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Initial results from a pilot study to understand dolphinfish (*Coryphaena hippurus*)

trans-boundary movements in the Eastern Pacific Ocean

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trans-boundary movements in the Eastern Pacific Ocean

Preparado por:

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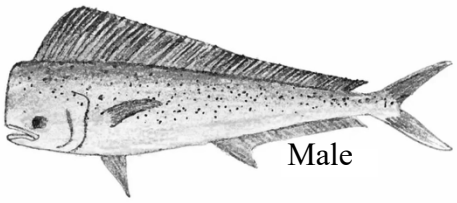
Ecuador, 15 de diciembre de 2025

Tag Number 24

4 days at liberty
Movement: 0.62 m s^{-1} Northwest (bearing 312°)
Growth: 0.25 cm day^{-1} (92 cm TL to 93 cm TL)


Male

Key Points

1. This is a very short deployment in international waters, indicating the high "catchability" of dolphinfish, especially near Fish Aggregating Devices (FADs). However, there is a fair amount of down-current displacement over the 4 days of tag deployment, with the fish crossing the geographic equator in that time.

2. Strong currents in the area coincided with fish movement patterns in both direction and speed indicating that perhaps the currents dictated fish movement.

Fish Biology & Movement Patterns

This approximately 5-month-old mature male, measuring 92 cm TL (80 cm FL) was tagged on 28 Aug 2023 in El Niño conditions (ONI = 1.6) and recaptured only 4 days later at 93 cm TL. In those 4 days, this fish crossed the equator from 0.8°S to 0.5°N, also moving westerly from 96.9°W to 98.3°W, a for a net heading of 312°, roughly NW, and a net displacement of 214 km (133 nm). Overall speed was 53.4 km per day (33 nm/day) or 0.62 m/s, roughly 0.67 bl/s (total body lengths per second). Backdating to a "hatch date" of approximately 28 Mar 2023 indicates fertilization during neutral ENSO conditions (ONI = 0.20). The likelihood of this particular fish entering Peruvian waters is difficult to determine given the short time frame; however, there is nothing to indicate that possibility.

Deployment Date	28 Aug 2023
Recovery Date	1 Sep 2023
Days At Liberty	4
Sex	M
Total Length at deployment (cm)	92
Fork Length at deployment (cm)	80
Total Length at recovery (cm)	93
Total growth (cm)	1.00
Growth Rate (cm/day)	0.25
Age (months)	4.24
Hatch Day	28 Mar 2023
Hatch Day ONI	0.2
Deployment ONI	1.6
Recovery ONI	1.6

Deployment Location	0.8°S x 96.9°W
Recovery Location	0.5°N x 98.3°W
Net Displacement (KM)	214
Net Displacement (NM)	133
Net Speed (KM/day)	53.42
Net Speed (NM/day)	33.20
Bearing (DMS)	312° 00′ 04″
Bearing (cardinal)	NW
Speed (bl/s)	0.67
Speed (m/s)	0.62

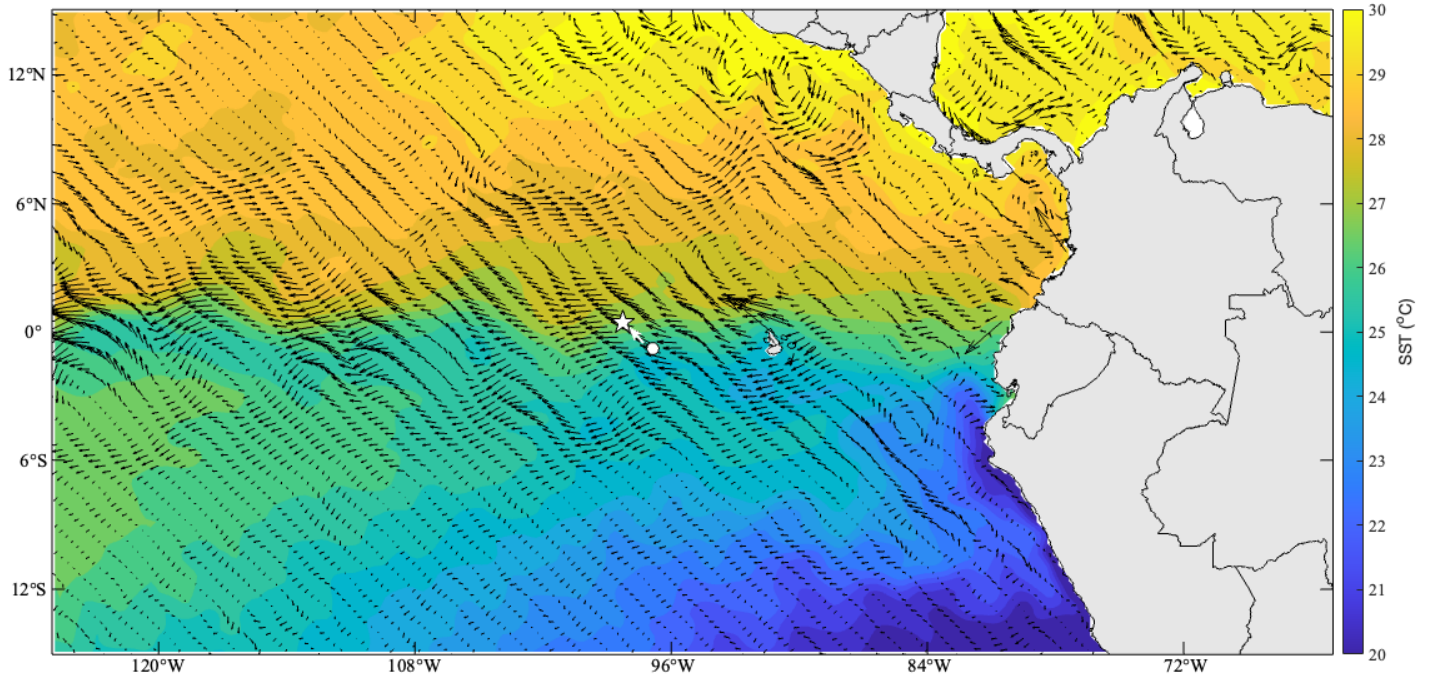


Figure 1. Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

During the four days that the fish was at liberty, the oceanography at the deployment and recapture sites was similar in both thermal environment and surface currents. Sea surface temperature dropped slightly throughout the course of the four days at both sites, with higher temperatures at the recapture site (27.1 °C ± 0.62°C) than at the deployment site (25.5°C ± 0.26°C). Mixed layer depth was similar throughout the deployment with average mld of 13.9 m ± 2.3 m at the deployment site and 13.3 m ± 2.0 m at the recovery site.

