tail_fork_swordfish_only, 24= in_cleithrum_to_tail_fork, 25= in_lower_jaw_or_lip_to_tail_fork, 26= in_snout_to_tail_tip_nonbillfish_only, 27= in_snout_to_tail_fork_nonbillfish_only, 28= in_tip_of_bill_to_tail_tip_billfish_only, 29= in_dorsal_fin_to_dorsal_fin.

Table 10. Description of attributes of the "lengths" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
length_cd (PK)	tinyint	N	Numeric code for length measurement type.
length_type	char(40)	Y	Length measurement type.

"location" table

The "location" table is important as it describes the colloquial fishing location of tag or recapture events when anglers do not provide coordinates and is useful for regional comparisons (Table 11). While the other lookup tables are static, new locations are occasionally added to the "location" table. The PK, *location_cd*, is a numeric code referenced by the "release," "recover," and "survey" tables (Figure 1). The table lists 131 common locations that are not geographically standardized (e.g. 10 minute fishing block, or degrees of latitude), but is instead specific to the most frequent and top-tagging areas of the CBTP.

Table 11. Description of the attributes of the "location" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
location_cd (PK)	tinyint	N	Numeric code for colloquial fishing location.
location	varchar(50)	Y	Colloquial fishing location (*e.g.* "Southern California").
region	varchar(50)	Y	Colloquial region of fishing location (e.g. "Southern California, U.S.A").
ocean	char(16)	Y	Ocean of fishing location (e.g. "Pacific").
quad	char(2)	Y	World quadrant of fishing location (e.g. "NW").

"place" table

The "place" lookup table describes the physical place where a tag was recovered, as many recaptured billfish are reported from commercial enterprises (Table 12). This information is useful in examining shed rates and mortality. The PK, *place_cd*, is a numeric code referenced only by the "recover" table (Figure 1) and is paired with the corresponding *place_type* attribute for 10 possible values: 0= unknown_or_other, 1= on_vessel, 2= offloading, 3= cannery_cutting_line, 4= cooker, 5= consumer_in_can, 6= transhipper, 7= fish_market, 8=

smokehouse, 9= taxidermist. This table is modifiable to add new recapture places but is largely static.

Table 12. Description of the attributes of the "place" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
place_cd (PK)	tinyint	N	Numeric code for place type.
place_type	char(20)	Y	Place type where fish was recaptured.

"weight" table

The static "weight" lookup table describes the measurement type used to report billfish weight (Table 13). The PK, *weight_cd*, is a numeric code referenced by the "recover" and "releases" tables (Figure 1) and is paired with the corresponding *weight_type* attribute for four possible values: 0= unknown, 1= round_whole, 2= gilled_gutted, 3= other.

Table 13. Description of the attributes of the "weight" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
weight_cd (PK)	tinyint	N	Numeric code for fish weight measurement type.
weight_type	varchar(13)	Y	Fish weight measurement type.

"species" table

The "species" lookup table describes the species identification information (Table 14). The PK, *species_cd*, is a numeric code referenced by the "recover" and "releases" tables (Figure 1). The table lists 95 billfish and non-billfish species encountered throughout the operations of the CBTP and is modifiable to add new species.

Table 14. Description of the attributes of the "species" table in the Billfish Database.

Attribute	Data Type (length)	Allow Nulls	Description
species_cd (PK)	tinyint	N	Numeric code for species.
species_type	char(8)	Y	Type of species (e.g. "billfish").
species_name	varchar(50)	Y	The common name of the species (e.g. "pacific_blue_marlin").
species_other_name	varchar(50)	Y	Other names for the species (e.g. "marlin_azul").
species_scientific_name	varchar(50)	Y	The scientific name (genus species) of the species (e.g. "makaira mazara").

1.3 Database management

The database is stored on a shared network drive at the SWFSC and is backed up every two weeks. Limited CBTP staff are allowed read and write permissions with linked or static copies of the Billfish Database on the MS Access desktop application interface.

Quality Assurance

To minimize human input errors, only dedicated staff familiar with the data manually populate the database. Typically, just the current CBTP program manager processes incoming tag report cards, angler surveys, and recapture calls or emails. The program manager then manually populates tables linked to the server with raw tagging, survey, and recapture data via MS Access. Occasionally, one to two additional SWFSC staff will add data when necessary throughout the calendar year.

Quality Control

One main management task for the nearly six decades of data collected by the CBTP is quality control. Data from tag report cards, recovery forms, or angler surveys are entered as raw values into their respective tables. Automatic quality control measures for all attributes are implemented by three constraints established at the time of database design—data type, data size, and null data allowances. Data values must meet these constraints, as defined for each table (Tables 1-14), otherwise records are automatically flagged at the time of entry. These three automatic constraint types are important for flagging duplicates or missing values for the PK in the dynamic "constituents," "release," "recovery," and "survey" tables (Tables 1,2,3,5).

Additional quality control constraints based on logical validation rules are applied for various non-calculated attributes in the Billfish Database. These logical constraints are based on the stochastic nature of tagging, survey, and biological information of the CBTP, which typically cannot be registered by the computational data type, data size, or null constraints. Managers of the CBTP also graph the data to manually look for outliers. These constraints will flag errors (e.g. an accidental addition of a digit that makes a logical 700 pounds into an impossible 7000 pounds). Fifteen such logical constraints on a variety of required and not required non-calculated attributes are implemented in their respective tables (Table 16).

Table 16. Logical validation rules for non-calculated attributes in the Billfish Database.

Attribute	**Table**	**Logical validation rule (*units*)**
tag_id (PK)	releases, recover, tag_distribution	A000000- ZZ100000
dup (PK)	releases, recover	A, B, or C
len (2, 3)	releases, recover	10-1000 (*centimeters)*
effort	survey	0-365 (*days*)
lat_dg	releases, recover	0-90 (*degrees*)
lat_mn	releases, recover	0-60 (*minutes*)
n_s	releases, recover	North (N), South (S), or blank
e_w	releases, recover	East (E), West (W), or blank
sex	releases, recover	Male (M), Female (F), Unknown (U), or blank
weight	releases, recover	1-2500 (*kilograms* or *pounds*)
temp_f	releases, recover	40-100 (*degrees Fahrenheit*)
temp_c	recover	0-30 (*degrees Celsius*)
mm	releases, recover, survey	1-12
dd	releases, recover, survey	1-31
yyyy	releases, recover, survey	1963-2030

One source of duplications not automatically flagged by any of the four listed data constraints is the constituent record, identified by the *seq* PK. The *seq* is created in the "constituents" table for every person that has participated in the CBTP. Given that multiple constituents may have the same first and last name and even live in the same state or city, there are no logical validation rules that will flag duplicate entries. Discerning whether constituents are distinct is based on additional identifying information such as address, phone number, or email address from handwritten hardcopy tag report cards and angler surveys. If distinct, sequential values for their *seq* PK are then generated manually upon entry. When handwriting is illegible and/or additional identifying information is not provided, multiple records for one distinct constituent may be created mistakenly. The CBTP program manager eliminates duplicate constituent records based on name, address, and other identifying information such as mail code, boat name, or club name. These duplications are corrected continually when identified.

1.4 Data sharing

The data reported by constituents is voluntary and not scientifically verified at time of collection, unless specifically indicated as "research" in the Billfish Database. As such, fish species, weights and lengths, condition, and fight time are estimated by the angler or captain. Although many location coordinates may be accurately sourced from Global Positioning System (GPS) equipment, all locations are treated as estimates. Blanks are treated as "No data". These data issues should be considered before interpreting any analyses using CBTP data.

All data, excluding PII, are considered public. PII is defined by the Federal Government as "*information which can be used to distinguish or trace an individual's identity, such as their name, social security number, biometric records, etc. alone, or when combined with other personal or identifying information which is linked or linkable to a specific individual, such as date and place of birth, mother's maiden name, etc.*" (Privacy Act, 5 U.S.C § 552a (1974)). Constituent name alone, or in combination with at least one of the following attributes is considered PII: address (*address1, address2, city, state_region*, *country*, or/and *mail_code*), phone number (*phone_work* and/or *phone_home*), *fax*, and/or *email*. Therefore only biological and fishing information is provided on the publically available and downloadable dataset, with sequence numbers (*seq*) representing unique constituents.

Any member of the public (domestic or international) can request raw or summarized public data from the CBTP, excluding PII. Prior to fulfilling the data requests, both the SWFSC and the requesting party must sign a data sharing agreement (Appendix I) which describes data quality and caveats and objectives behind the request. This agreement ensures data sharing terms are clear, and helps SWFSC track data requests. Data are delivered as flat files (.csv, .xls). The CBTP also has an established collaborative agreement with The Billfish Foundation to share fishing data to promote the conservation of billfish.

