A continued investigation into the emergence of a parasite in sea scallops

David B. Rudders
Robert Fisher
Jan McDowell
Sally Roman

Virginia Institute of Marine Science

Sea Scallop Plan Development Team
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Preliminary – PDT use only.

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Affected scallops

- Typical gross appearance and intensity of affected scallops.
- Reports from industry concerning infected scallops began in May of 2015 and have continued throughout 2016.
- Reports of infected scallops began in the DMV and have extended into the ET.

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Appearance of affected scallops

- Typical lesion size with number per scallop meat ranging from 1-6.
- The lesions presented on the exterior of the adductor muscle, typically opposite the sweet meat.
- Visible to the naked eye against the white meat. (~2-5mm)

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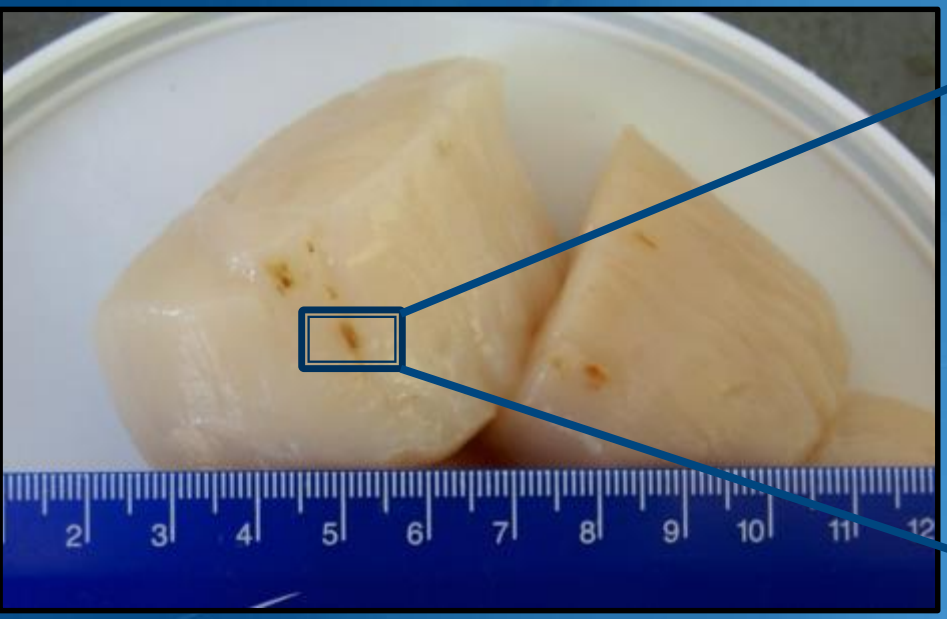
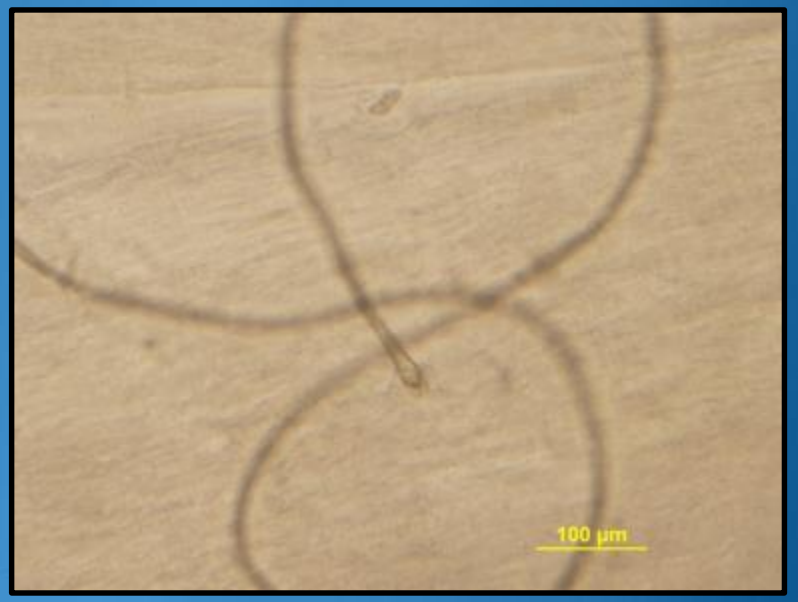
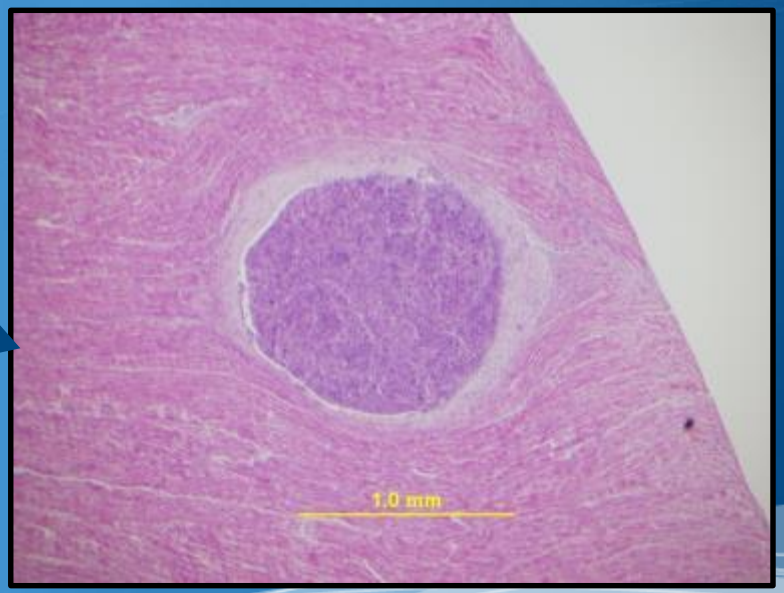
Preliminary histology

