# Hydroacoustic tracking data from blue crabs released in receiver arrays along the Atlantic coast from May 2019 to Feb 2020

**Website**: https://www.bco-dmo.org/dataset/836916
**Data Type**: Other Field Results
**Version**: 1
**Version Date**: 2021-01-19

**Project**
» Collaborative research: Variation in life history and connectivity as drivers of pathogen-host dynamics and genetic structure in a trans-hemispheric pathosystem (Blue Crab Connectivity)

| Contributors | Affiliation | Role |
|---|---|---|
| Behringer, Donald | University of Florida (UF) | Lead Principal Investigator |
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**Abstract**
Hydroacoustic tracking of blue crab movements was performed along the Atlantic coast. Crabs were tagged with Vemco V9 acoustic tags and released in receiver arrays in Virginia (Aug 2019) and Florida (St. Petersburg in May 2019, Jacksonville in Jan-Feb 2020). Potential positions and pathways of crabs within each coastal receiver array were estimated using a Center of Activity analysis.

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## Coverage

**Spatial Extent**: **N**:37.62097 **E**:-75.5965 **S**:27.7004 **W**:-82.80439
**Temporal Extent**: 2019-05-21 - 2020-02-03

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## Dataset Description

### Methods & Sampling

**Location:**
Gulf coast of Florida outside of Tampa Bay (27 N & 82 W); < 7m depth
Eastern shore of Virginia; Atlantic coast; (37 N & 75 W); < 7m depth
Atlantic coast of Florida outside mouth of St. Johns River; (30 N & 81 W); < 7m depth

**Sampling and analytical procedures:**
At each site, commercial style blue crab traps were baited and deployed in the area where we wished to study crab movement. After 48 hours, traps were checked and if at least 10 crabs were found in the traps we deployed an array of 17 Vemco VR-2Tx hydroacoustic receivers attached to PVC poles set into concrete bases. The GPS location of each receiver was recorded and each was approximately 100 meters from any other receiver. We then placed Vemco V9 hydroacoustic tags on the backs of 9 to 11 crabs using aluminum wire and released them at the center point of the receiver array. The size and sex of each crab was recorded prior to release. After 48 to 72 hours, the receivers were retrieved and the raw hydroacoustic data were downloaded and analyzed.

The potential pathways of tagged crabs were estimated using a Center of Activity analysis following Simpfendorfer et al (2002). Estimates of latitude and longitude were made from the mean center of detections within the receiver array over 15-minute intervals for each transmitter. The mean center at a given time was weighted relative to how many receivers detected a transmitter during an interval (e.g., if a crab transmitter was recorded 3 times, 2 times and 15 times on receivers A, B and C respectively then the mean would be the average position of 3 × receiver A + 2× receiver B + 15 × receiver C). Bearings and velocities were calculated from the position estimate at the last interval. If a transmitter was not detected during the previous analysis interval, a position estimate would be recorded, but no bearing or velocity would be recorded, and the crab was considered inactive. This ensured that velocities and bearings were only recorded during times at which a crab was actively moving to best couple the appropriate environmental data. If a crab was absent for many sequential intervals while within the array, it was assumed to have buried or otherwise masked its transmitter. Analysis was conducted between the first and last position estimate for each crab within the array to encompass only the timespan when the crab was known to be detected by the array.

Tidal impact was examined using tide and current data from NOAA stations nearest the site locations. Values were obtained from the NOAA Tide and Current Dataserver:

- Virginia site location used the Wachapreague, VA station (# 8631044)
- Jacksonville site location used the _________ station (# 8719525 (??)
- StPeteMay site location used the Clearwater Beach, FL station (# 8726724)

The values are height from MLLW (mean lower low water--relative to the water level at the lowest daily low tide). We looked at the difference from the last predicted instance to see if the tide was actively increasing or decreasing and the relative strength of that increase.