2. The Billfish Tagging Program

The Billfish Tagging Program (hereafter the Tagging Program) provides free conventional mark-recapture tagging supplies to constituents around the world, with a primary focus on billfish

species in the Pacific Ocean. Tagging is designed to be voluntary, collaborative, and accessible to any member of the public. The taggers participation is voluntary and unpaid, and data are used to enhance research on and management of billfish species.

The operations of the Tagging Program require year-round attention dedicated from at least one SWFSC staff member to acquire, prepare, distribute, and process tags and associated data. An average of 2,000 conventional tags and tag report cards are distributed annually to individuals, programs, and tournament charter desks around the world. Anglers tag the fish, fill out the card, and mail the card back to the SWFSC where data is processed, stored, and managed. While tagging billfish is a valuable research exercise, and promotes catch and release fishing, the ultimate goal of conventional mark-recapture research is tag recapture. Only when biological and location information is reported for both the tag release and recovery event, can billfish movement, time at liberty and growth be calculated. These metrics enhance the current volume of scientific research on billfish movement, life history parameters, and distribution useful in the stock assessments used for sustainable management. Mark-recapture data are distributed to the public, to academia and collaborating researchers, and to management councils.

The main operations of the Billfish Tagging Program fall into four sections:

1. Tagging equipment acquisition
2. Tag bundle preparation and distribution
3. Processing returned tag report cards
4. Processing tag recapture reports

2.1 Tagging equipment acquisition

The tagging equipment is designed to be analog, light, expendable, easy to operate, and maintenance-free. This enables the SWFSC to purchase large quantities of conventional tags to distribute to a large number of anglers around the world by postal service. The equipment is also intended to be fairly easy to operate and understand, requiring no oversight by the SWFSC of tagging procedures or return of the tag report cards.

2.1.1 Conventional tags

Two models of conventional tags are customized and purchased by the SWFSC from Floy Tag and Manufacturing, Inc. (4616 Union Bay Place NE, Seattle, WA 8105; (206) 524-2700) in batches of 2500. Both models have a plastic body with the tag identification number, reward information, and SWFSC contact information printed in English and Spanish as follows:

"A(########) REWARD (RECOMPENSA) FOR TAG RECAPTURE INFO A(########) SWFSC, 8901 LA JOLLA SHORES DR., LJ CA 92037 PH +1 (858) 546-7000"

Tag numbers are unique alphanumeric identifiers often starting with one or two letters followed by four to six numbers. To account for inherent changes in both SWFSC and private manufacturing corporations over five decades of operations, there has been no set standard for the tag number. The CBTP program manager keeps records of the ordered tag numbers as "series" (e.g. A080000- A081000) through documentation of tag distribution in the "tag_distribution" table.

The billfish tags are Floy model "BFIM- 96, Large Billfish Tag (Yellow, #92701-93950)" and have a double-barb nylon anchor (Figure 2A). These are intended for use with the steel applicator tips, "Applicator BFIM-96", also ordered from Floy Tag and Manufacturing, Inc. (Figure 2B). New orders are typically placed when only 250 tags remain and the new tag number series is dictated by the CBT program manager. This timing accounts for the variable manufacturing and shipping time.

Figure 2. Conventional double-barbed plastic anchor BFIM- 96 Large Billfish Tag (A) printed with SWFSC contact information for recapture reporting, and accompanying BFIM-96 steel applicator tip (B). Tag and applicator tip shown are to scale.

2.1.2 Billfish Tagging Report Cards

The Billfish Tagging Report cards are designed for anglers to fill by hand at the time of tagging, and then mailed free of charge (in the U.S.) to the SWFSC when back on land. The report cards are double-sided 7.5" x 3.5" light canary yellow vellum cardstock pre-punched with two holes, through which the tag is fed. The card design is custom for the CBTP and printed by the NOAA Duplicating Plant (1315 East West Highway, Silver Spring, MD 20910). One side is printed with data fields relevant to the tagging event (see *Section 1.2*) and the opposite side is printed with the official business permit information for pre-paid government postage and the return address to the SWFSC (Figure 3). Given this data collection is funded by the federal government, the tag report cards are required by the Paperwork Reduction Act (PRA) to be approved by the federal Office of Management and Budgeting every three years. The expiration date of

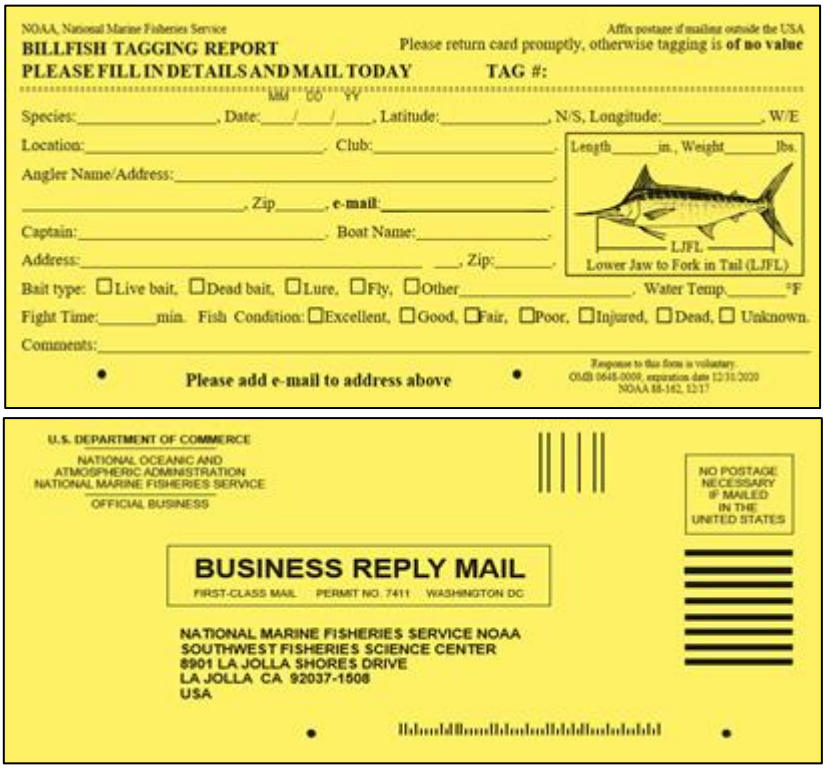

NOAA, National Marine Fisheries Service
BILLFISH TAGGING REPORT
PLEASE FILL IN DETAILS AND MAIL TODAY
Affix postage if mailed outside the USA
Please return card promptly, otherwise tagging is **of no value**
TAG #:
MM DD YY
Species:_____, Date:___/___/___, Latitude:_____, N/S, Longitude:_____, W/E
Location:_____, Club:_____
Length_____in., Weight_____lbs.
Angler Name/Address:_____
_____, Zip_____, e-mail:_____
Captain:_____, Boat Name:_____
Address:_____, Zip:_____
LJFL
Lower Jaw to Fork in Tail (LJFL)
Bait type: ☐Live bait, ☐Dead bait, ☐Lure, ☐Fly, ☐Other_____, Water Temp._____°F
Fight Time:_____min. Fish Condition: ☐Excellent, ☐Good, ☐Fair, ☐Poor, ☐Injured, ☐Dead, ☐ Unknown.
Comments:_____
Please add e-mail to address above
Response to this form is voluntary
OMB 0648-0008, expiration date 12/31/2020
NOAA 88-162, 12/17
U.S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL MARINE FISHERIES SERVICE
OFFICIAL BUSINESS
NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES
BUSINESS REPLY MAIL
FIRST-CLASS MAIL PERMIT NO. 7411 WASHINGTON DC
NATIONAL MARINE FISHERIES SERVICE NOAA
SOUTHWEST FISHERIES SCIENCE CENTER
8901 LA JOLLA SHORES DRIVE
LA JOLLA CA 92037-1508
USA

Figure 3. The blank form (*top*) and postage information (*bottom*) of the CBTP Billfish Tagging Report card. Card is not to scale.

the most current approved PRA permit is updated every order cycle and printed on the form (Figure 3).

2.2 Tag bundle preparation and distribution

Blank tag report cards and numbered billfish tags are physically paired together before distribution to constituents. Each report card is printed with the serial number of the associated tag by CBTP staff (Figure 3). The body of each tag is then fitted into the pre-punched holes on the corresponding labeled tag report card to form a tag-card unit (Figure 4). Bundles of 25 sequential tag-card units are further organized into bundles of 100 tag-card units ready for dispersal. At least 250 tag-cards are typically on site during the season to meet the needs of anglers.

Figure 4. A tag-card unit for the conventional plastic anchor billfish tag, numbered A094169, and the accompanying labeled tag report card. Tag bundle is not to scale.