Fresh squash mount







Histologically processed: pink=muscle, blue=hemocytes surrounding foreign object (host response)

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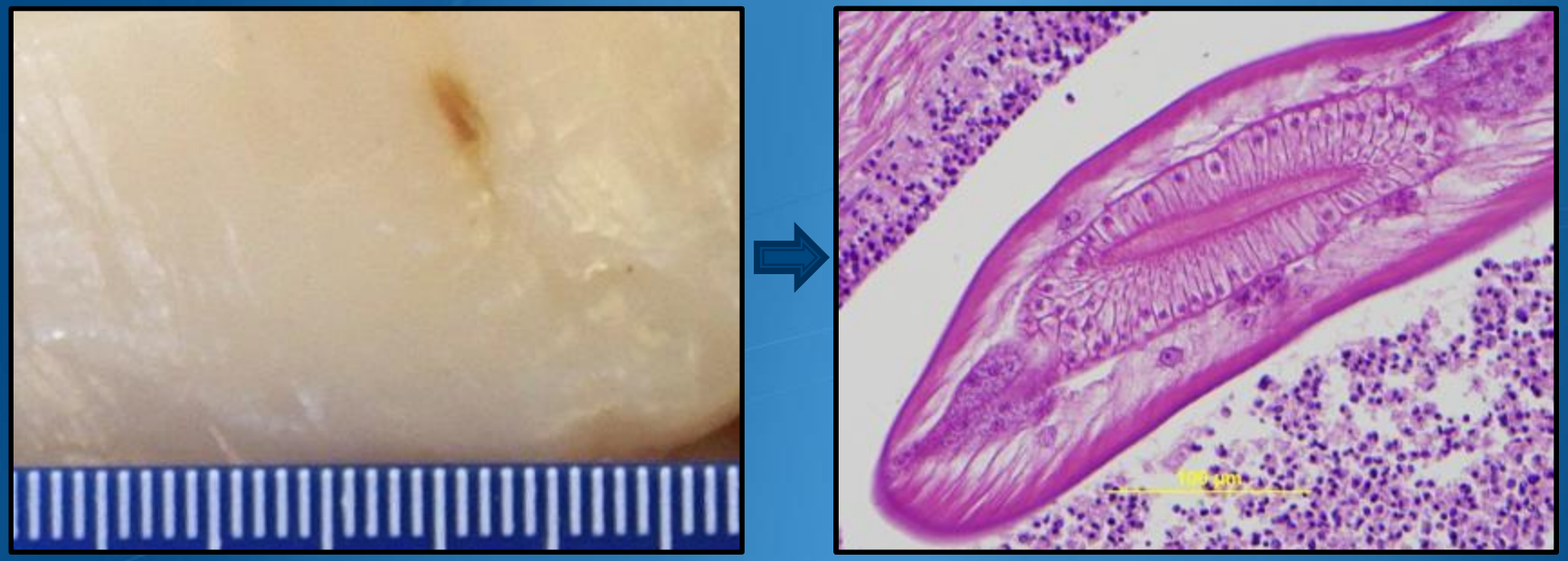
Preliminary histology



