Tagging Blue Marlin and Tunas in the Azores Archipelago

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INTRODUCTION

The Azores archipelago in the center of the North Atlantic is internationally recognized as a premier destination for sport fishing of blue marlin, bluefin and bigeye tunas. This mid-ocean hotspot emerges from a unique combination of geographical, oceanographic and ecological conditions. Nine volcanic islands and extensive seamount systems create a dynamic interface between temperate and subtropical marine ecosystems, while the archipelago's distance from continental shores results in relatively low anthropogenic disturbance and healthier pelagic populations compared to other Atlantic regions.

The Azores Current—the southeastern branch of the Gulf Stream— flows east of the Mid-Atlantic Ridge, generating persistent mesoscale eddies that interact with the region's complex bathymetry. These warm and cold-core eddies, combined with steep volcanic topography, produce localized upwelling through the island mass effect, fueling primary productivity that supports a dynamic pelagic food web (Caldeira and Reis 2017). This bottom-up productivity attracts krill, baitfish, and deeper mesopelagic species, which in turn attract apex predators including billfish, tunas, mahi-mahi, pelagic sharks, and cetaceans. The resulting biodiversity is exceptional: 24 cetacean species, five sea turtle species, ten nesting seabird species, six tuna species, five billfish and spearfish species, and over 60 shark and ray species utilize these waters (Afonso *et al.* 2020).

This extraordinary megafauna diversity has positioned the Azores as a high-priority area for marine research. Afonso et al. (2020) outlined a conservation action plan emphasizing the need for research investigating the patterns and processes underlying these aggregations. Given the wide-ranging movements of these species across offshore and remote habitats, satellite telemetry represents an ideal approach to address critical knowledge gaps. While tracking studies have documented movements of numerous whales, seabirds, tunas, and sharks from the region (Figure 1), billfish remain conspicuously understudied despite their ecological significance and economic value to both recreational and commercial fisheries.

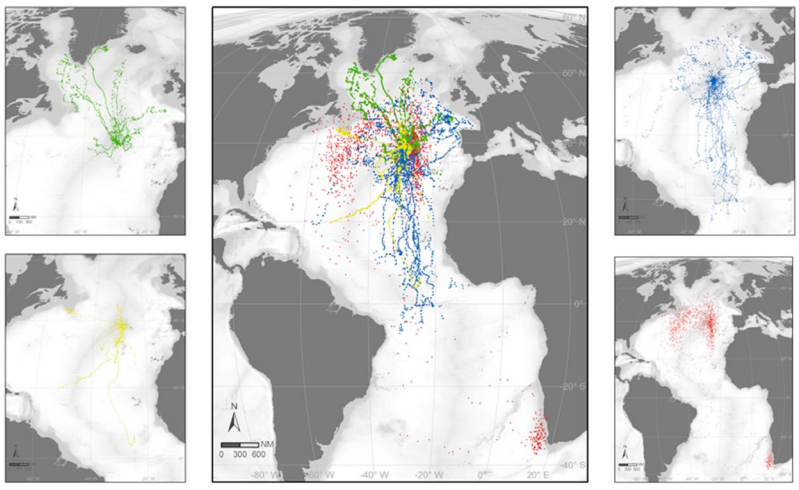

Figure 1. Tracks obtained via satellite tagging programs implemented in the Azores archipelago. Dots represent estimated positions from individual baleen whales (green), seabirds (red), and tuna (yellow) and

sharks (blue). Redrawn from data in published and unpublished reconstructed geolocations, GPS-logged or ARGOS positions. Figure from Afonso et al 2020.

Blue marlin (*Makaira nigricans*) are apex predatory billfish distributed throughout the Atlantic Ocean and managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). One of the most highly prized game fish in the North Atlantic, blue marlin remain poorly understood and are classified as "data deficient" by the IUCN. They support valuable recreational fisheries while simultaneously experiencing high bycatch mortality in pelagic longline fisheries targeting tuna and swordfish (Mourato *et al.* 2018; Martinez-Escauriaza *et al.* 2021). Although direct retention in Azorean waters is minimal (Pham *et al.* 2013), their transoceanic migrations expose populations to fisheries across multiple jurisdictions, and recent evidence suggests illegal and unreported catch within the Azores EEZ may be substantial (Moura *et al.* 2025).