Constituents request prepared tag bundles via email, phone, or in person. Individual anglers generally request one to two bundles (25 or 50 tags), while dedicated sportfishing charter desks or tournaments request more than 300 tags at a time for distribution throughout the calendar year. Inventorying tag distribution helps the CBTP program manager establish routine shipments of tags to repeat recipients, track tag number series, and understand focused tagging efforts. Tag distribution information is recorded in the "tag_distribution" table (Table 4). The same information, except sequence number and comments, is populated into a tag distribution letter (Appendix II) that is sent with the tags. Constituents can also request steel applicator tips to make their own reusable tagging poles using common materials like wooden broom handles and epoxy. The CBTP provides a printed "Constructing a Tagging Pole Guide" (Appendix III) when steel applicator tips are requested. Additional printed materials are occasionally included in tag shipments, such as the "Take Along Tagging Guide" (Appendix IV) or the "Take Along Billfish Identification Guide" (Appendix V).

2.3 Billfish Tagging and Identification Guides

The Tagging Program instructs constituents on best tagging practices and billfish identification through the "Take Along Tagging Guide" (Appendix IV) and the "Take Along Billfish Identification Guide" (Appendix V), both available in print and/or digital PDF format on the

CBTP webpage, in the *Billfish Newsletter*, and other outreach material. The instructions and tips provided on the "Take Along Tagging Guide" serve as the official CBTP methods for at-sea tagging and release:

1. Before you catch your fish:
   First decide if you plan to tag and release any fish. If so, use a circle hook which reduces deep or foul hooking when bait fishing or a single circle or single 'J' hook if trolling. Do not use double rigged 'J' hooks when releasing your catch.
2. While fishing:
   Never attempt to tag a fish while it is jumping or thrashing about. Bring your fish to leader as quickly as possible but wait until the fish is calm and swimming beside the boat before tagging.
3. Tagging:
   Tag the fish as it is being towed alongside the boat by inserting the applicator and tag in the back muscle below the tallest part of the dorsal fin. Avoid the gills, head, and stomach. Take care not to allow your fish to injure itself on the vessel's transom or hull.
4. Releasing:
   Revive all fish by slowly towing it through the water, allowing water to flow over the gills until its normal color returns and it begins to swim on its own. Remove the hook with a good pair of pliers, or if deeply hooked in the throat or stomach, release it by cutting the leader as close to the hook as possible.
5. Complete the Billfish Tagging Report Card:
   Fill out the yellow Billfish Tagging Report card and return it as quickly as possible. Though easily forgotten in the heat of battle and glow of success, returning the card is the most critical and final step in tagging your fish.
   - Fill out the card completely and as accurately as possible.
   - Indicate latitude, longitude and/or locally known fishing area.
   - Estimate the length of the fish as "tip of lower jaw-to-fork" length (LJFL).
   - Estimate weight of the fish.
   - Include any remarks, club name, and complete address of the angler and the boat captain.
   - Return cards promptly to the Southwest Fisheries Science Center. Tagging is of no scientific value unless this Billfish Tagging Report card is returned. Postage is paid if mailed in the U.S.A.

The "Take Along Billfish Identification Guide" (Appendix V) is a visual reference for the main identifying features of black marlin, broadbill swordfish, Pacific blue marlin, shortbill spearfish, striped marlin, and sailfish likely to be encountered while tagging.

2.4 Processing returned tag report cards

Completed tag report cards returned to the SWFSC are entered into the Billfish Database. Data verified at time of collection by the SWFSC or a credentialed scientific party is identified as "research". The "research" label identifies biological information measured with calibrated

calipers and scales using either CBTP tagging protocol or another scientific protocol, while those without the "research" label are assumed as estimated length and weight using CBTP protocol.

A sequence number for the angler and captain is assigned before entering release information, as the database enforces referential integrity for *seq* in the "release" table to the "constituents" table. If information for both angler and captain is not already in the "constituents" table (Table 1), a new constituent profile entry is created for both by assigning a unique sequence number and the contact information reported on the tag report card. This can follow a number of procedures:

- The angler/captain is new and provides a name: enter a new *seq* with the name
- The angler/captain is new but does not provide a name: enter a new *seq* and set the name to "Unknown". This ensures a running count of distinct anglers/captains despite their lack of information, instead of labeling all "Unknown" constituents the same.

The angler and captain sequence number are written on the physical card for later storage. Once this information is established, then all information reported on the tag report card is manually populated into the "releases" table (see Table 2).

2.5 Processing tag recapture reports

Tag recaptures are reported to SWFSC staff using the phone number printed on the tag or the contact information listed on the SWFSC CBTP webpage. Data for the recapture is recorded by SWFSC staff on the Large Pelagics Tag Recovery Datasheet (Appendix VI). This form records the information detailed in the "recover" table (Table 3). Fields for post-processing used by SWFSC staff include reward given, reward delivery type, and date reward was sent. These fields are only relevant for research projects when fish are tagged with electronic tags or sharks that have been injected with oxytetracycline for growth research. The only reward offered by the CBTP for a reported tag recapture is a T-shirt and an accompanying letter.

A separate query is made to match the *tag_id* in the "recover" record with the exact *tag_id* in the "release" table (Table 2) to find a coupled mark-recapture event. Often, tag release report cards are not returned and no such information can be found in the "release" table. If the release tag report card is found, it is physically stapled to the Large Pelagics Recovery Datasheet and filed for hardcopy records at the SWFSC. The mark-recapture information is also populated into a tag recapture reward letter (Appendix VII) mailed to the reporting constituent along with a T-shirt.

3. The International Billfish Angler Survey

The International Billfish Angler Survey (hereafter the Angler Survey) started in 1969 as a postcard enclosed in the annual report mailed to participating anglers in the CBTP (Squire, 1974). The purpose of the Angler Survey is to quantify fishing effort and billfish catch by location per calendar year. The continual distribution of the Angler Survey since 1969 has created the longest time series index of recreational billfish effort and catch in the Pacific Ocean. While the Angler Survey operates independently from the Tagging Program, it shares many of the same operations, protocols, and participating constituents. Like the Tagging Program, the Angler Survey is voluntary, collaborative, and accessible to any member of the public.

Constituents who actively partake in the Angler Survey understand their participation is voluntary and unpaid, and the fishing information they submit is public data aimed to enhance the research and management of billfish species.

The main operations of the Angler Survey fall under three sections:

1. Survey design
2. Survey distribution
3. Processing returned surveys

3.1 Survey design

The Angler Survey is designed to be an efficient form widely accessible to the public. It is completed just once a year by any recreational angler who fishes at least one whole or partial day in the entire calendar year. The Angler Survey does not require prior participation in the Tagging Program and is focused on billfish catch, defined as the catch of a billfish regardless of whether the fish was tagged and released, just released, or kept. Fishing effort is defined as the act of fishing regardless of catch and is measured in whole days. The Angler Survey is a digital or hardcopy 11" x 8.5", double-sided, tri-fold form to collect the following important fishing and constituent information: fishing location, fishing effort in the calendar year, total number of Pacific blue marlin, black marlin, striped marlin, shortbill spearfish, and broadbill swordfish caught (kept or released) at each location, angler name, angler address, and angler email address (Figure 5).