Fourth stage nematode larvae coiled within brownish lesion in sea scallop adductor muscle. Some of the brown coloration may be the result of a *Haplosporidium spp.* hyperparasite

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Preliminary identification

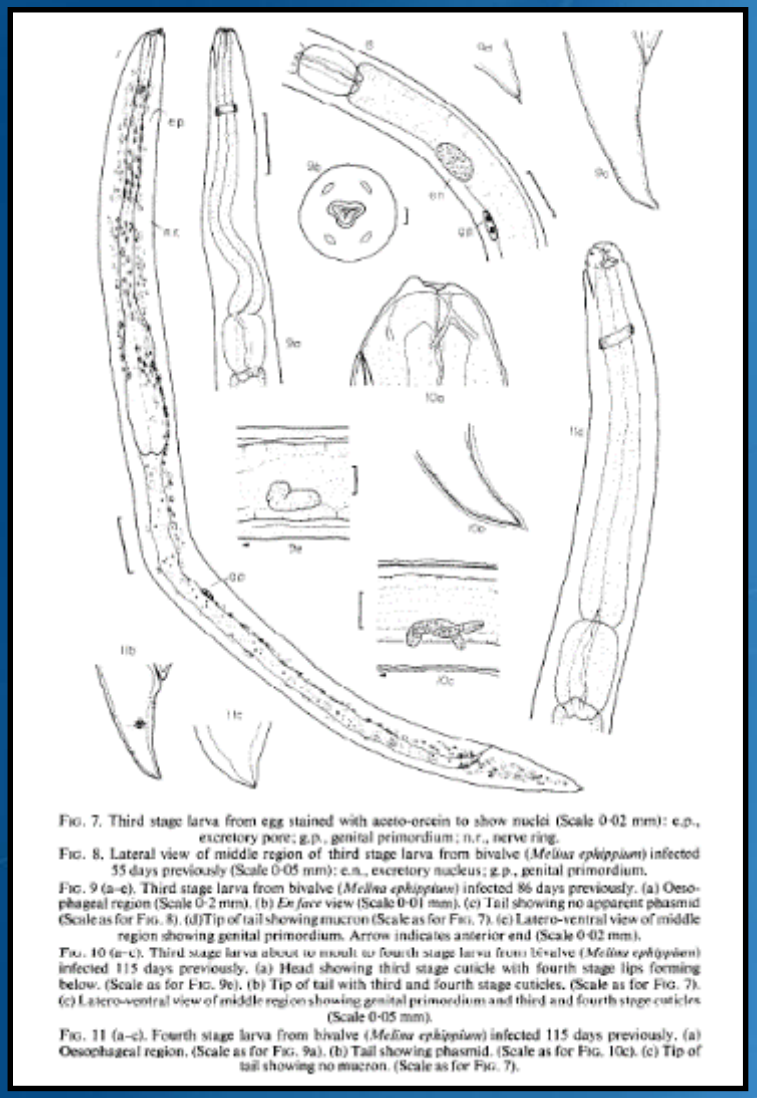

FIG. 7. Third stage larva from egg stained with aceto-orcein to show nuclei (Scale 0·02 mm): e.p., excretory pore; g.p., genital primordium; n.r., nerve ring.

FIG. 8. Lateral view of middle region of third stage larva from bivalve (*Mellina ephippium*) infected 55 days previously (Scale 0·05 mm): e.n., excretory nucleus; g.p., genital primordium.

FIG. 9 (a–e). Third stage larva from bivalve (*Mellina ephippium*) infected 86 days previously. (a) Oesophageal region (Scale 0·2 mm). (b) *En face* view (Scale 0·01 mm). (c) Tail showing no apparent phasmid (Scale as for FIG. 8). (d) Tip of tail showing mucron (Scale as for FIG. 7). (e) Latero-ventral view of middle region showing genital primordium. Arrow indicates anterior end (Scale 0·02 mm).