Table 1. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	28 August 2023	1 September 2023
Location	0.8°S, 96.9°W	0.5°N, 98.3°W
Surface Current[4] Bearing	WNW (308°)	WNW (285°)
Surface Current[4] Speed	0.45 m s^{-1}	0.92 m s^{-1}
Sea Surface Temperature[5]	25.7 °C	26.1 °C
Mixed Layer Depth[6]	13.1 m	16.9 m

Sea surface currents were similar at both the deployment (0.70 m s^{-1} ± 0.17 m s^{-1}) and recovery (0.75 m s^{-1} ± 0.22 m s^{-1}) sites. At both sites, current speed increased through the four days with speeds nearly doubling in value by the time the fish was recaptured. Although the speed of the currents increased, the bearing was consistently in the WNW direction at both the deployment (294.8° ± 6.7°) and recapture sites (272° ± 12°).

Credits

***Tag 24 was deployed by**: José Zambrano Reasco (captain), William Franco Zambrano, Elvis Cedeño Obando, Pablo Cusme Murillo, Daniel Bello López, Juan Zambrano López, Yoffre Mero Rivas, Ángel Salto Mero y Miguel Saltos Cruz*

***Tag recaptured by**: The recovery was made by a tuna purse seine vessel (Juan Pablo II) during a set on a fish aggregating device (FAD).*

Data maintained by: TBD

***Analysis and Report by:** Christopher R. Perle and Stephanie Snyder Koch*

Footnotes:

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2] The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

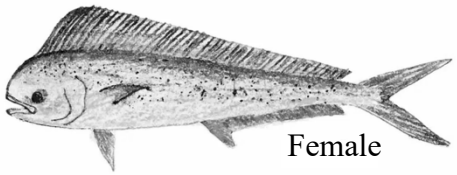
[4]Surface currents velocities were derived from Ocean Surface Current Analyses Real-time (OSCAR) Surface Currents – Final 0.25 Degree (Version 2.0) product (https://doi.org/10.5067/OSCAR-25F20) using Matlab circular (bearing) and linear (speed) statistics packages.

[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html.*

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)

Tag Number 32

141 days at liberty
Movement: 0.12 m s^{-1} NorthEast (bearing 38°)
Growth: 0.47 cm day^{-1} (42 cm TL to 108 cm TL)


Female

Key Points

1. This fast-growing female experienced a variety of currents and sea surface temperatures over nearly 5 months as El Nino conditions developed and while net displacement was distant, average daily movements do not appear to be particularly fast.
2. Changes in current speeds at the deployment site and directions at the recapture site may have played a role in the movement of the fish. Strengthening of surface currents at deployment site in July and the newly available eastward currents in August may have played a role in the observed movement.
3. Transition between cold to warm waters may be a spawning strategy.

Fish Biology & Movement Patterns

This mature female, approximately 9-months-old, measured 42 cm TL (35 cm FL) upon tagging on 11 July 2023 in early El Niño conditions (ONI = 1.10). Recaptured within the EEZ of Costa Rica 141 days later, on 29 Nov 2023 at 108 cm TL, this fish grew 66 centimeters while at liberty, for a growth rate of 0.47 cm/day as ONI increased to 2.0 during the deployment. In 141 days, this fish crossed the equator from 1.1°S to 9.3°N and moved easterly from 93.7°W to 85.5°W, a for a net heading of 38.44°, roughly NE, and a net displacement of 1468 km (912 nm). Overall speed was 10.4 km per day (6.5 nm/day) or 0.12 m/s, roughly 0.161 bl/s (total body lengths per second). A calculated "hatch date" of approximately 11 Nov 2022 indicates fertilization during La Niña conditions (ONI = -0.90). This particular fish is unlikely to have entered Peruvian waters at any point during the deployment; however, movement dynamics indicate that capacity given favorable conditions.

Deployment Date	11 Jul 2023
Recovery Date	29 Nov 2023
Days At Liberty	141
Sex	F
Total Length at deployment (cm)	42
Fork Length at deployment (cm)	35
Total Length at recovery (cm)	108
Total growth (cm)	66
Growth Rate (cm/day)	0.47
Age (months)	8.74
Hatch Day	11 Nov 2022
Hatch Day ONI	-0.9
Deployment ONI	1.1
Recovery ONI	2.0

Deployment Location	1.1°S x 93.7°W
Recovery Location	9.3°N x 85.5°W
Net Displacement (KM)	1468
Net Displacement (NM)	912
Net Speed (KM/day)	10.4
Net Speed (NM/day)	6.47
Bearing (DMS)	038° 26′ 57″
Bearing (cardinal)	NE
Speed (bl/s)	0.16
Speed (m/s)	0.12