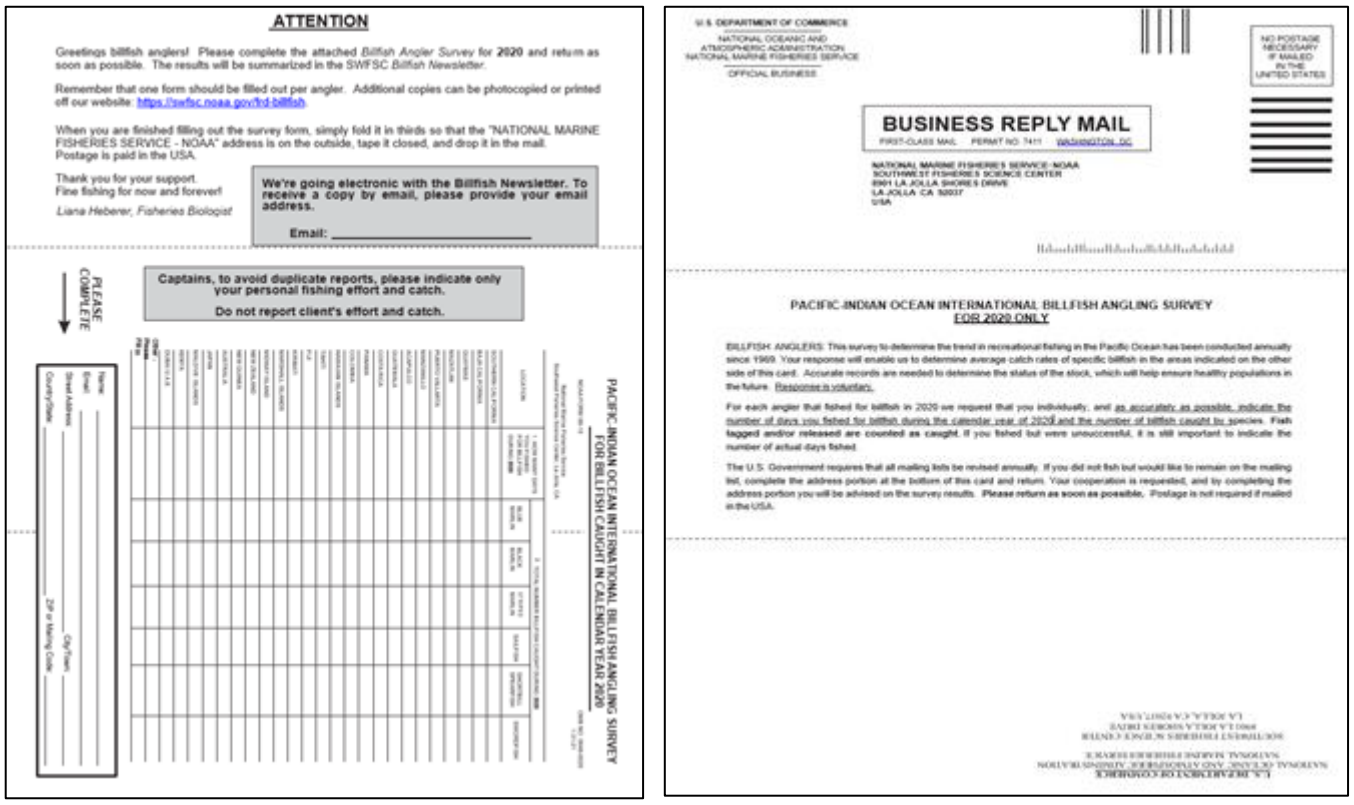


Figure 5. The survey (*left*) and postage information (*right*) of the 2020 International Billfish Angler Survey form, sent out as a digital PDF via email.

3.2 Survey distribution

The form is created as either a digital PDF or a printed hardcopy form processed by the NOAA Duplication Plant. Given these data are collected by funding from the federal government, the forms are printed with the currently approved PRA permit information. Digital Angler Survey PDFs are uploaded to the public-facing SWFSC CBTP webpage and attached as a PDF in an email to recent and willing constituents every January or February. Hardcopy forms are addressed to constituents and mailed out from the SWFSC using the U.S. Postal Service.

The delivery format of the Angler Survey has changed over the history of the Program: from 1969 to 2015, it was distributed as a hardcopy form; from 2015 to 2017, it was distributed as either a hardcopy form via the postal service or as a digital PDF form via email and the SWFSC CBTP website; and since 2017, it has been distributed as only a digital PDF form via email and the SWFSC CBTP website. The decision to switch to purely digital distribution arose out of a combination of logistical and logical factors and cost. The total operational time between hardcopy survey printing and manufacturing, physically labeling surveys with addresses, mailing to constituents, and then receiving surveys mailed back to the SWFSC ranges from a few weeks to a few months. Many surveys, particularly international surveys, never reach their intended destination and are returned to the SWFSC due to spelling or address errors. In contrast, digital surveys can be designed, emailed to thousands of constituents, uploaded to a website, and even returned by anglers in one business day by one staff member and carries no environmental mailing footprint. Any failed email deliveries are bounced back immediately, allowing for a better estimation of constituents actually receiving the survey.

The Angler Survey is released at the beginning of the calendar year to document the aggregate fishing effort and billfish catch of the prior calendar year. For example, the 2019 Angler Survey is distributed in January 2020 and collects the summed fishing effort and summed catch between January 2019 and December 2019. Constituents are asked to return the surveys as soon as possible and no later than spring (usually May) of that calendar year.

3.3 Processing returned surveys

Completed surveys are returned to the SWFSC as PDFs or images attached to individual emails, or as printed copies through the postal service. The location, number of days fished during the survey year, and total number of billfish caught by species are then manually populated into the "survey" table (Table 5) in the Billfish Database. If angler information is not already in the "constituents" table (Table 1) in the Billfish Database, a new constituent profile entry is created using a unique sequence number and the contact information reported on the Angler Survey. This can follow a number of procedures:

- The angler is new and provides a name: enter a new *seq* with the name
- The angler is new but does not provide a name: enter a new *seq* and set the name to "Unknown". This ensures a running count of distinct anglers/captains despite their lack of information, instead of labeling all "Unknown" constituents the same.

The angler sequence number is written on the physical Angler Survey for later storage. Once this information is established, then all information reported on the Angler Survey is manually

populated into the "survey" table, with associated codes for location and angler sequence number, as defined in their respective tables (Table 11 and Table 1). Angler survey data are still populated even if location code, effort, and catch are zero, so as to record Survey reporting effort.

4. Outreach and Reporting

Considering tag distribution and reporting relies on digital communication and physical correspondence directly to constituents, the third main component of the CBTP is outreach and reporting. The CBTP is one of the biggest outreach programs for SWFSC and NMFS to interact with recreational anglers across the world, notably in the Pacific. A goal of the CBTP is to bridge the gap between the science behind fisheries management and the fishing community.

The main operations of Outreach and Reporting fall into two categories, occurring year-round:

1. The *Billfish Newsletter*
2. The SWFSC CBTP webpage and other communications

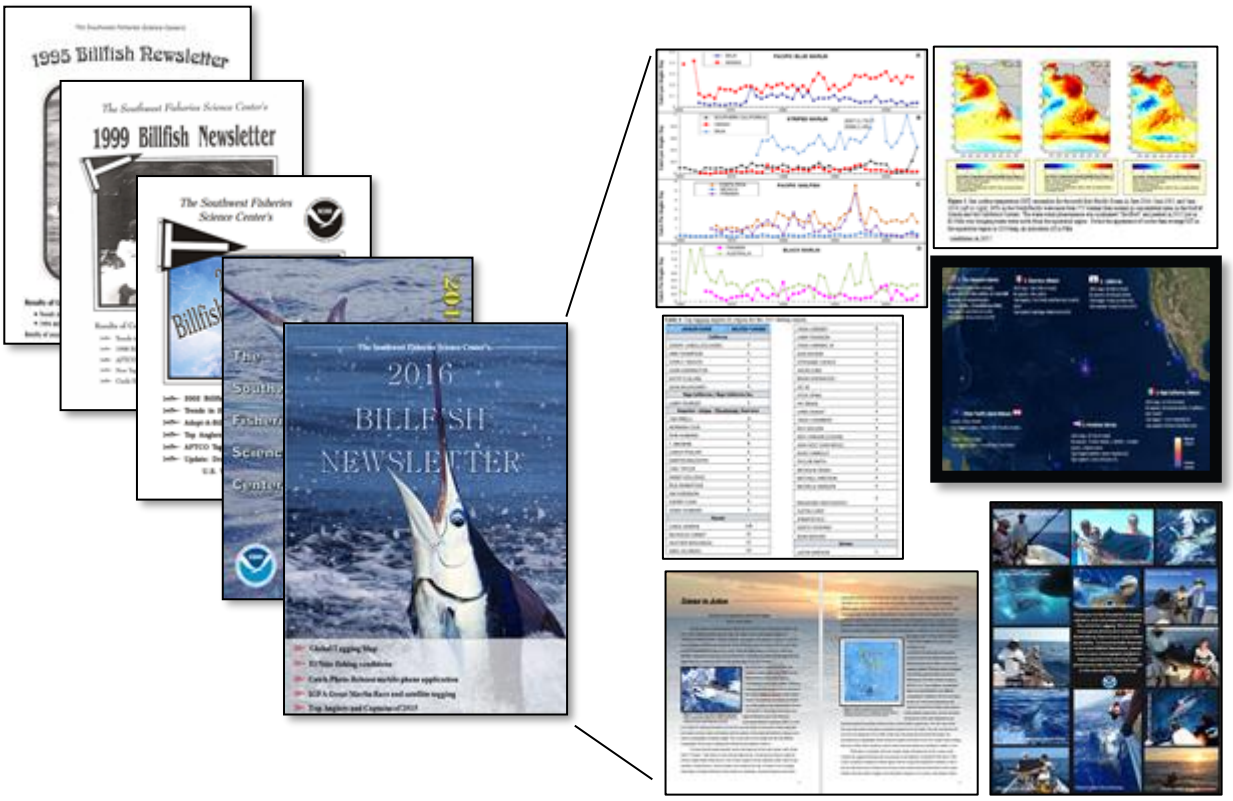
4.1 The SWFSC Billfish Newsletter

While any member of the public can request and receive data, the SWFSC releases an annual or biennial report midyear of summarized and aggregate tagging, recapture, and angler data entitled the *Billfish Newsletter* (BFNL) (Figure 6). The purpose of the BFNL is to communicate the methods and results of the Tagging Program and the International Angler Survey, and to provide a platform to highlight current natural events and research related to billfish. Many participating members wait to see the top-tagging angler and captain results and their photos published in the document.