Recreational catch data from the broader Macaronesian region indicate blue marlin undertake seasonal latitudinal migrations, moving from equatorial waters in early winter northward through late winter and spring, arriving in Azorean waters during summer months (Figure 2; Martinez-Escauriaza et al. 2021). Satellite telemetry studies across the North Atlantic corroborate these patterns, revealing blue marlin occupy lower latitudes during cooler months and higher latitudes during warmer periods (Andrzejaczek *et al.* 2023). While numerous individuals tagged in the eastern Atlantic have been tracked westward across the basin, limited tag retention prevents confirmation of return migrations. Furthermore, tagging efforts from the western Atlantic have suffered from small sample sizes and short deployment durations, leaving substantial uncertainty regarding population connectivity and migratory phenology. Critically, no published blue marlin tracking data exist from the Azores—a significant knowledge gap given the region's importance as a seasonal aggregation area.

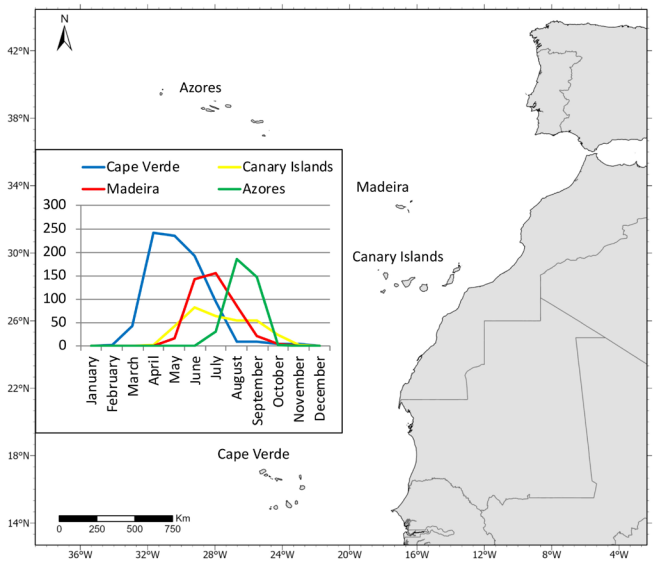

Figure 2. Macaronesian archipelagos and the presence of blue marlin throughout the year (2011 to 2019) reported to billfishreport.com. Figure from Martinez-Escauriaza et al. 2021.

Importantly, prior work by our team through the Great Marlin Race Program in collaboration with local fishers and the International Game Fish Association (IGFA) has enabled limited tagging in the region with excellent results (Figure 3), demonstrating both the feasibility of deployments and the value of the resulting data. The Stanford Block Lab has pioneered satellite tag technology and deployment techniques for pelagic species, generating significant tracking datasets on tunas, billfish, and sharks across the Atlantic and Pacific oceans (Block *et al.* 2005; Block *et al.* 2011; Freitas *et al.* 2022; Andrzejaczek *et al.* 2023). Additionally,

our team has collected approximately 100 Atlantic bluefin tuna tracks—primarily from Mediterranean bluefin tuna stock—that pass through the Azores archipelago during trans-Atlantic migrations. These existing datasets, which include depth, temperature, and oceanographic data, have never been analyzed specifically to understand how bluefin tuna exploit Azorean waters, representing an untapped resource for understanding pelagic habitat use in the archipelago as the tags record oceanographic conditions in the region.