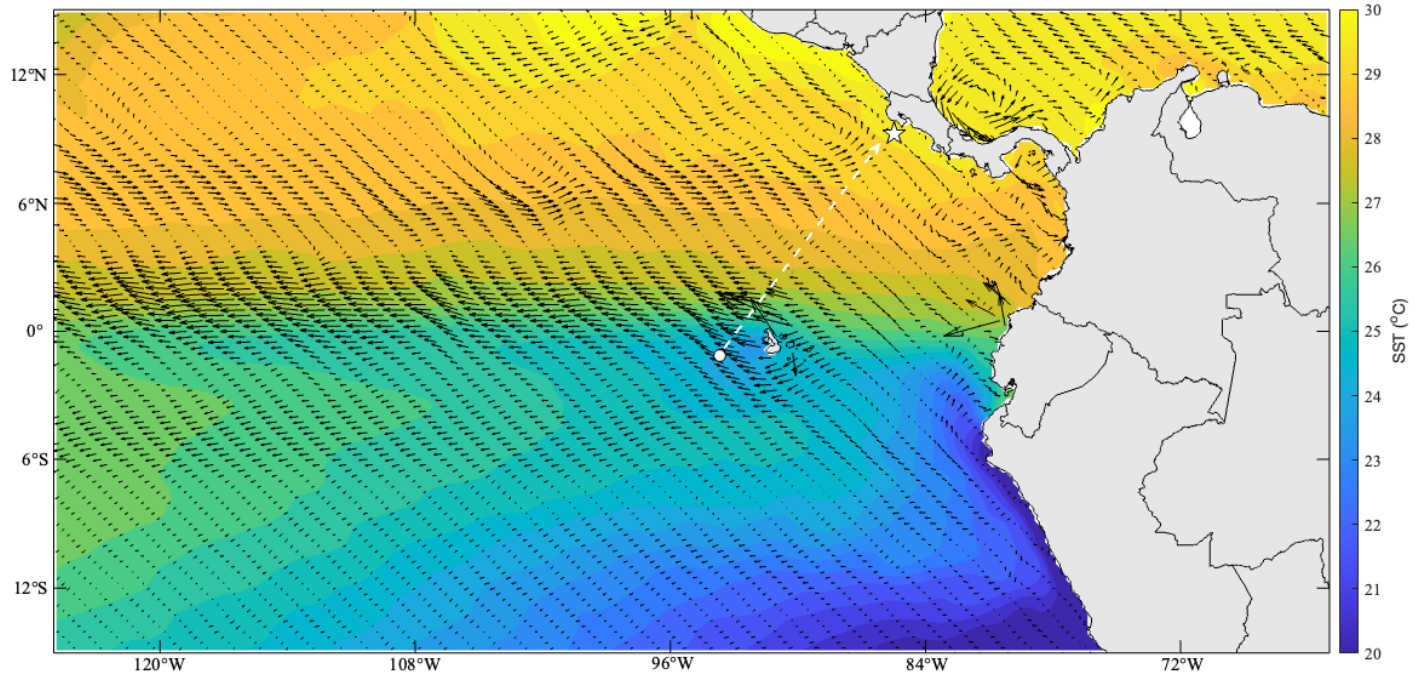


Figure 2. Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

The tagged fish traveled through a strong gradients in surface currents as well as sea surface temperatures transitioning from a site with colder temperatures (24.4°C ± 0.8°C) and deeper mixed layer depths (13.0 m ± 2.2 m) than found at the recapture location (SST: 29.7°C ± 0.41°C; MLD: 10.6 m ± 0.32 m).

Table 2. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	11 July 2023	29 November 2023
Location	1.1°S, 93.7°W	9.3°N, 85.5°W
Surface Current[4] Bearing	215.5° (SSW)	292.8° (WNW)
Surface Current[4] Speed	0.12 m s^{-1}	0.20 m s^{-1}
Sea Surface Temperature[5]	25.8 °C	29.3 °C
Mixed Layer Depth[6]	24.7 m	14.3 m

The journey transects several major surface currents and thermal fronts (Figure 1) that are also temporally dynamic. After the fish left the deployment site, this area experienced an uptick in current strength with an average current speed of 0.49 m s^{-1} ± 0.20 m s^{-1} for the duration of the fish's time at liberty. On the other hand, the recapture site had consistently lower current speeds (0.11 m s^{-1} ± 0.06 m s^{-1}). The sea surface current bearings at the deployment site were fairly consistently in the SW direction (289.6° ± 28°) while the bearing of the surface currents at the recapture site had significant variability - with a standard deviation of 85° - around an average SSW direction (190°). Rather than shifting sporadically, the bearing of the currents at the recapture site swung from a NW direction in July to an E direction in August to a S direction in September and then finally back to a WNW in November.

Credits

***Tag 32 was deployed by**: Johnny Mero Posligua (captain), Gabriel Mero Pilligua, Luis Carranza Valencia, José Rodríguez Quijije y Sergio González Jiménez.*

***Tag recaptured by**: The recovery was made by a Costa Rican-flagged artisanal longline vessel (Daznet)*

Data maintained by: TBD

***Analysis and Report by:** Christopher R. Perle and Stephanie Snyder Koch*

Footnotes:

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2] The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

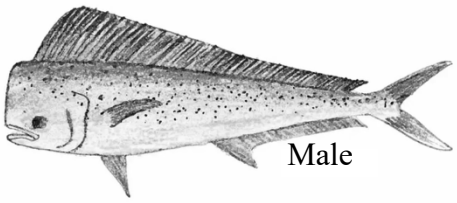
[4]Surface currents velocities were derived from Ocean Surface Current Analyses Real-time (OSCAR) Surface Currents – Final 0.25 Degree (Version 2.0) product (https://doi.org/10.5067/OSCAR-25F20) using Matlab circular (bearing) and linear (speed) statistics packages.

[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html.*

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)

Tag Number 41

24 days at liberty
Movement: 1.65 m s^{-1} West Northwest (bearing 278°)
Growth: 0.25 cm day^{-1} (100 cm TL to 106 cm TL)


Male

Key Points

1. Very rapid movements allowed this fish to travel 3245 kilometers from east of the Galapagos to the central Pacific Ocean in only 24 days.
2. The fish experienced a wide range of sea surface temperature from 22.6°C to 28.2°C.
3. Currents may have facilitated rapid movement with consistent direction and speeds.

Fish Biology & Movement Patterns

In only 24 days, this large mature male dolphinfish travelled 3,425 kilometers (2128 nautical miles), nearly due west from 18 Sep 2023 to 12 Oct 2023, as ONI increased from 1.60 to 1.80 in clearly developed El Niño conditions. Growth was moderate at 0.25cm/day as the fish moved from 1.77°S to 2.45°N and 85.5°W to 116°W. This fish was approximately 5 ½ months old, having hatched around 18 March 2023 in neutral ENSO conditions. Net displacement of 143 kilometers per day required average speeds of 1.65 m/s, or 1.60 body lengths per second, a fast rate of travel for any fish. This particular individual most likely travelled down-current to the west in water just north of the equator in international waters and was eventually captured by a purse seine tuna vessel setting on a FAD.