The BFNL is titled for the year of release but summarizes data collected the prior year or two (e.g. the *2016 Billfish Newsletter* released in June 2016 summarized data from 2015) (Figure 6). While the BFNL is subject to the creativity of the writer tasked with its preparation, it generally includes the following important metrics queried annually from the Billfish Database:

- **Billfish catch and effort:** the yearly fishing effort by location, queried as the sum of the days fished for billfish as reported on the Angler Survey; the yearly billfish catch by location and species, queried as the sum of the total number of billfish caught as reported on the Anger Survey; the nominal catch-per-unit-effort (nCPUE), calculated as billfish catch per fishing day by species, year, and location; and an nCPUE time series figure by year since 1969.
- **Top-tagging anglers and captains:** the count of distinct tags released on billfish by distinct anglers and distinct captains as self-reported on submitted Tag Report Cards.
- **Tag releases:** the total billfish tagged queried as the sum of the distinct billfish tagged by location and species as reported on submitted Tag Report Cards.
- **Tag returns:** the total billfish recaptured as the sum of the distinct tagged billfish recaptured by location and species as reported by constituents; distance traveled, time-at-liberty, and calculated metrics of growth, when available.

The BFNL also features current billfish research as a column written by an invited guest scientist, and angler photos submitted throughout the year by participating anglers. In the email sent out by SWFSC staff in January or February of each calendar year to distribute the digital Angler Survey PDF, constituents are also asked to submit their digital angling photos via email to be included in the upcoming issue of the *BFNL*. While many are featured, one is chosen as the winner of the annual Cover Photo Contest. The winning angler is notified and awarded a SWFSC CBTP T-shirt and credited as the featured cover photographer in the BFNL.



A digital or hardcopy publication is released to an average of 2,000 constituents annually. The final publication format has changed over the history of the Program. Since 1964, the BFNL was sent to constituents as a hardcopy document in the mail. Digital PDF scans of the early BFNL have been retroactively produced for historical editions and for modern editions to accompany hardcopy publications. Since 2017, the gazette-style BFNL has been published as an interactive 508-compliant PDF available for download from the SWFSC CBTP website and distributed via email to consenting constituents as indicated on their Angler Survey and Tag Report Card responses. Like the Angler Survey, the decision to switch to purely digital distribution arose out of a combination of logistical and logical factors. Many mailed hardcopy BFNL never reached their intended destinations and were returned to the SWFSC due to spelling or address errors. In

contrast, digital PDFs distributed entirely online carry no environmental and printing costs or resources. Additionally, the digital BFNL is interactive and allows readers to access active embedded hyperlinks, Quick Response codes to relevant websites or contact information, and an indexed table of contents for quicker navigation.

4.2 The SWFSC CBTP webpage and other communications

Select SWFSC staff also manage a public-facing website dedicated to releasing information, describing research, hosting downloadable issues of the *Billfish Newsletter* and Angler Survey PDF forms. The CBTP conducts additional outreach and research operations throughout the calendar year. SWFSC staff bring tagging supplies, answer questions, and distribute free printed tagging guides, identification guides, and *Billfish Newsletters* during in person interactions with constituents at recreational fishing events. These include the Fred Hall Fishing Show in Del Mar and Long Beach, California, the Day at the Docks outreach event in Point Loma, California, and at various fishing clubs in Southern California. The CBTP also keeps an inventory of unisex shirts on hand to mail out upon request and to all participants who report a recaptured tag, the winner of the annual photo contest, top anglers and captains, and to local clubs. The CBTP provides tagging support and advice to research collaborators who have modeled conventional mark-recapture efforts off the operations of the CBTP, including advice on database design and equipment acquisition.

5. Discussion

The Cooperative Billfish Tagging Program has operated for nearly six decades to promote the ethical catch and release of billfish species. The data collected through the Tagging Program and the International Billfish Angler Survey is a legacy dataset that quantifies fishing and biological information on a wide range of pelagic species in the Pacific, Indian, and Atlantic Oceans since 1963. The mission of the CBTP reflects the larger mission of the SWFSC and NOAA in promoting productive and sustainable fisheries backed by sound science. Much gratitude is owed to the dedication of the thousands of voluntary constituents who have released, recaptured, and reported tags on billfish to advance the research and conservation of these important pelagic species. While technical pitfalls and challenges are inherent in every large scale, constituent based, conventional mark-recapture tagging program, detailing the operations of the CBTP not only provides reference for the legacy public dataset, but also provides an opportunity to share important learning lessons for future research tagging programs.

Recommendations for future conventional tagging programs

The SWFSC implemented minimal changes to the operational protocols of the CBTP since 1963 to ensure consistency in the statistical design of the data collection methods. Many technological advances have been developed in the last six decades that, if available at the establishment of the CBTP, could have aided in the collection of tagging data and survey responses. A retrospective analysis of the challenges faced by the CBTP to integrate newer methods into an established program points to three areas of recommendations for future conventional tagging programs, each enhancing the utility of the other. Ultimately, we recommend at the establishment of a

program, 1) efficient data management, 2) a focus on electronic reporting, and 3) preparing for program growth.

5.1 Efficient data management

Comprehensive and longstanding scientific surveys require timely and robust backend data management. We recommend a preemptive database design, documentation, and a standardized data extraction scheme to enhance the analysis of data while allowing for flexibility. Database design is a subjective practice and ultimately limited by the software of choice, but some lessons learned by the CBTP point to using a normalized spatial database with constraints based on the natural biological limits of tagged species and the inherent underreporting in conventional mark-recapture tagging research.

Like the Billfish Database, we recommend a relational database to normalize the extensive data types and information associated with tagging data (e.g. dates, locations, gear types, constituent information, and morphometric data). Populating raw data into just a few dynamic tables, supplemented by codified information stored in separate lookup tables, reduces redundancy, streamlines the continuous addition of data, and mitigates human input error. We recommend keeping raw data values only in release and recovery tables, and creating separate views from queries joining data to store calculated match mark-recapture information. The use of standardized formats for concatenated dates (e.g. yyyy-mm-dd) and signed decimal degrees of longitude and latitude (e.g. 32.869896, -117.253007) will allow for the automatic calculation of days at liberty and displacement between tag release and tag recapture.

Planning ahead for appropriate data types can also improve data population and query performance. This should be an important consideration during the development of a tagging database, as recasting of data types for decades of existing records will ultimately limit the kind of information that can be stored in the field. A spatial database supporting vector or raster geospatial information is an optimal choice for tagging programs with positional release and recovery data. Although non-spatial relational databases can store location data as character or numeric types, spatial databases natively support spatial joins and queries, and additional data types like linestrings (i.e. linear displacement vectors), polygons (i.e. exclusive economic zone boundaries), and geographic points (i.e. tag recovery coordinate). As open source software options are widely available, spatial database types can be enhanced by Open Source Geospatial Foundation (OSGeo) projects and libraries, among many other features that can augment research.

Depending on the geographic scale of the tagging program and the target tagging species, selecting appropriate geographic data types may also help with query performance. The precision and scale used for storing latitude and longitude should match the spatial resolution of the data you intend to collect. For example, if tagging a species that rarely migrates offshore from an island on which a tagging program is based, storing locations as a decimal (5,2) (five total digits in the value with 2 digits after the decimal point) produces a spatial resolution of about 1600 m, which may mean the difference between a lagoon and a reef. Instead, storing locations as a decimal (7,4) produces a spatial resolution of 16 m, which may illuminate a different pattern in the tagging data more localized to the scale of the species. As many tagging programs are

established because movement patterns and extent are unknown, we recommend storing the highest resolution geographic data as available computation space allows.

Designing a database to ensure tagging data is stored logically despite the inherent underreporting of release or recovery events is a fundamental process that can take various forms. This includes enforcing referential integrity and establishing joins on incomplete data when tag releases and tag recoveries are not reported. Additional recommendations include using automated serial primary keys for dynamic tables in order to reduce human errors when assigning unique identifiers to tag data. Storing codified primary keys as integers, rather than as string or text data types, will enhance matching and querying performance. Additionally, as codes need to be updated or deleted in lookup tables, the foreign keys stored as integers in dynamic tables can be set to cascade so any update in the lookup table will be updated in the dynamic table.