**Data Processing Description**

**BCO-DMO processing:**
- Imported data from source file "CrabPositions_CoA_velocities.csv" into BCO-DMO system.
- Added latitude and longitude values for the midpoint of each array
- Added datetime in ISO8601 format by converting Local DateTime from Eastern time zone (EST/EDT) to UTC/GMT
- Removed units from column names
- Modified parameter (column) names to conform with BCO-DMO naming conventions.
    *The only allowed characters are A-Z,a-z,0-9, and underscores.*
    *No spaces, hyphens, commas, parentheses, or Greek letters.*

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## Related Publications

Simpfendorfer, C. A., Heupel, M. R., & Hueter, R. E. (2002). Estimation of short-term centers of activity from an array of omnidirectional hydrophones and its use in studying animal movements. Canadian Journal of Fisheries and Aquatic Sciences, 59(1), 23–32. doi:10.1139/f01-191 https://doi.org/10.1139/F01-191
*Methods*

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## Parameters

| Parameter | Description | Units |
|---|---|---|
| ISO_DateTime_UTC | Date and time (UTC) formatted to ISO8601 standard. Format: yyyy-mm-ddTHH:MM:SSZ (Z indicates Zulu/GMT) | unitless |
| Latitude | Latitude of experimental site (midpoint of array) | decimal degrees |
| Longitude | Longitude of experimental site (midpoint of array) | decimal degrees |
| Site | Array site | unitless |
| Crab_ID | Animal's VEMCO tag ID | unitless |
| Distance_Moved | Distance animal moved | meters (m) |
| Crab_Bearing | Bearing from last position | degrees |
| Crab_Velocity | Speed from last position | meters per second (m/s) |
| Tidal_Height | Sea height change from last position | meters (m) or feet (????) |
| Wind_Bearing | Bearing from which wind comes | degrees |
| Wind_Speed | Speed of wind | meters per second (m/s) |
| Local_Datetime | Local date and time (month/day/year hour:minute:second) | unitless |

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## Instruments

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|---|---|
| **Dataset-specific Instrument Name** | Garmin GPSMap 60x GPS |
| **Generic Instrument Name** | Global Positioning System Receiver |
| **Dataset-specific Description** | Garmin GPSMAP 60x is a waterproof high-sensitivity GPS receiver |
| **Generic Instrument Description** | The Global Positioning System (GPS) is a U.S. space-based radionavigation system that provides reliable positioning, navigation, and timing services to civilian users on a continuous worldwide basis. The U.S. Air Force develops, maintains, and operates the space and control segments of the NAVSTAR GPS transmitter system. Ships use a variety of receivers (e.g. Trimble and Ashtech) to interpret the GPS signal and determine accurate latitude and longitude. |

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| **Dataset-specific Instrument Name** | Vemco VR-2Tx receiver |
| **Generic Instrument Name** | Telemetry Equipment Device |
| **Dataset-specific Description** | The VR2Tx Acoustic Receiver is an acoustic monitoring receiver that is ideal for multi-researcher tracking operations in the ocean. The built-in transmitter can be used as a synchronization tag for improved fine-scale positioning results and provides a means to retrieve receiver health status from the surface while units are still deployed. |
| **Generic Instrument Description** | Equipment designed to transmit and receive data from a remote source using telecommunications methods. |

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| **Dataset-specific Instrument Name** | Vemco V9 acoustic tags |
| **Generic Instrument Name** | tracking tag |
| **Dataset-specific Description** | The Vemco V9 coded tag, 9 mm in diameter, was developed to provide researchers with the means to track and determine the behaviour patterns of small animals. The V9 tag can function as a simple pinger giving location only, or can be equipped with depth and/or temperature sensors. V9 coded transmitters operate at 69 kHz and can be detected by all VEMCO 69 kHz receivers. NERC term: http://vocab.nerc.ac.uk/collection/L22/current/TOOL1157/ |
| **Generic Instrument Description** | Devices attached to living organisms with the purpose of determining the location of those organisms as a function of time after tagging and release. |