Deployment Date	18 Sep 2023
Recovery Date	12 Oct 2023
Days At Liberty	24
Sex	M
Total Length at deployment (cm)	100
Fork Length at deployment (cm)	86
Total Length at recovery (cm)	106
Total growth (cm)	6.00
Growth Rate (cm/day)	0.25
Age (months)	5.53
Hatch Day	18 Mar 2023
Hatch Day ONI	-0.10
Deployment ONI	1.6
Recovery ONI	1.8

Deployment Location	1.77°S x 85.5°W
Recovery Location	2.45°N x 116°W
Net Displacement (KM)	3425
Net Displacement (NM)	2128
Net Speed (KM/day)	143
Net Speed (NM/day)	89
Bearing (DMS)	277° 46′ 29″
Bearing (cardinal)	W
Speed (bl/s)	1.60
Speed (m/s)	1.65

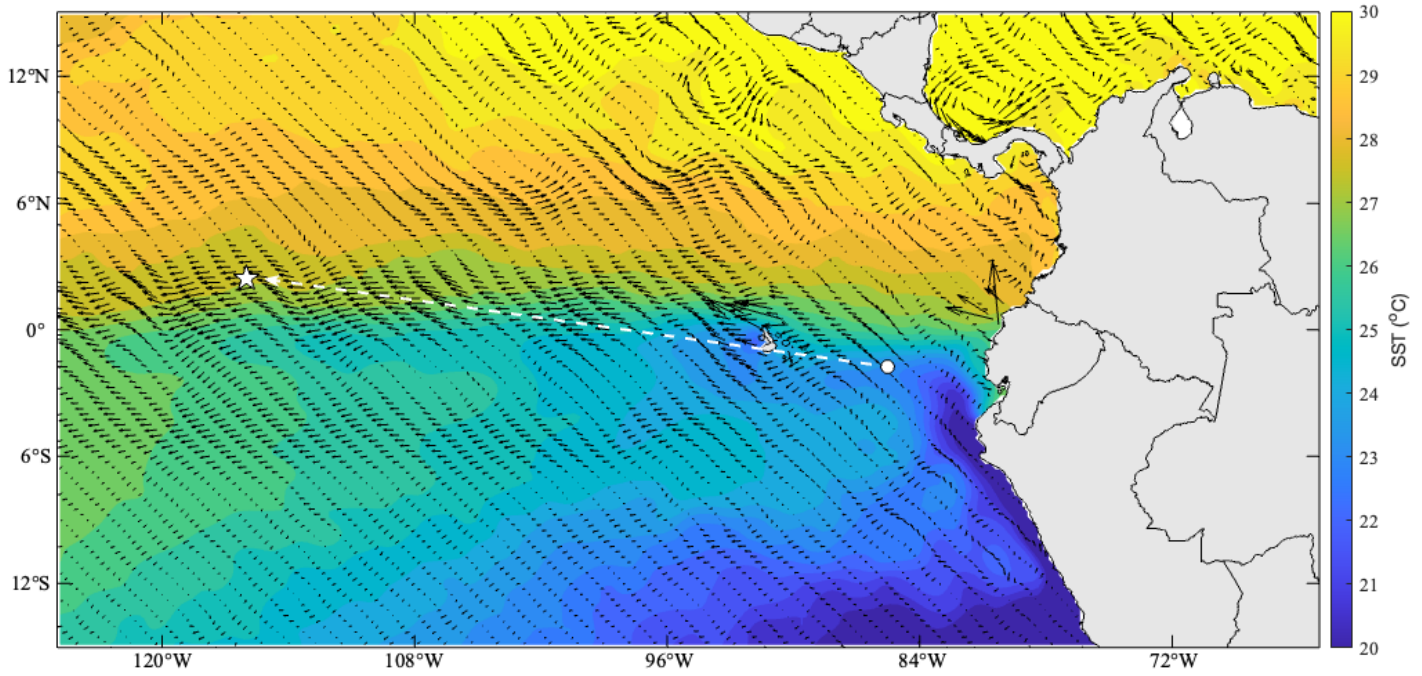


Figure 3 Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

Over the course of this fish's month at liberty, it traveled with consistent oceanographic currents and was recaptured at a much warmer thermal environment than where it was deployed (Table 1). The recapture location had consistently higher sea surface temperatures (27.6 °C ± 0.4 °C) and a deeper mixed layer depth (34.1 m ± 7.7 m) than the deployment location (SST: 23.5 °C ± 0.6 °C, MLD: 14.9 m ± 3.2 m).

Table 3. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	18 September 2023	12 October 2023
Location	1.77°S, 85.5°W	2.45°N,116°W
Surface Current[4] Bearing	WNW (308°)	WNW (285°)
Surface Current[4] Speed	0.31 m s^{-1}	0.55 m s^{-1}
Sea Surface Temperature[5]	22.6°C	28.2°C
Mixed Layer Depth[6]	11.8 m	26.8 m

Currents at both the fish's deployment and recovery locations were consistent in speed (Deployment Location: 0.44 m s^{-1} ± 0.13 m s^{-1}; Recapture Location: 0.59 m s^{-1} ± 0.28 m s^{-1}) and in direction (Deployment Location: 318° ± 53°; Recapture Location: 261° ± 30°).