5.2 Electronic reporting

The CBTP relied on small handwritten data on hardcopy tag report cards submitted by anglers via the postal system. While this longstanding method has proven successful, newer electronic methods may streamline the workflow of tag release and recovery reporting for both the staff processing data and the anglers reporting data. The elimination of handwritten forms delivered and received through the mail also reduces the environmental footprint associated with data collection.

Digital forms, interfaced via mobile applications or online surveys, minimize data misreporting or under-reporting, encourage the use of device-enabled GPS location data, and enforce data constraints by using dropdown and toggle menus. One of the most important data points collected in mark-recapture research is the location of tag release and location of tag recovery. Digital forms with options for integrated GPS can improve the quality, precision, and resolution of reported coordinates. While all data collected by the CBTP is self-reported by voluntary constituents and considered best estimates, many of the locations reported since 1963 on hardcopy forms have exceeded logical longitude or latitude ranges (e.g. 181° W or 90.6° N). Enforcing data constraints by only allowing submission of coordinates within the logical longitude and latitude ranges can flag out-of-range entries at the time of submission. A mobile application also enables one-touch submission of the constituent's location, assuming the constituent is reporting the tag release or recovery location at the precise location. Online forms, presumably used for reporting information from a computer, may not benefit from GPS-enabled location because it would correspond to the location of the desktop machine. In such cases, drop down menus for location reporting suffice.

The delivery of surveys, like the International Billfish Angler Survey, may also benefit from digital delivery and submission. The use of fillable forms as PDFs, online links, or as a mobile application interface may encourage more users to quickly submit information that was previously hampered by the need to return surveys in the mail. Years of feedback from constituents participating in the CBTP indicated that the ability to submit survey data online was a welcome change to the traditional hardcopy forms. Additionally, many hardcopy forms

delivered by mail never reached their intended destination due to address errors and would be returned to the SWFSC weeks later. Delivering forms by email allows for instantaneous acknowledgement of failed delivery, which can generally be rectified by checking for spelling mistakes using database querying tools. Distributing and receiving surveys by email or other digital mediums also supports distribution and participation statistics generated by online form services (i.e. Google Forms) otherwise laborious and often inaccurate by manual inventorying methods for hardcopy forms.

Digital forms with options for attachments may enhance the quality of data by allowing for the simultaneous collection of important images during tagging data submission. Often, release and recovery reports for the same tag may not identify the same species. For example, the species at time of tag release may be identified as a Pacific blue marlin, while later identified as a striped marlin at the time of tag recovery. Encouraging the submission of an accompanying photo during data reporting allows the scientists managing the tagging program to confirm identity of the animal. The early implementation of a digital medium for reporting tag releases and recoveries may also enhance the design of the backend database. Handwritten data on hardcopy forms need to be interpreted and manually populated into the database, often leading to human error during data input. Digital data collection results in standardized flat files which can be automatically imported into dedicated database tables. This workflow improves data accuracy by eliminating variable handwritten responses, and when data processing is automated via scripting, can drastically reduce the backend manual data processing for a tagging program.

While digital data collection and processing presents many advantages over manual and hardcopy methods, there are still challenges. First, the ability of the constituent base to access mobile devices during tagging operations may be highly variable. Many anglers may prefer the hardcopy forms because they present less risk of water submersion than cell phones at the time of tagging. Many digital forms require a constituent email to quantify distinct users, confirm and inventory receipt of submissions, and communicate results. This email requirement may exclude certain demographics either not willing to share their email or those without email accounts. The choice to develop a mobile application should also account for the varied operating system (OS) software native to different mobile devices—which include fully open source, partly open source, and closed or proprietary software—and the eventual successors to the current OS. Unless a tagging program has a dedicated staff member to manage source code to keep up with inevitable OS changes, patches, bugs, and fixes inherent in application development, the use of online forms with backend support is recommended.

5.3 Program growth

The very existence of the CBTP was the result of the Cooperative Gamefish Tagging Program, originally founded in the Atlantic Ocean, expanding to the Pacific Ocean to accommodate for the unexpected geographic range of new tagging efforts. Conventional tagging programs targeting highly migratory species should prepare for the eventual growth in the geographic range of international constituents reporting tag and biological information over time. Using global and standardized location designations (e.g. 10° blocks) rather than colloquial ones (e.g. “Southern California”) will help prepare for the eventual globalization of a program.

Tag recovery is the ultimate goal of mark-recapture research, so broadcasting information on how to best report tag recoveries as widely as possible should be a priority for any tagging program. Preparing reward announcements in multiple regional languages is fundamental to the success of recapture reporting. The most common regional languages encountered by the CBTP based out of Southern California, are English and Spanish, and the CBTP recapture report form, tag distribution letter, recapture letter, and reward information on the body of the physical tag are printed in both languages. Depending on the geographic range of the species, we recommend the inclusion of as many relevant language options as possible on the tag body or data reporting form. If using a logographic writing system (e.g. Japanese kanji), we recommend the additional use of an alphabetic writing system to supplement readability. Universal symbols, like those for currency (e.g. $, ¥,£,€), may also supersede the need for language translation, especially when paired with a phone number.

Outreach and reporting is another component of a tagging program that may need to change over time due to growth of a constituent base. We recommend the use of a centralized webpage to streamline the reporting workflow for program staff and to ensure constituents can access information year-round on their own accord. Web mapping services are an efficient method to release data in near real-time to inform the tagging community of releases and recoveries without the need to send individual updates. The use of a date-filtered map may also allow anglers to understand the temporal characteristics of fish movement and availability and provide records for anglers on their fishing activity.

6. References

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Appendix I: Data Sharing Agreement

The Southwest Fisheries Science Center Cooperative Billfish Tagging Program: Data Sharing Agreement

This agreement establishes the terms and conditions under which the Southwest Fisheries Science Center (SWFSC) Cooperative Billfish Tagging Program (hereafter, the Program) shares tagging data with the following party:

Organization: _____

Point of Contact: _____

Research purpose: _____

Date: _____

1. The confidentiality of voluntary participants will be protected as follows:
    a. Personally identifiable information (PII) will not be released. PII is defined as constituent name in combination with one or many of the following attributes: address (*address1, address2, city, state_region, country*, or/and *mail_code*), phone number (*phone_work* and/or *phone_home*), *fax*, and/or *email*. Constituent name, organization or club name, and/or boat name by themselves or in combination are considered public information, as they relate to fishing information.
    b. 5-digit numeric sequence will represent individual taggers in the interest of quantifying repeat tagging effort for data analysis.
2. The receiving party will not release data to a third party without prior approval from the Program. Approved data sharing to a third party must abide by these terms, confirmed by a signed copy of the agreement by such party.
3. Any publication, report, or presentation using the data should cite the origin of the data as "the Southwest Fisheries Science Center's Cooperative Billfish Tagging Program".
4. Data shall be utilized solely for the original stated research purpose. Changes to this purpose should be approved by the Program prior to publication.
5. The receiving party acknowledges and understands the data quality and caveats listed in this agreement.

Data Collection

Since 1963, the Program has provided conventional tags and reporting cards to anglers around the world to promote the ethical angling, skillful tagging, and catch-and-release of highly migratory billfish species. Anglers fish on their own impetus and are instructed to affix tags to the dorsal musculature of live billfish species before release and record the following information on a tagging card: *Tag number, species, fish length, fish weight, date, latitude and longitude, location, club, angler name and address and email, captain name and address, boat name, gear type, bait type, water temperature, fight time, fish condition, and other comments.*

Since its inception, the Program has released more than 80,000 tags on billfish, sharks, and tuna around the world and compiled catch effort data from more than 26,000 voluntary angler surveys gauging number of fishing days, fishing location, and number of fish caught per angler per calendar year since 1969. Hardcopy tag report cards are received in the mail and annual surveys are distributed online and/or emailed to willing participants as digital forms and returned either via email or hardcopy in the mail. Reports of recaptures are fielded by phone and email and include: *tag number, angler name and contact information, location, date, species, sex, length, weight, gonad weight, fishing gear, vessel type, vessel name, and water temperature*.

Survey and tag release and recapture data are manually populated into the relational Billfish Tagging Database managed at the SWFSC using numeric codes for species, location, condition, and bait type. Codes will be attached to the shared data file.

Data Quality and Caveats

The voluntary angler-based data reported to the SWFSC is not verified at time of collection by the SWFSC or a credential scientific party, unless specifically indicated as "research" in the database entry (conducted by SWFSC or affiliate university and research institutions). As such, fish weight, length, condition, and fight time are assumed to be estimated by the angler or captain. Although many location coordinates may be accurately sourced from GPS, all locations should be treated as estimates. Blanks should be treated as "No data", as the integer "0" is a valid code for some data fields. These data issues should be considered before interpreting any analyses based on SWFSC Cooperative Billfish Tagging Program data.