FIG. 10 (a–c). Third stage larva about to moult to fourth stage larva from bivalve (*Mellina ephippium*) infected 115 days previously. (a) Head showing third stage cuticle with fourth stage lips forming below. (Scale as for FIG. 9e). (b) Tip of tail with third and fourth stage cuticles. (Scale as for FIG. 7). (c) Latero-ventral view of middle region showing genital primordium and third and fourth stage cuticles. (Scale 0·05 mm).

FIG. 11 (a–c). Fourth stage larva from bivalve (*Mellina ephippium*) infected 115 days previously. (a) Oesophageal region. (Scale as for FIG. 9a). (b) Tail showing phasmid. (Scale as for FIG. 10c). (c) Tip of tail showing no mucron. (Scale as for FIG. 7).

From Berry and Cannon, 1981

- Preliminary histology and molecular analysis has been completed on samples taken from the 2015 MAB survey.
- DNA results concluded that the sequences analyzed have a 99% identity with *Sulcascaris sulcata* .
- This species is cosmopolitan and has been identified in many genera of bivalve molluscs.
- Saucer scallop (Aus.), Calico scallop (US), Surf clams (US).
- Similar ephemeral observation of similar affected sea scallops was reported in May 2003.

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Sulcascaris sulcata life cycle

- The life cycle of *Sulcascaris sulcata* involves two hosts.
- Adult nematodes attach to the esophagus of Loggerhead and Green sea turtles.
- Eggs pass through the GI tract and enter the benthos via the feces.
- Eggs are filtered by benthic molluscs and the larval stages (1-4) develop.
- Fourth stage larvae are ingested by turtles.