Credits

Tag 41 was deployed by*: Johnny Mero Posligua (captain), Gabriel Mero Piligua, Luis Carranza Valencia, José Rodríguez Quijije, and Sergio González Jiménez*

Tag recaptured by*: The recovery was made by a tuna purse seine vessel (Maria Eulagia) during a set on a fish aggregating device (FAD).*

Data maintained by: TBD

Analysis and Report by: *Christopher R. Perle and Stephanie Snyder Koch*

Footnotes

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2]The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

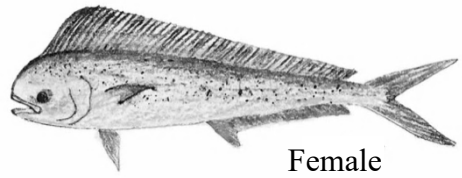
[4]Surface currents velocities were derived from Ocean Surface Current Analyses Real-time (OSCAR) Surface Currents – Final 0.25 Degree (Version 2.0) product (https://doi.org/10.5067/OSCAR-25F20) using Matlab circular (bearing) and linear (speed) statistics packages.

[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html.*

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)

Tag Number 50

76 days at liberty
Movement: 0.21 m s^{-1} East Northeast (bearing 79°)
Growth: 0.2 cm day^{-1} (91 cm TL to 106 cm TL)



Female

Key Points

3. This fish moved from purely oceanic waters to the coastal waters of Ecuador where it was captured perhaps taking an indirect route. Required effort may have reduced its growth rate.
4. A direct route would have required the fish to swim against the current to accomplish this migration, suggesting that the fish was swimming at speeds up to 1 m s^{-1}.

Fish Biology & Movement Patterns

This mature female travelled from west of the Galapagos islands to the coastal region of Ecuador in 76 days as El Niño conditions developed strongly (ONI = 2.0 at recapture). Growing modestly at 0.20 cm per day, net movement speeds were relatively low at 0.21 m/s. At 14 months old, this fish would have hatched on around 22 July 2022 in La Niña conditions (ONI = -0.80). In travelling from 1.6°S to 0.78°N and 92.5°W to 80.5°W, the displacement was largely east and mostly north at around 17.8 km/day. Given the recovery location and the location of local currents, it is quite possible this fish transited Peruvian waters before it was recaptured by the artisanal long-line vessel close to the coast, however, it would not have been necessary for it to have done so,

Deployment Date	22 Sep 2023
Recovery Date	7 Dec 2023
Days At Liberty	76
Sex	F
Total Length at deployment (cm)	91
Fork Length at deployment (cm)	76
Total Length at recovery (cm)	106
Total growth (cm)	15.0
Growth Rate (cm/day)	0.20
Age (months)	14.1
Hatch Day	22 Jul 2022
Hatch Day ONI	-0.80
Deployment ONI	1.6
Recovery ONI	2.0

Deployment Location	1.6°S x 92.5°W
Recovery Location	0.78°N x 80.5°W
Net Displacement (KM)	1359
Net Displacement (NM)	844
Net Speed (KM/day)	17.9
Net Speed (NM/day)	11.1
Bearing (DMS)	078° 55′ 56″
Bearing (cardinal)	ENE
Speed (bl/s)	0.21
Speed (m/s)	0.21

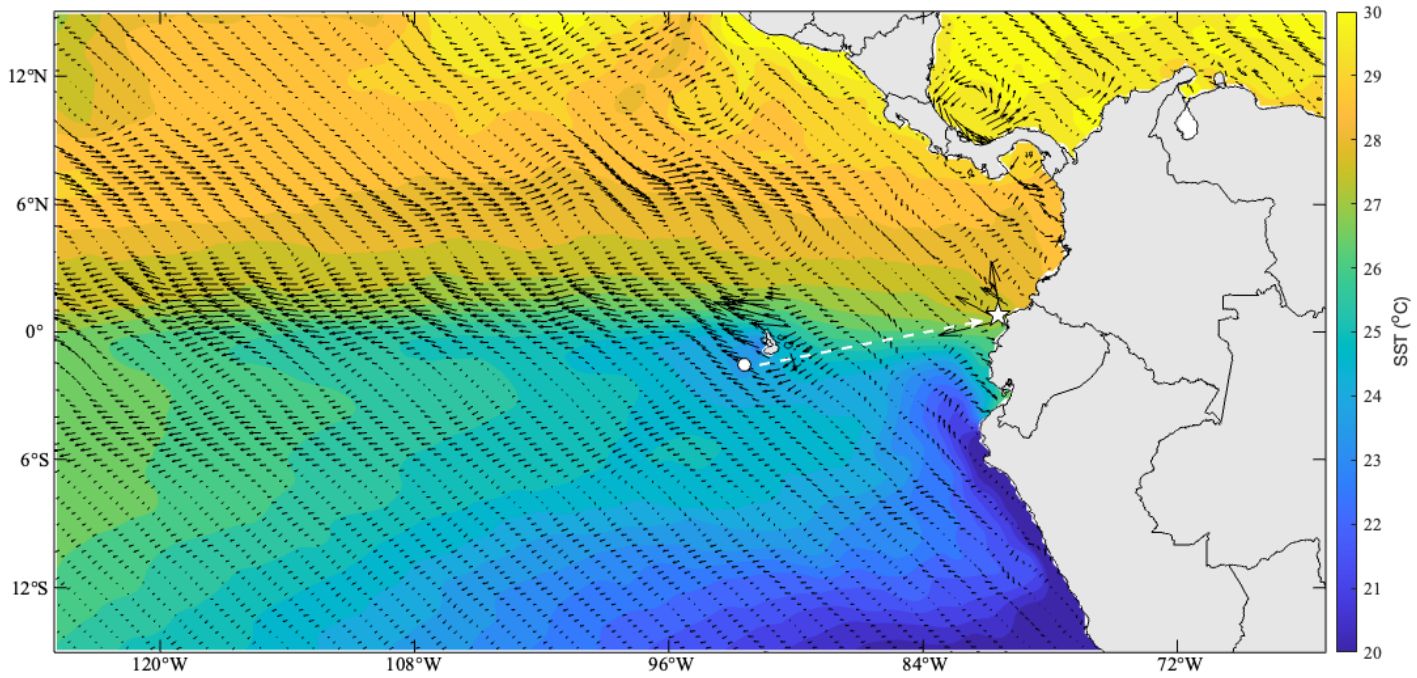


Figure 4. Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

There were no temporal shifts in the oceanography at either the deployment or recapture locations during the months the fish was at liberty. The thermal environment of the recapture location had warmer sea surface temperature (27.5°C ± 0.3°C) and deeper mixed layers (22.8 m ± 4.5 m) than the deployment location (SST: 23.9°C ± 0.5°C; MLD: 11.7 m ± 1.4 m). This was true across the timeseries.

