

# Methods for estimating fish tracks using AOTTP electronic tags.



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Ligth geolocation uncertainty increases due to:

Sun declination

- latitudinally > longitudinally
- when approaching to equinoxes.

Light at surface estimation

- Depth (during dusk and dawn)
- Water transparence  $\downarrow \downarrow$







#### High uncertainty in light-geolocations:

**Technical** limitations

Depends on tag type and manufacturer; Lotek > Wildlife Computers (Schaefer et al 2006)

Major source is external to the tags.

<u>Environmental</u> conditions: cloud cover, wind strength, sea state... find analyzing <u>moored</u> tags (Welch et al. 1999; Musyl et al. 2001)

<u>Alive</u> animals:

Two equal tags on a single individual  $\rightarrow$  different results (Wilson et al. 2007).

### light estimation at surface:

<u>Deep diving</u>  $\rightarrow$  wrong light at surface curve  $\rightarrow$  computed as a twilight  $\rightarrow$  outlier Is the case of BET (Lam et al. 2014)

<u>upwelling</u> areas  $\rightarrow$  light attenuation  $\uparrow \uparrow \rightarrow$  surface estimates limited in deep.





### **Uncertainty in light-geolocations**



#### Example # 1



(no recovery position)

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Track estimation overcoming light-geolocations uncertainty relies on:

- The model and fitting parameters.
  - Sun declination error
  - Fish movement dynamic
    - maximum speed
      - diffusion coefficient + advection
- Fit data from the fish with external fields; Environmental variable's with gradients
  - SST = sea surface temperature
  - PDT = Profiles of depth and temperature
- Constrains: Land. Bathymetry.



#### Most probable track estimation methods

Tag type / manufacturer	Track estimation method Hidden Marcov Model	Number of tracks	Environmental fields	remarks
miniPAT WC	Global Position Estimator 3 GPE3	83	SST	Black box usual recently
LAT-810 Lotek	(Braun et al., 2018) HMMoc	18	SST PDT	Open source, manipulable Review fitting process

Fish movement dynamic = maximum fish speed (user-defined) Constrain = Bathymetry

The results are equivalent.

Both methods and are based in the same previous methods (Patterson et al. 2009; Pedersen et al. 2011; Michelot et al. 2016)

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Geolocation errors will expand its uncertainty to the entire track, leading worse estimates with higher variance (Nielsen 2004).

#### Overcome uncertainty estimating most probable track.

SST fields small gradients→ accuracy ↓ (Lam et al. 2010) equatorial area Western African upwelling.

Recovery position is not available (internal archival).  $\rightarrow$  accuracy  $\downarrow$ 







constrained daily likelihood ↓ precise track









#### PDT

Consistent & More precise





#### **Recomendations.**

Reviewing each step involved in track estimation process:

- Rejection of non-informative light-geolocations.
- Compare result's uncertainty using PDT SST fields.
- Compare track with raw geolocations for consistency
- Try with different model fitting parameters to obtain robust results.

PDT (modeled) might not be realistic or too constraining  $\rightarrow$  incongruent fitting probability  $\uparrow$ 