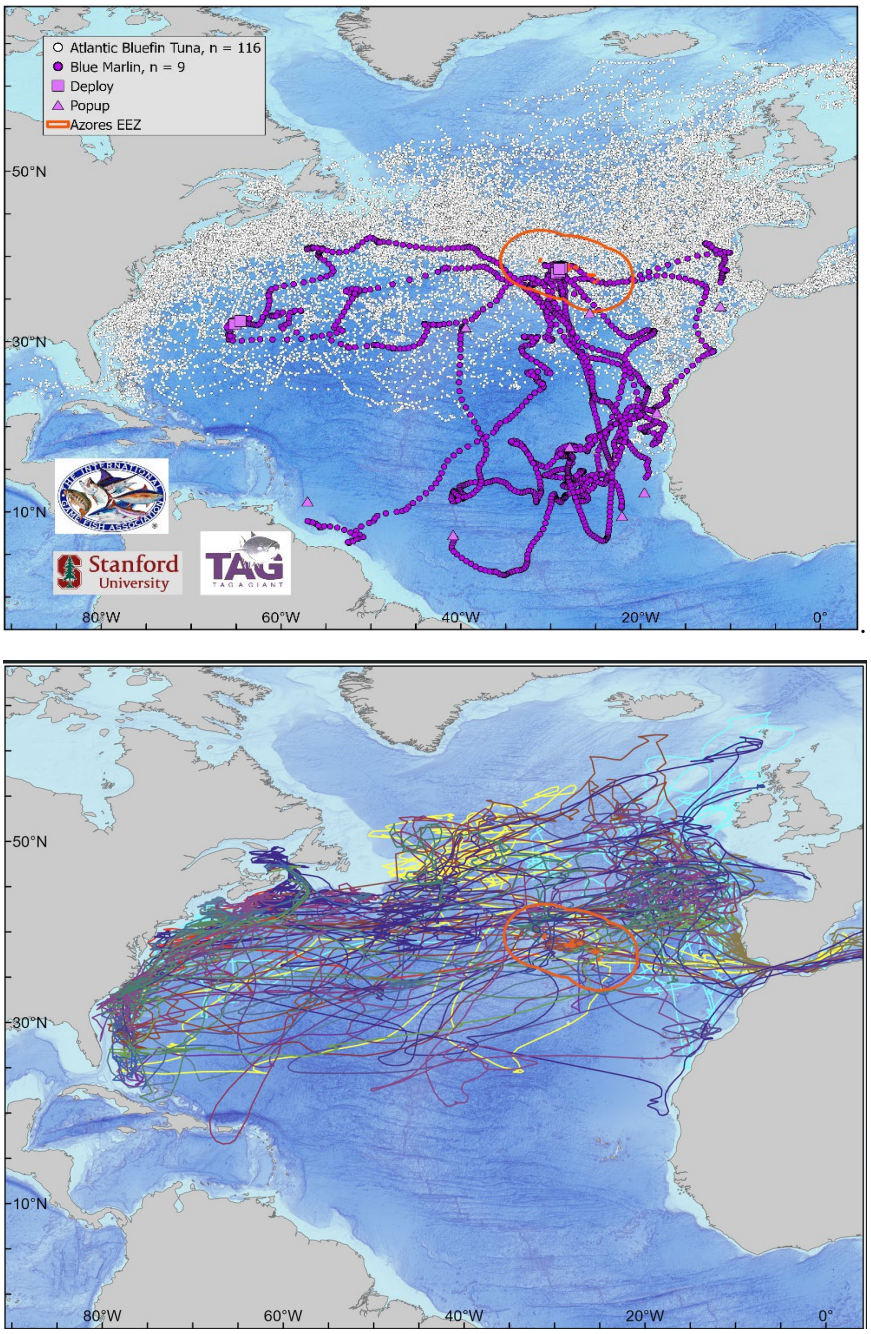

Figure 3. (Top) The Azores Archipelago has emerged as a hot spot for pelagic fish. Here blue marlin (Magenta) & bluefin tuna (white) occupy the EEZ (red circle around the Archipelago yet use vast regions of the North and South Atlantic ocean. (Bottom) The individual tracks of fish that pass into the Portugal EEZ (red circle) surrounding the Azores archipelago.

To conserve and effectively manage billfish and tuna populations as vital components of Atlantic pelagic food webs and significant protein sources across Atlantic nations, it is essential to understand the role of the Azores archipelago in creating critical habitat for these species. This proposal presents a unique opportunity to collect baseline data necessary for understanding how highly migratory pelagic fish utilize the region through collaboration between Stanford University, the Guy Harvey Foundation, and Portuguese researchers. We propose in this new project to work with the local marine community (identifying our prior collaborators from Portugal) and under the direction of regional sportfishers. We plan to collect high resolution data from within the archipelago primarily on billfish (n=15). In addition, we recommend that we utilize a small number of tags (n=5-10) on bigeye and/or yellowfin tuna species which are caught simultaneously while billfishing. Together we hope to better understand how these extraordinary pelagic fish utilize the region. Safeguarding pelagic fish biodiversity requires innovative technologies that address critical questions about these iconic yet poorly understood species that comprise a multi-billion-dollar global commodity.