Table 4. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	22 September 2023	7 December 2023
Location	1.6°S, 92.5°W	0.78°N, 80.5°W
Surface Current[4] Bearing	W (271.6°)	NW (315.5°)
Surface Current[4] Speed	0.60 m s^{-1}	0.83 m s^{-1}
Sea Surface Temperature[5]	23.1°C	27.4°C
Mixed Layer Depth[6]	10.92 m	22.7 m

Both deploy and recapture locations had surface currents heading west northwest (Deploy: 286.3° ± 20°; Recapture: 294.7° ± 17°). However, the current speeds were higher at the recapture site (1.24 m s^{-1} ± 0.4 m s^{-1}) than at the deployment site (0.45 m s^{-1} ± 0.14 m s^{-1}). While current speeds were relatively stable at the deployment site, large oscillations in current speed were seen at the recapture site, with the fish being recaptured when the current speeds were in a slow phase for that location.

Credits

Tag 50 was deployed by: *Johnny Mero Posligua (captain), Gabriel Mero Pilligua, Luis Carranza Valencia, José Rodríguez Quijije y Sergio González Jiménez*

Tag recaptured by: *Recovery was made by an Ecuadorian-flagged artisanal longline vessel (Bruce Anthony).*

Data maintained by: *TBD*

Analysis and Report by: *Christopher R. Perle and Stephanie Snyder Koch*

Footnotes:

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2] The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

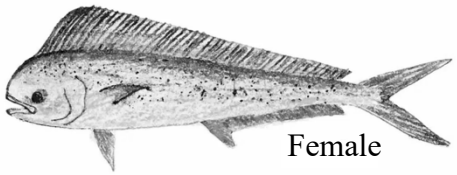
[4]Surface currents velocities were derived from Ocean Surface Current Analyses Real-time (OSCAR) Surface Currents – Final 0.25 Degree (Version 2.0) product (https://doi.org/10.5067/OSCAR-25F20) using Matlab circular (bearing) and linear (speed) statistics packages.

[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html.*

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)

Tag Number 84

111 days at liberty
Movement: 0.027 m s^{-1} East (bearing 91°)
Growth: 0.21 cm day^{-1} (101 cm TL to 124 cm TL)


Female

Key Points

1. This fish showed the lowest degree of displacement by a factor of 5 despite being the largest fish and having the second longest deployment duration. It is possible this fish travelled far beyond where the initial and end positions indicate.
2. Relative to surface currents, the fish's dispersal patterns are roughly ten times slower and in the opposite direction. This may indicate that the fish swam against the current at speeds of up to 0.29 m s^{-1} to remain in the region. Alternatively, for the fish to have swam in eastward currents, this fish would have needed to travel north of the equator across a strong westward equatorial current.

Fish Biology & Movement Patterns

This large mature female was tagged south of the Galapagos islands and showed very little movement and slow growth, perhaps as a function of its age and size. In nearly four months of strengthening El Niño conditions (ONI increased from 1.1 to 1.9 during this deployment), this fish moved only 257 kilometers for a slow net speed of 0.027 m/s (0.024 bl/s). At 16.7 months old, a calculated hatch date during March 2022 would have been during La Niña conditions (ONI = -1.0). This fish likely did not approach Peruvian waters, but rather probably stayed in the same general waters for the entire deployment. However, such movements cannot be decisively ruled out.

Deployment Date	8 Jul 2023
Recovery Date	27 Oct 2023
Days At Liberty	111
Sex	F
Total Length at deployment (cm)	101
Fork Length at deployment (cm)	86
Total Length at recovery (cm)	124
Total growth (cm)	23
Growth Rate (cm/day)	0.21
Age (months)	16.27
Hatch Day	8 Mar 2022
Hatch Day ONI	-1.0
Deployment ONI	1.1
Recovery ONI	1.9

Deployment Location	5.1°S x 91.5°W
Recovery Location	5.1°S, 89.2°W
Net Displacement (KM)	257
Net Displacement (NM)	159
Net Speed (KM/day)	2.31
Net Speed (NM/day)	1.44
Bearing (DMS)	091° 03′ 52″
Bearing (cardinal)	E
Speed (bl/s)	0.024
Speed (m/s)	0.027