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|---|---|
| **Dataset-specific Instrument Name** | Vemco VR-2Tx receiver and transmitter |
| **Generic Instrument Name** | Vemco VR2Tx receiver and transmitter |
| **Generic Instrument Description** | A submersible single-channel acoustic receiver with onboard transmitting capabilities, designed for use in the monitoring of aquatic fauna. It is capable of transmitting its assigned ID code, identifying other Vemco coded transmitters in the receiver area, and acoustically communicating with a surface VR100-200 receiver. It can communicate additional information and make select changes to other Vemco transmitters via the surface VR100-200 receiver. It uses VUE software for communication via Bluetooth. The VR2Tx is housed in a corrosion-resistant cylindrical high-pressure plastic case, depth-rated to 500 m. The VR2Tx has 16 MB of onboard memory storage (approx. 1.6 million detections). The VR2Tx operates on a factory-set frequency of 69 kHz, and has an approximate battery life of 14 months. It can operate in temperatures ranging from -5 degC to +40 degC. |

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## Project Information

**Collaborative research: Variation in life history and connectivity as drivers of pathogen-host dynamics and genetic structure in a trans-hemispheric pathosystem (Blue Crab Connectivity)**

**Coverage**: Atlantic coast of north and south America from Massachusetts to Southern Brazil, Caribbean

NSF Award Abstract:

Marine invertebrates use an array of strategies to survive, move, and reproduce across diverse and dynamic environmental conditions. This project investigates the intersection of these strategies and how they facilitate the persistence of blue crabs and a pathogenic virus along the Atlantic coast of North and South America. The widespread distribution of this crab-virus system makes it useful for investigating host-pathogen interactions. Blue crabs can reduce their activity level and induce winter dormancy in colder climates, but it is unclear how this alters progression and transmission of the pathogen. Conversely, year-round growth and reproduction of tropical blue crabs may be offset by higher pathogen abundance and activity. This project will use a combination of field and laboratory studies to reveal how crab life history and pathogen dynamics interact and adapt at the extremes of their range. Genetic sequencing, crab movement tracking and oceanographic models will be used to understand how crab-disease dynamics vary across temperate and tropical latitudes. The blue crab is an ecologically and economically important species and knowledge generated in this project will help provide management guidance to support sustainable fisheries. Best practices to avoid and limit disease will be communicated to commercial and artisanal harvesters through partnerships and workshops. Local high school and undergraduate students from underrepresented groups will be engaged through a variety of formal and informal educational programs. Public outreach will be implemented through a museum partnership with the Shedd Aquarium and will include the training of a science communication intern.

This collaborative project will combine empirical field and laboratory experiments, population genomics, and biophysical modeling to explore the consequences of latitude-driven changes in life history and oceanic connectivity on a trans-hemispheric pathosystem comprised of the blue crab, Callinectes sapidus, and the pathogenic virus, CsRV1. The virulence of the CsRV1 virus from tropical and temperate latitudes and the impact of overwintering will be studied by experimental virus challenges of crabs transplanted between high and low latitudes. The impact of infection and virulence on crab movement will be investigated in laboratory raceway experiments of healthy and infected crabs and in the field with acoustically tagged crabs deployed in temperate and tropical locations. Population genetic studies using thousands of genome-wide RAD sequencing markers for crabs and whole-genome sequencing for the virus will define genetic connectivity of crab and virus populations across their range, and will investigate the possible latitudinal, seascape, and life history-driven changes in blue crab and virus genomes. The two population genomic data sets are expected to provide different inferences and scales of connectivity because CsRV1 virus genotypes are transmitted only among post-larval crabs while blue crab genotypes also move by a potentially long-range dispersive larval stage. Finally, integrated biophysical models will be used to investigate the relative contributions of adult and larval dispersal on the population structure of the crab and the pathogen across a broad swath of habitat between New England and Argentina with a decade of simulations. An open-source Lagrangian stochastic model will estimate pelagic larval transport, and spatially explicit biased-correlated random walk models will estimate adult movement. Models will be informed by experimentally-derived movement and behavior data, as well as information on crab larval and adult behavior and overwintering duration available in the published literature. Under a series of scenarios in which crab behavior is affected by latitude and virus infection, statistical comparisons will be made between biophysical model-based predictions of connectivity and genetic estimates of connectivity. These analyses will advance our understanding of the physical, environmental, and biological factors that shape the dynamics of the blue crab CsRV1 pathosystem.

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## Funding


| Funding Source | Award |
| --- | --- |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1658466 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1658396 |
| NSF Division of Ocean Sciences (NSF OCE) | OCE-1658389 |


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