Proposed Plan

The Stanford Block lab team, led by Drs. Block and Andrzejaczek, will prepare electronic tags in the lab for field deployments. In summer 2026, both scientists will travel separately to the archipelago to work alongside local fishers and Dr. Guy Harvey, ensuring proper tag attachment techniques and maximizing long-term tag retention. Dr. Block can teach the mate and crew the methods; however, to guarantee success – particularly for tuna tagging – we recommend having a two person team including experienced taggers and lip hookers (Mr. Ted Reimer or Rob Schallert) present if funding permits. Deploying tags across multiple pelagic species will increase our capacity to characterize habitat use patterns and evaluate how different apex predators utilize the region.

Tagging

We propose to deploy most of the tags (15) on blue marlin using established techniques in a dedicated satellite tagging program to characterize blue marlin distribution, behavior, and habitat use in the Azores and resolve how this population segment relates to broader North Atlantic stock structure. Potential interactions with international fishing fleets will be evaluated through incorporating vessel data from Global Fishing Watch. These data can identify areas of overlap with fisheries that could benefit from increased management efforts. Assessment of movement corridors and aggregation hotspots would aid in identification of suitable management strategies such as marine protected area placement and time-based area closures. The resulting data will inform species-specific management while contributing to collaborative efforts mapping multispecies megafauna hotspots throughout the archipelago—addressing priority research needs identified in the regional conservation action plan (Afonso *et al.* 2020).

In addition, we propose to put 5 satellite tags on bigeye tunas opportunistically captured during blue marlin fishing operations and released using established protocols for bluefin in the North Atlantic. If an additional five tags become available, we will similarly tag yellowfin tuna. These deployments will provide comparative data on tuna habitat use within the region and enable multispecies niche analyses.

Analyses of Data

Drs. Block and Andrzejaczek, in collaboration with lead IT data manager Mike Castleton, will integrate existing and newly collected satellite tag data with oceanographic data from Copernicus Marine Service to

identify critical aggregation areas and characterize environmental conditions associated with pelagic fish presence. Dr. Andrzejaczek will lead spatial analyses to discern species-specific and multispecies habitat use patterns. As new tag data are received, we will expand our analyses and prepare manuscripts for publication in peer-reviewed journals.

We also propose to analyze the bluefin tuna dataset from the region (Figure 3) and then examine at a finer scale how these species are utilizing the ocean. For this analysis, our existing TAG dataset will be used to better understand the timing of arrival and departure as well as the habitat use within the region. For this analyses, we need to provide information on the size classes using the Azores, their residency period, the location of their foraging areas and then model the habitat they utilize within the region.

Habitat Modeling all 4 species.

Within a year we will have data that might enable habitat modeling of 4 species of pelagics (blue marlin), bluefin, bigeye and yellowfin tunas. Together this will create a rich dataset that will enable better understanding of niche separation and overlap in the region inclusive of foraging hotspots.

Budget Narrative

The budget will support purchasing of electronic tags (20) and deployments on 15 blue marlin and 5 tunas. The tags will be purchased from Wildlife Computers ($3650); programmed and prepared with anti-fouling and tethhers with their proper titanium darts and leaders at the Block lab ($550 each). Post preparation they will be shipped to the Azores ($500) with 3 tag pole sets that will enable multiple teams to participate in deployments ($2000 for tag poles and applicator tips). Once tags pop up the team will have satellite and computational costs to produce a track ($500 per tag).

Dr. Sammy Andrzejaczek will be responsible for analyzing all data generated from the tags and preparing the tracks with technical support from Mr. Michel Castleton. This project will require 1 month of time from Mr. Castleton and 6 months of time from Dr. Andrzejaczek which we have put in the budget with staff time and fringes.