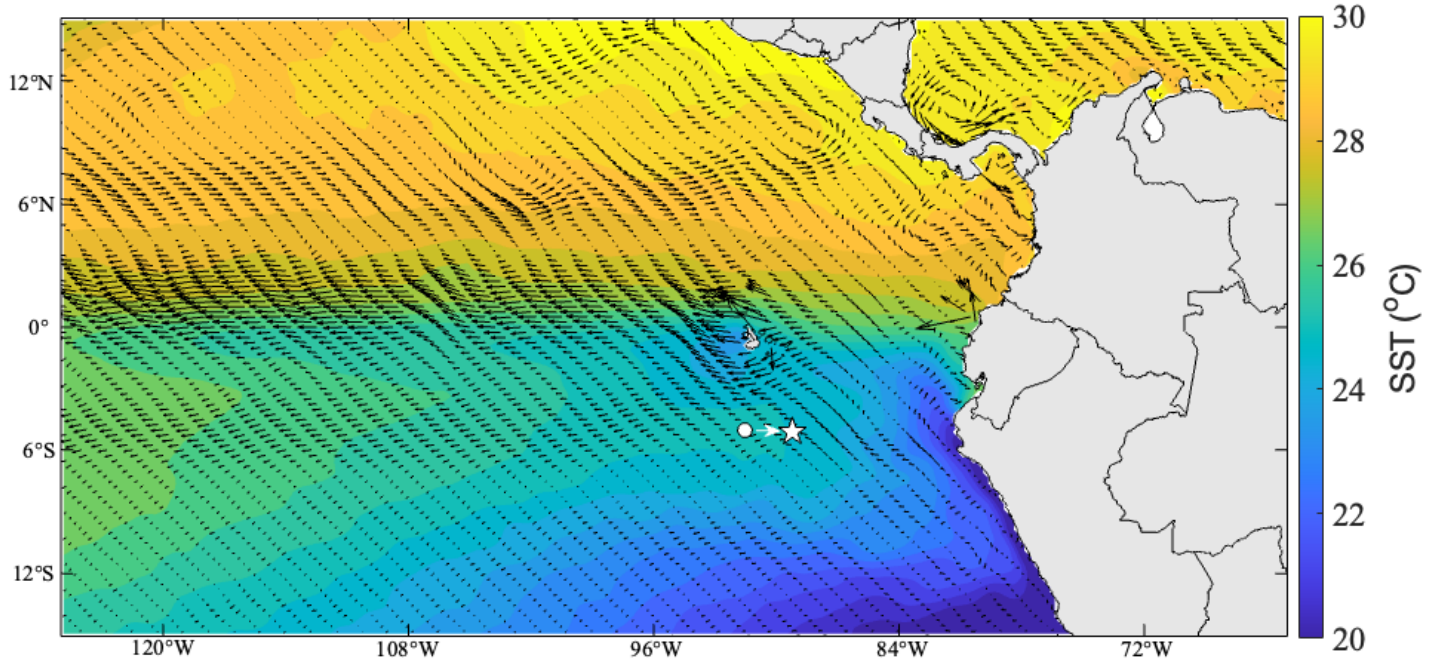


Figure 5 Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

As the fish's movements were minimal, the differences in oceanography at the deployment and recapture sites (Table 1) are largely due to seasonal changes occurring in the region. Sea surface temperatures cooled across the region with similar average temperatures at the deployment (25.2 °C ± 0.67 °C) and recovery sites (25.0 °C ± 0.74 °C). Mixed layer depth deepened throughout July with both sites experiencing mixed layer depths below 45 m; however, mixed layer shoaled again in early August and remained constant such that both sites had average mixed layer depths of approximately 27 m over the fish's time at liberty. Surface currents at both the deployment and recapture sites moved from ESE in early July to WSW with average directions of WSW (246° ± 43°) and W (272°± 34°) at the deployment and recapture sites, respectively. Surface currents in the region had average speeds of 0.26 m s^{-1} ± 0.11 m s^{-1} at the deployment site and 0.22 ± 0.11 m s^{-1} at the recapture site.

Table 5. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	8 July 2023	27 October 2023
Location	5.1°S, 91.5°W	5.1°S, 89.2°W
Surface Current[4] Bearing	ESE (127°)	SW (225°)
Surface Current[4] Speed	0.15 m s^{-1}	0.23 m s^{-1}
Sea Surface Temperature[5]	26.0°C	24.8°C
Mixed Layer Depth[6]	24.1 m	25.2 m

Credits

***Tag 84 was deployed by**: Luis Zambrano (captain), Carlos Anchundia, Wilmer Arcentales, and Fricson Peñafiel.*

***Tag recaptured by**: Ecuadorian-flagged longline mothership (X Siempre Don Carlos)*

Data maintained by: TBD

***Analysis and Report by:** Christopher R. Perle and Stephanie Snyder Koch*

Footnotes

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2]The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

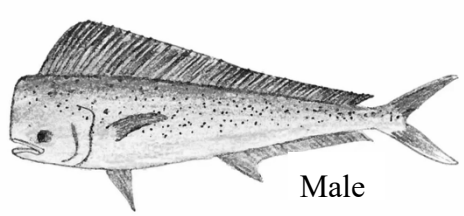
[4]Surface currents velocities were derived from Ocean Surface Current Analyses Real-time (OSCAR) Surface Currents – Final 0.25 Degree (Version 2.0) product (https://doi.org/10.5067/OSCAR-25F20) using Matlab circular (bearing) and linear (speed) statistics packages.

[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html*.

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)

Tag Number 149

10 days at liberty
Movement: 0.28 m s^{-1} North (bearing 3°)
Growth: 0.5 cm day^{-1} (100 cm TL to 105 cm TL)


Male

Key Points

1. This is a very short deployment that nonetheless resulted in a net displacement of 238 kilometers at moderate swimming speeds.
2. Although the time at liberty was less than two weeks, its movement – particularly being at odds with a relatively fast surface current – demonstrates potential for long distance dispersal.

Fish Biology & Movement Patterns

This large mature male approximately 5.5 months old travelled from 1.2°S roughly due north to 0.97°N along 93.2°W over the course of 10 only days This net displacement resulted in speeds of around 0.28 m/s as El Niño developed from and ONI of 1.6 to 1.8. A back calculated hatch date in mid-May 2023 would have occurred in the short neutral period between ENSO extremes. It is highly unlikely that this fish travelled into Peruvian waters during the time of this deployment.

Deployment Date	22 Sep 2023
Recovery Date	2 Oct 2023
Days At Liberty	10
Sex	M
Total Length at deployment (cm)	100
Fork Length at deployment (cm)	86
Total Length at recovery (cm)	105
Total growth (cm)	5
Growth Rate (cm/day)	0.5
Age (months)	5.5
Hatch Day	22 Mar 2023
Hatch Day ONI	-0.1
Deployment ONI	1.6
Recovery ONI	1.8

Deployment Location	1.2°S x 93.3°W
Recovery Location	0.97°N x 93.2°W
Net Displacement (KM)	238
Net Displacement (NM)	148
Net Speed (KM/day)	23.8
Net Speed (NM/day)	14.8
Bearing (DMS)	002° 52′ 09″
Bearing (cardinal)	N
Speed (bl/s)	0.27
Speed (m/s)	0.28