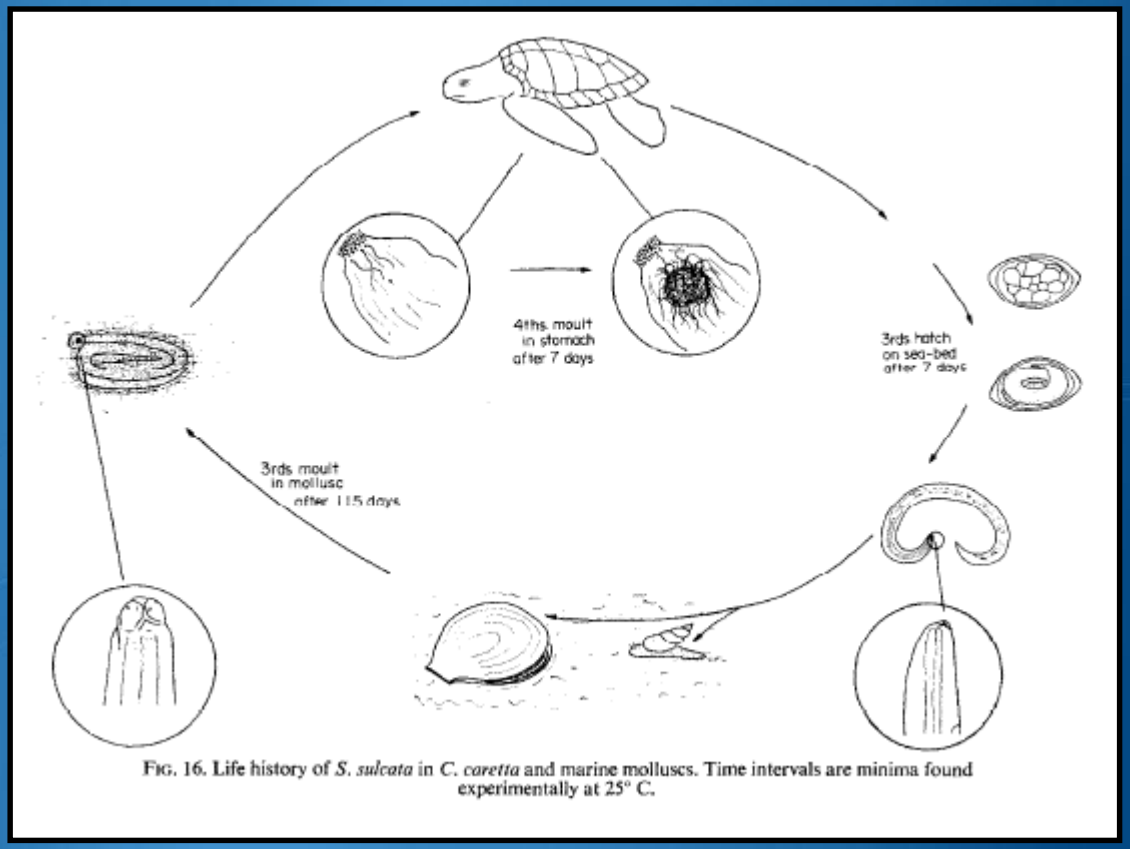

FIG. 16. Life history of *S. sulcata* in *C. caretta* and marine molluscs. Time intervals are minima found experimentally at 25° C.

From Berry and Cannon, 1981

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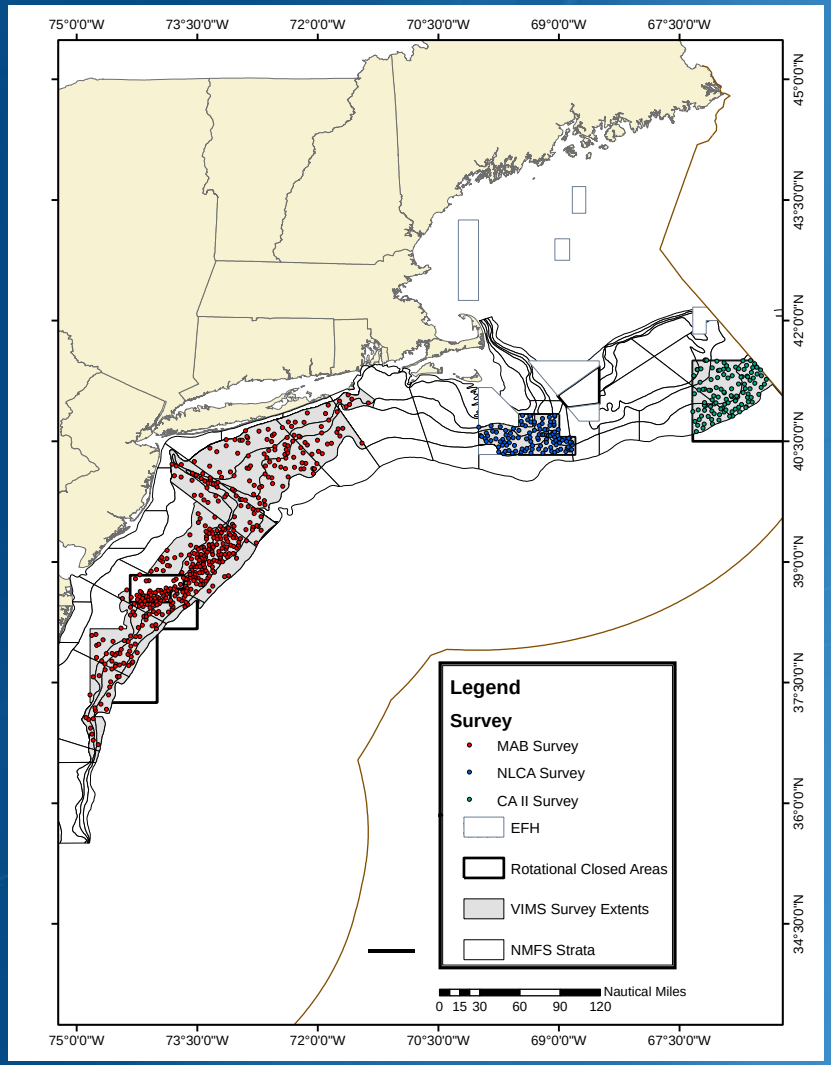
Parasite surveillance



- For the 2016 surveys, VIMS continued an expanded biological sampling protocol to capture the spatial extent of the parasite as well as the prevalence and intensity of infected scallops.
- Sampled 15 animals at every station that had scallops .
  - Histological and genetic samples.
  - Gross observation of the number of infected scallops/sample (prevalence).
  - Gross observation of the number of nematodes/scallop (intensity).