Budget

Title: Analyzing Hot Spots for Billfish and Tunas in the Azores Archipelago
Period: January 1, 2026- December 30, 2026
Sponsor: Guy Harvey Foundation

BUDGET

Category - Details	YEAR 1 TBD	Total
Personnel		
Other Professionals - Samanthan (9 months)	61,028	61,028

Other Professionals - Mike Castleton (2 months)	19,243	19,243
Total Salary	**80,271**	**80,271**
Fringe benefits Staff at 32.90%	**26,409**	**26,409**
Travel		
Flights to the Azores 2 Trips (Flights, lodging and food)	7,500	7,500
Other Direct Costs		
Preparation of 20 tags with Titanium darts ($550 each)	11,000	$11,000
2 tagging poles $650	1,300	1,300
15* Wildlife Computer Tags: $3650 ea	54,750	54,750
	450	450
Applicator tips for tagging poles 10 units @45 each	1,000	1,000
Other tagging supplies for animal care	1,200	1,200
RNA Later for tissue samples	500	500
Tota Other Direct Costs	**70,200**	**70,200**
Total Other Direct Costs	**184,380**	**182,680**

***Block lab will contribute 5 Satellite tags for the Tuna tagging**

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CURRICULUM VITAE

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ADDRESS

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Department of Oceans and Biology

EDUCATION:

1980	B.A., University of Vermont. Zoology
1986	Ph.D., Duke University. Zoology

PROFESSIONAL POSITIONS:

1986-1988	Muscular Dystrophy Association Postdoctoral Fellow. Department of Biology and Department of Anatomy, University of Pennsylvania
1989-1993	Assistant Professor, Department of Biology, University of Chicago.
1994-1998	Assistant & Associate Professor, Department of Biological Sciences, Stanford
1999-Present	Charles & Elizabeth Prothro Professor of Marine Science, Stanford University
2004-Present	Professor, Department of Biological Sciences, Stanford University
2022-Present	Department of Oceans, Professor, Stanford University

SELECTED AWARDS

1996	MacArthur Foundation Fellow
2012	Rolex Award for Enterprise
2016	Benchley Award for Ocean Science
2021	Elected to IGFA Hall of Fame
2023	Elected Member of the National Academy, USA

RECENT PUBLICATIONS

H Factor: 95, Publications 261

Gilmour, M.E., Pollock, K., Adams, J., Block, B.A., Caselle, J.E., Filous, A., Friedlander, A.M., Game, E.T., Hazen, E.L., Hill, M. and Holmes, N.D., 2025. Multi-Species Telemetry Quantifies Current and Future Efficacy of a Remote Marine Protected Area. *Global Change Biology*, *31*(4), p.e70138.

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EDUCATION HISTORY

April 2024 – Present	**Research Scientist**, Block Lab, Hopkins Marine Station, Stanford University
2019 – March 2024	**Postdoctoral Fellow**, Block Lab, Hopkins Marine Station, Stanford University
2015 – 2018	**Ph. D.**, The University of Western Australia (UWA) *Thesis title: Investigating the drivers of vertical movement patterns in predatory pelagic fishes.*
2013	**Bachelor of Marine Science (H1 Honours),** The University of Western Australia *Thesis title: The ecological connectivity of whale shark aggregations in the Indian : a photo-identification approach*
2010-2012	**Bachelor of Marine Science,** James Cook University

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OTHER ACADEMIC POSITIONS

2025 – present Member of the Scientific Advisory Committee to the US sections of the IATTC

2024 – present Member of Stanford Oceans Department seminar committee

2024 – present Guest editor for special issue of Wildlife Research journal

2022 – present Editor at ICES Journal of Marine Science

PUBLICATIONS

H Factor: 15, Publications: 35

1. Daley S, **Andrzejaczek S**, Shallert RJ, Carlson PM, Caselle JE, Papastamatiou Y, Block BA (Accepted) Reef manta ray habitat use and residency at a remote marine protected area. Marine Ecology Progress Series.

2. Beale CS, Runtuboy F, Sianipar AB, Beer AJE, Kadarusman, Erdmann MV, Setyawan E, Green L, Duffy CAJ, **Andrzejaczek S**, Block BA, Fordberg K, Meekan M, Gleiss AC (2025) Deep diving behaviour in oceanic manta rays and its potential function. Frontiers in Marine Science 10.3389/fmars.2025.1630451

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20. Jorgensen SJ, Micheli F, White TD, Van Houtan KS, Alfaro-Shigueto J, **Andrzejaczek S**…, Ferretti F (2022) Emergent research and priorities for shark and ray conservation. Endangered Species Research. 10.3354/esr01169

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