Please contact the Program for any other questions regarding the dataset. An entity-relationship diagram (ERD) for the database is also available upon request.

Appendix II: Template Tag Distribution Letter

Date

Name
Organization
Address
Address

Dear ___,

In response to your request for tags I have enclosed ___ tags numbered from A_____ to A_____. These tags are for tagging billfish as part of our angler based tagging program. A Billfish Identification Guide and Billfish Tagging Guide are also available on our Billfish Research webpage found at the Southwest Fisheries Science Center website, https://swfsc.noaa.gov.

Since the establishment of the Marine Game Fish Tagging Program in 1963, the Southwest Fisheries Science Center has provided tagging supplies for tagging swordfish and marlin in the Pacific and Indian Oceans. These tags should only be used to tag swordfish, marlin, spearfish and sailfish. The guides enclosed will help you identify billfish to species, and provide you with the best practices to tag and release fish safely. When you tag fish, please return tagging cards to us as soon as possible so we may add your information to our database. Thank you for supporting the Billfish Tagging Program!

If you have any questions regarding the Billfish Tagging Program, please feel free to phone me at the Southwest Fisheries Science Center.

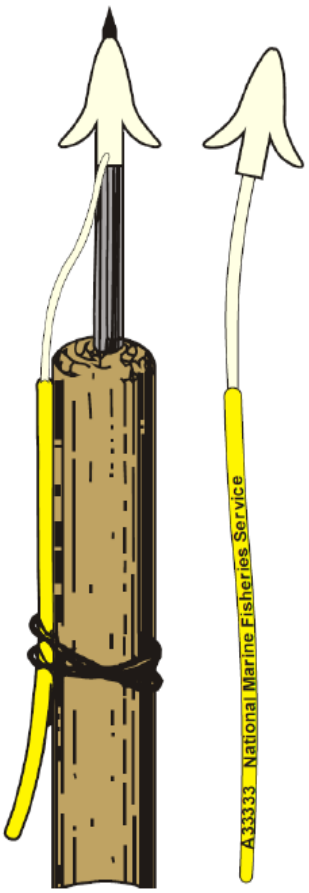
Good luck and happy fishing!

Appendix III: "Constructing a Tagging Pole" Guide

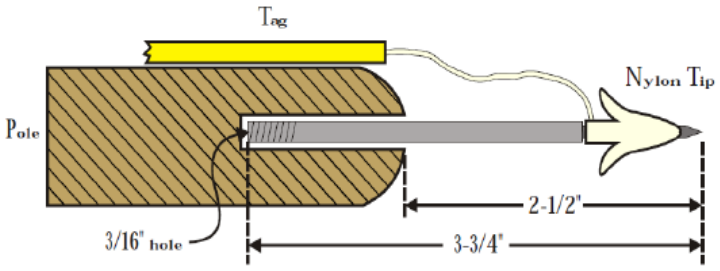
NOAA FISHERIES
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

CONSTRUCTING YOUR TAGGING POLE FOR SUCCESSFUL CATCH, TAG, AND RELEASE

It is important that the billfish tag be applied properly. Tag location, angler, and depth are critical to successful tagging. For striped marlin 100 to 200 pounds, the tag should be inserted 2.5 inches just below the tallest part of the dorsal fin. It is important to check the length of the applicator pin installed on these poles to ensure the length of the tip matches the fish you are seeking. For larger fish such as blue and black marlin, the tagging applicator pin may be 3.5 inches deep. Conversely, if you are tagging small narrow fish like sailfish and shortbill spearfish, then it would be better to shorten the pin. Manufactured tagging poles are available at most retail sportfishing stores. Some manufacturers have tagging poles that have pin lengths that are adjustable by moving the stopper.



If you construct your own tagging pole, an old wooden broom or mop handle about five feet long works very well. A hole should be drilled with a 3/16 inch or No. 16 drill bit to a depth of 1.25 inches for the applicator tip (see diagram below). Use a good-grade epoxy to secure the applicator pin and seal out saltwater.



Appendix IV: "Take Along Tagging Guide"

"Take Along" Tagging Guide

1. BEFORE YOU CATCH YOUR FISH:

First decide if you plan to tag and release any fish caught. If so, use a circle hook which reduces deep or foul hooking when bait fishing or a single circle or single 'J' hook if trolling. Do not use double rigged 'J' hooks when releasing your catch.

2. WHILE FISHING:

Never attempt to tag a fish while it is jumping or thrashing about. Bring your fish to leader as quickly as possible but wait until the fish is calm and swimming beside the boat before tagging.

3. TAGGING:

Tag the fish as it is being towed alongside the boat by inserting the tag in the back muscle below the tallest part of the dorsal fin. Avoid the gills, head, and stomach. Take care not to allow your fish to injure itself on the vessel's transom or hull.

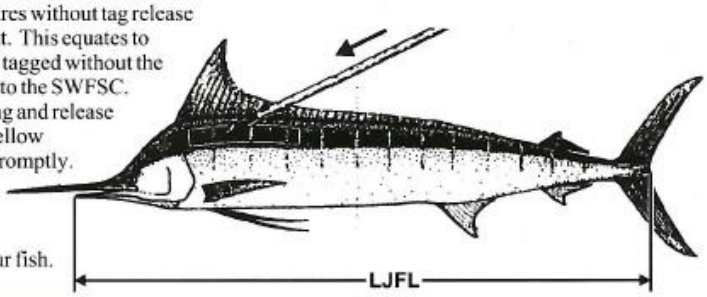
4. RELEASING:

Revive all fish by slowly towing it through the water, allowing water to flow over the gills until its normal color returns and it begins to swim on its own. Remove the hook with a good pair of pliers, or if deeply hooked in the throat or stomach, release it by cutting the leader as close to the hook as possible.

5. COMPLETE THE BILLFISH TAGGING REPORT CARD:

Fill out the yellow Billfish Tagging Report card completely and as accurately as possible indicating latitude and longitude, date of release, estimated length (lower jaw-to-fork length; LJFL) and estimated weight of the fish. Include name and mailing address of the angler and boat captain and other remarks as appropriate. Return cards promptly to the Southwest Fisheries Science Center.

PLEASE NOTE: Billfish recaptures without tag release information now stand at 12 percent. This equates to nearly 6,400 billfish that have been tagged without the release information being returned to the SWFSC. Make your tagging effort count. Tag and release your fish skillfully and return the yellow BILLFISH TAGGING REPORT promptly. Though easily forgotten in the heat of battle and glow of success, returning the card is the most critical and final step in tagging your fish.



- Fill out the card completely and as accurately as possible.
- Indicate latitude, longitude and locally known fishing area.
- Estimate the length of the fish as "tip of lower jaw-to-fork" length (LJFL).
- Estimate weight of the fish.
- Include any remarks, club name and complete address of the angler and the boat captain.
- Return cards promptly to the Southwest Fisheries Science Center. Tagging is of no value unless this *Billfish Tagging Report* card is returned. Postage is paid if mailed in the U.S.A.