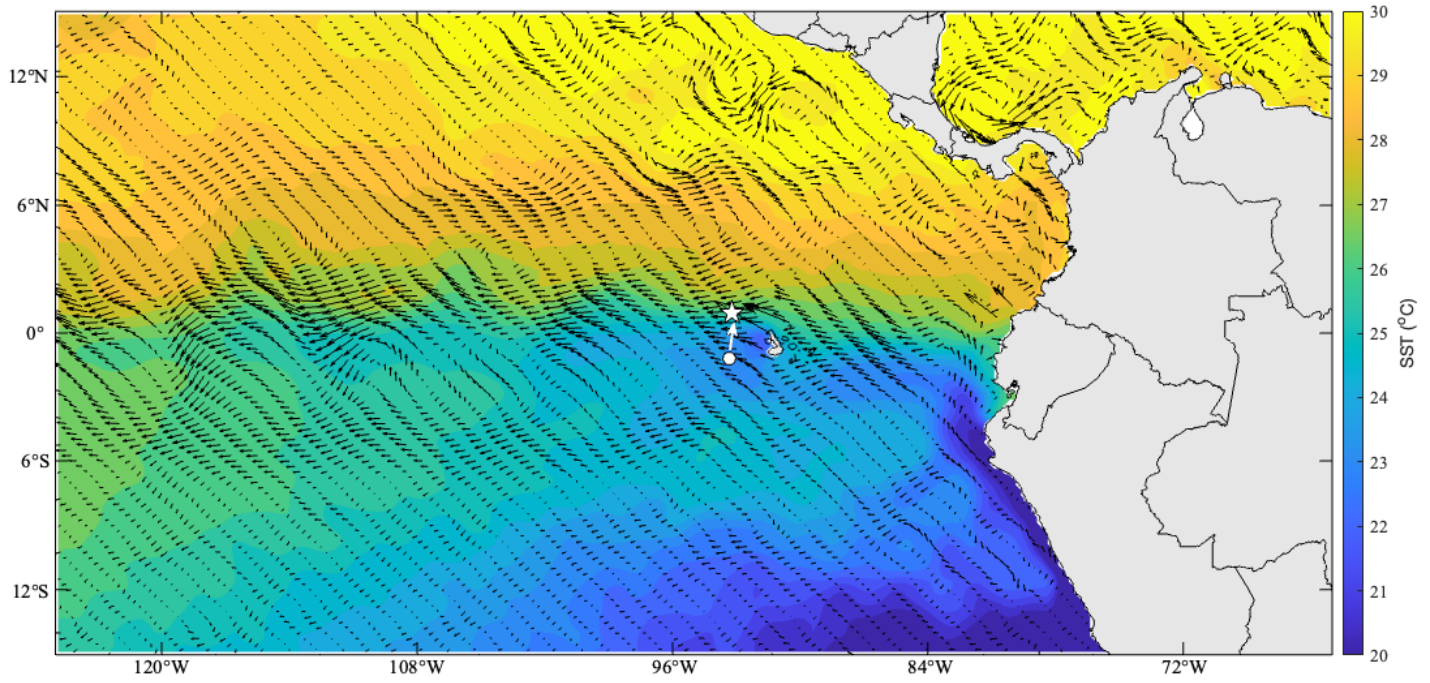


Figure 6 Map of tag deployment (white circle) and recapture (white star) locations with average surface current velocities (black arrows) and sea surface temperatures (color contours) during the deployment.

Oceanographic Environment

At some point during the 10-day period, the fish crossed a strong thermal front entering waters that were warmer and had a deeper mixed layer depth (Table 1). The sea surface temperatures and mixed layer depths were consistent across the time series at both the deployment location (SST: 23.4°C ± 0.1°C; MLD: 10.8 m ± 0.4 m) and the recapture location (SST: 26°C ± 0.3°C; MLD: 18.2 m ± 3.9 m).

Table 6. Oceanographic conditions on the date and location of tag deployment and recapture

	Deploy	Recapture
Date	22 September 2023	2 October 2023
Location	1.2°S, 93.3°W	0.97°N, 93.2°W
Surface Current[4] Bearing	W (271°)	W (272°)
Surface Current[4] Speed	0.73 m s^{-1}	0.48 m s^{-1}
Sea Surface Temperature[5]	23.4°C	26.1°C
Mixed Layer Depth[6]	10.7 m	15 m

Surface currents were similar at both the deployment and recapture sites, with consistent current direction (Deploy: 283° ± 18°; Recapture: 268° ± 7.4°) and similar speeds at both locations (Deploy: 0.48 m s^{-1} ± 0.12, Recapture: 0.64 m s^{-1} ± 0.13). Current speeds decreased at both locations throughout the 10-day timeseries.

Credits

Tag 149 was deployed by: Manuel Véliz Mero (captain)Javier Mise Castro, Leonardo Mise Castro, Anthony Vélez Alvia, Afrén López Eduarte and Segundo Vinces Delgado

Tag recaptured by: *The recovery was made by a tuna purse seine vessel (Doña Nancy) during a set on a fish aggregating device (FAD).*

Data maintained by: TBD

Analysis and Report by: Christopher R. Perle and Stephanie Snyder Koch

Footnotes

[1]Age at length estimates were determined using sex specific von Bertalanffy parameters published in "Edad y crecimiento del dorado (*Coryphaena hippurus*) capturado por la flota palangrera en aguas del pacífico costarricense" (https://www.incopesca.go.cr/investigacion/otras_investigaciones/08-informe_edad_crecimeinto_dorado.pdf); for females tØ = 0.5, K = 1.57 and L∞ = 116.33; for males tØ = -0.55, K = 0.87 and L∞ = 147.01

[2]The Oceanic Niño Index (ONI) is provided by the Climate Prediction Center of the U.S. National Weather Service: https://origin.cpc.ncep.noaa.gov/products/analysis_monitoring/ensostuff/ONI_v5.php

[3]Body lengths per second calculations are based on average total length of the fish during the deployment period.

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[5]Sea surface temperatures were obtained from the NOAA High-resolution Blended Analysis of Daily SST and Ice database (doi: 10.1175/JCLI-D-20-0166.1). Map was created using the m_map package. P*awlowicz, R., 2020. "M_Map: A mapping package for MATLAB", version 1.4m, [Computer software], available online at www.eoas.ubc.ca/~rich/map.html.*

[6]Mixed layer depth data were obtained from Copernicus Global Ocean Physics Analysis and Forecast system (https://doi.org/10.48670/moi-00016)