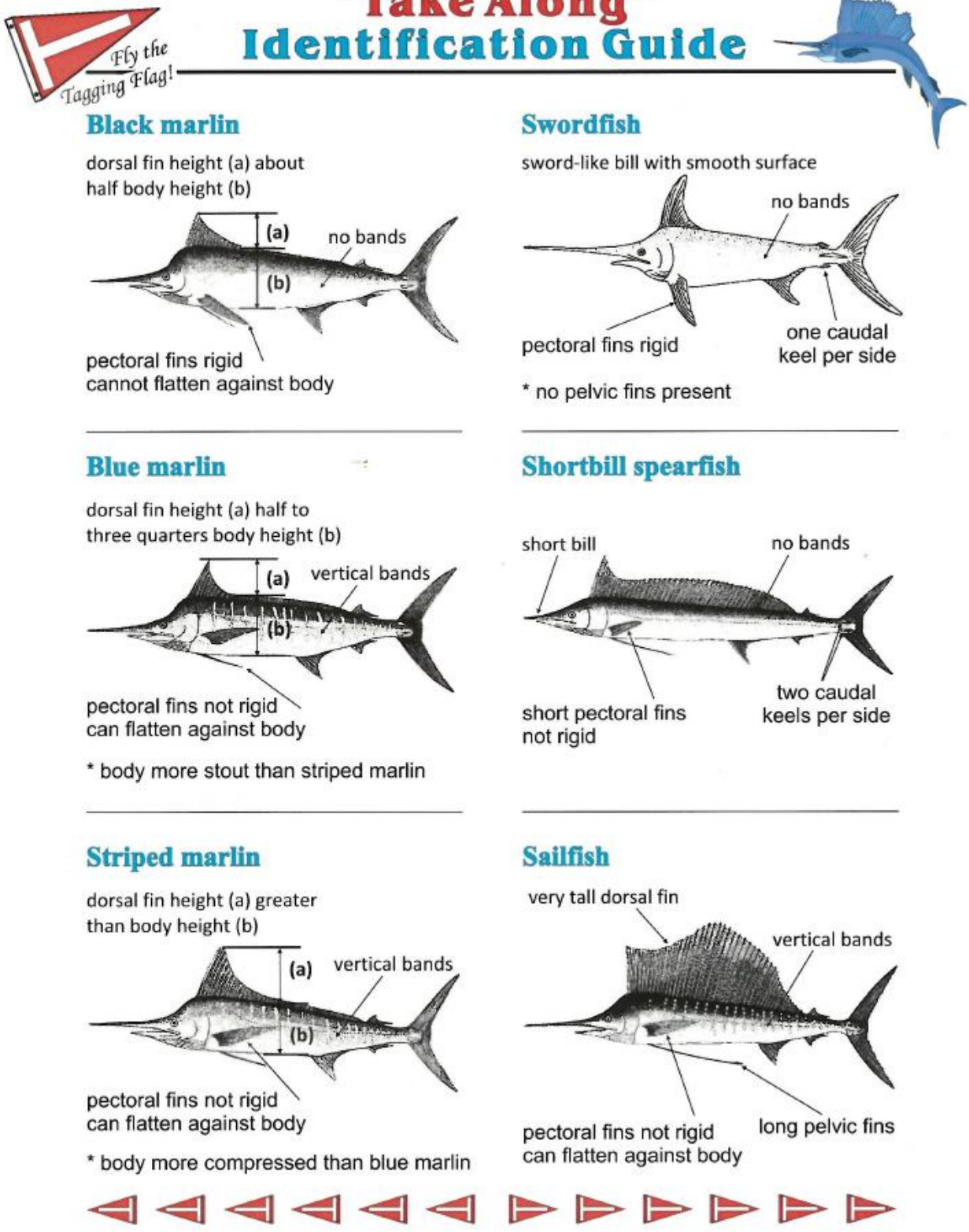
COMPLETING THE BILLFISH TAGGING REPORT CARD

NOAA, National Marine Fisheries Service
BILLFISH TAGGING REPORT
If mailing outside USA, postage must be affixed. Please return card. Otherwise tagging is of no value.
PLEASE FILL IN DETAILS AND MAIL TODAY. TAG #: A33333

Latitude: 33° 14' N Longitude: 118°14' W
Locality: East End Catalina Is. CA
Species: Striped Marlin Date: 6/10/98
Estimate length (tip of jaw to fork of tail): 72 inches. Weight: 140 lbs.
Fish Condition: Good Bait type: Plastic Lure
Angler: Bill Fish Fight time (minutes): 23
Address: P.O. Box 271 La Jolla, CA Zip: 92038
Club: Anglers Club
Captain: Capt. Joe Dew Boat name: Good Grief
Address: P.O. Box 271 La Jolla, CA Zip: 92038

Response to this form is voluntary.
OMB 0648-0008, expiration date 08/31/2001
NOAA 88-162, 2/98

Appendix V: "Take Along Identification Guide"



Appendix VI: Large Pelagics Tag Recovery Datasheet

PACIFIC BILLFISH, TUNA, AND SHARK TAGGING PROGRAM
Southwest Fisheries Science Center
TAG RECOVERIES

Angler and Tag Information (all fields required)

Angler Name: _____

Phone Number: _____ ☐ N/A

Address: _____ ☐ N/A

Email: _____ ☐ N/A

Species (common name): _____

Tag type(s)	Conventional (plastic spaghetti)	Satellite (SPOT or pop-off electronic)	Roto-tag (plastic tab for OTC)	Other
Tag number(s)				

Tag Affiliation: NMFS IATTC *NRIFSF Other: _____

Date recaptured (mm/dd/yyyy): ____/____/____

Vessel type: ☐ Commercial ☐ Recreational ☐ Research/Scientific ☐ Other: _____

Vessel name: _____ ☐ N/A

Gear: ☐ Longline ☐ Purse Seine ☐ Rod-and-Reel ☐ Pole-and-line ☐ Gillnet ☐ Harpoon ☐ N/A
☐ Other _____

Fish and Catch Information

Sex: ☐ Male ☐ Female ☐ Unknown (for sharks, ask about presence or absence of claspers)

[+]Weight: _____ ☐ Lbs. ☐ Kg. | ☐ Estimated ☐ Actual | ☐ Whole ☐ Eviscerated ☐ Other

Length: _____ ☐ In. ☐ Cm. | ☐ Estimated ☐ Actual | ☐ Fork length ☐ Total length ☐ LJFL
(Lower jaw-to-fork length)

Water temperature: _____° ☐ F ☐ C ☐ Unknown

Location: Latitude (0-90°) _____ ☐ N ☐ S; Longitude (0-180°) _____ ☐ E ☐ W

or general location: _____ ☐ Unknown

Biological Sample Information

	Quantity	Reward Given	Reward Delivery			Date Reward Sent
☐ Vertebrae	_____	☐ $100 ☐ [#]T-shirt	☐ In person	☐ Mail	☐ Electronic (SS#)	_____
☐ Stomach	_____	☐ T-shirt	☐ In person	☐ Mail		_____
☐ Ovaries	_____	☐ T-shirt	☐ In person	☐ Mail		_____
☐ Tissue	_____	☐ T-shirt	☐ In person	☐ Mail		_____
☐ Carcass	_____	☐ T-shirt	☐ In person	☐ Mail		_____

* National Research Institute of Far Seas Fisheries (Japan)
+ Whole: round, live, undressed; Eviscerated: dressed, gutted, gilled; Other: finned, decapitated, no tail, etc.
# Reward a T-shirt to anglers who contribute verts but do not want to give their SS# information

Your initials _____

Spanish Translations

Sexo: Sex
Hembra (H): Female
Macho (M): Male
Varón (V): Male

Artes de pesca: Fishing gear
Almadraba: Trap
Red de trasmallo: Gillnet
Arpón: Harpoon
Palangre: Longline
Caña: Pole-and-line
Curricán: Troll
Sedal y anzuelo: Hook-and-line
Red de cerco: Purse seine
Deportivo: Sport/Recreational
Red de arrastre: Trawl

Especies: Species
Atún albacora: Albacore (*Thunnus alalunga*)
Atún aleta amarilla: Yellowfin tuna (*Thunnus albacares*)
Atún aleta azul del Pacífico: Pacific bluefin tuna (*Thunnus orientalis*)
Atún barrilete: Skipjack tuna (*Katsuwonus pelamis*)
Atún patudo: Bigeye tuna (*Thunnus obesus*)
Dorado: Dorado (*Coryphaena* spp.)
Marlín azul: Blue marlin (*Makaira nigricans*)
Marlín negro: Black marlin (*Makaira indica*)
Marlín rayado: Striped marlin (*Kajikia audax*)
Marlín trompa corta: Shortbill spearfish (*Tetrapturus angustirostris*)
Peces cartilaginosos: Chondrichthyes
Peces picudos: Billfish
Pez espada: Swordfish (*Xiphias gladius*)
Pez vela del Indo-Pacífico: Sailfish (*Istiophorus platypterus*)
Tiburón azul (tollo aguado): Blue shark (*Prionace glauca*)
Tiburón blanco: White shark (*Carcharodon carcharias)*
Tiburón bocón: Basking shark (*Megachasma pelagios*)
Tiburón ojón (rabón amargo): Bigeye thresher (*Alopias superciliosus*)
Tiburón tinto (mako): Mako shark (*Isurus oxyrinchus*)
Tiburón zorro (rabón): Pelagic thresher (*Alopias pelagicus*)
Zorro pinto: Common thresher shark (*Alopias vulpinus*)

Appendix VII: Template Tag Recapture Reward Letter

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southwest Fisheries Science Center
8901 La Jolla Shores Dr.
La Jolla, CA 92037-1509

Date
Name
Organization
Address
Address

Dear _____,

Thank you for contacting us regarding the recapture of the tagged _____. The coordinates that you provided allow us to better understand the movements and migration of these fish.

Here are the details about the fish at the time it was tagged:

Tagged:
Location:

The fish traveled a net minimum _____ nautical miles from its release location after _____ days.

I've included a tee shirt for you as a reward for your efforts.

Thank you for your assistance. Good luck with future fishing and we look forward to hearing from you again!