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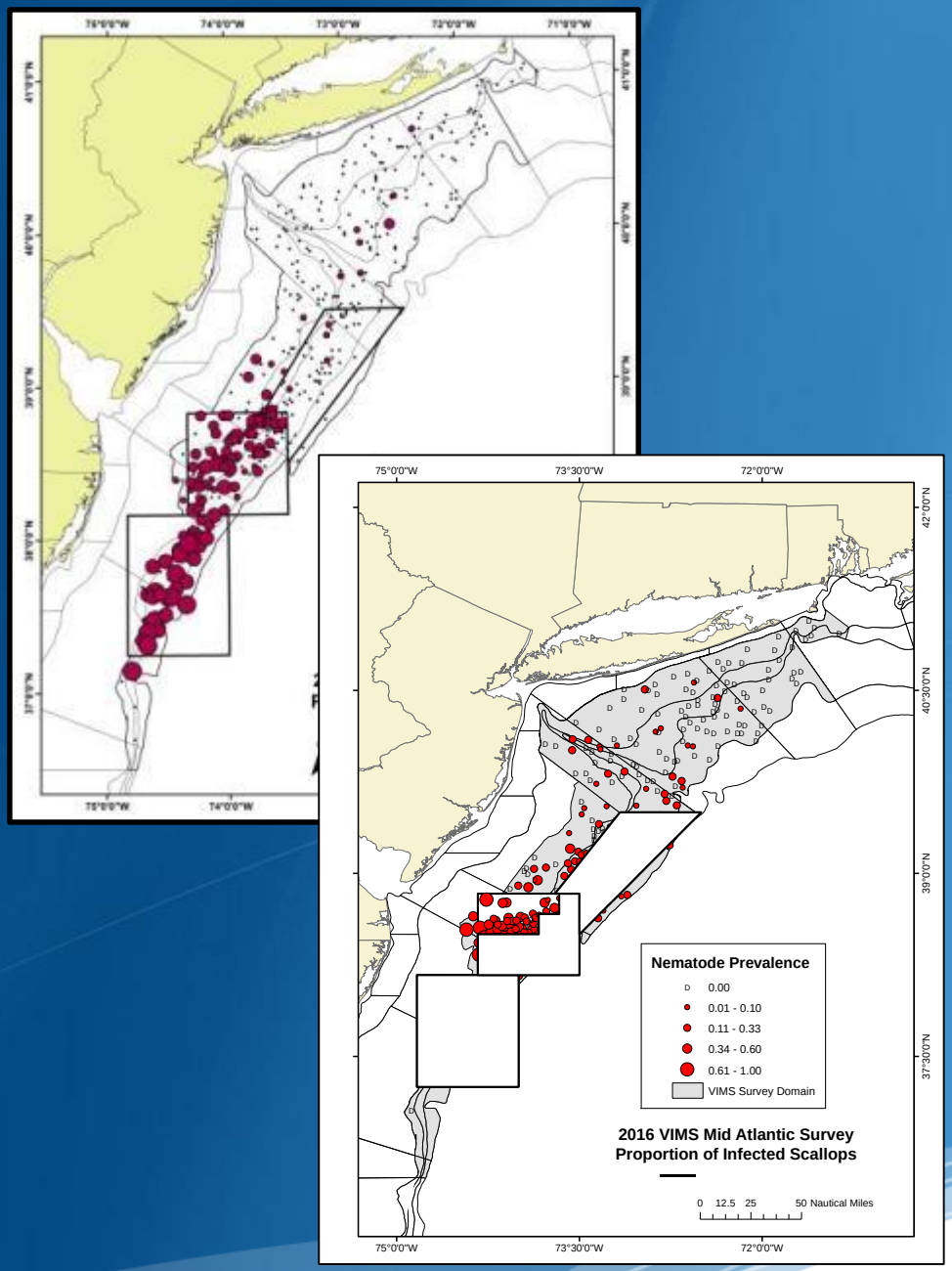
Nematode Prevalence



- Spatial distribution of the prevalence of the parasite in the sampled scallops.
- No infected scallops observed in the NLCA or the CA II survey areas.
- For each station with sampled scallops, a proportion of the sample that contained at least one nematode was calculated.
- Intensity appears to increase as a function if decreasing latitude.
- Prevalence appears to be increasing in the ET and Hudson Canyon compared to 2015.

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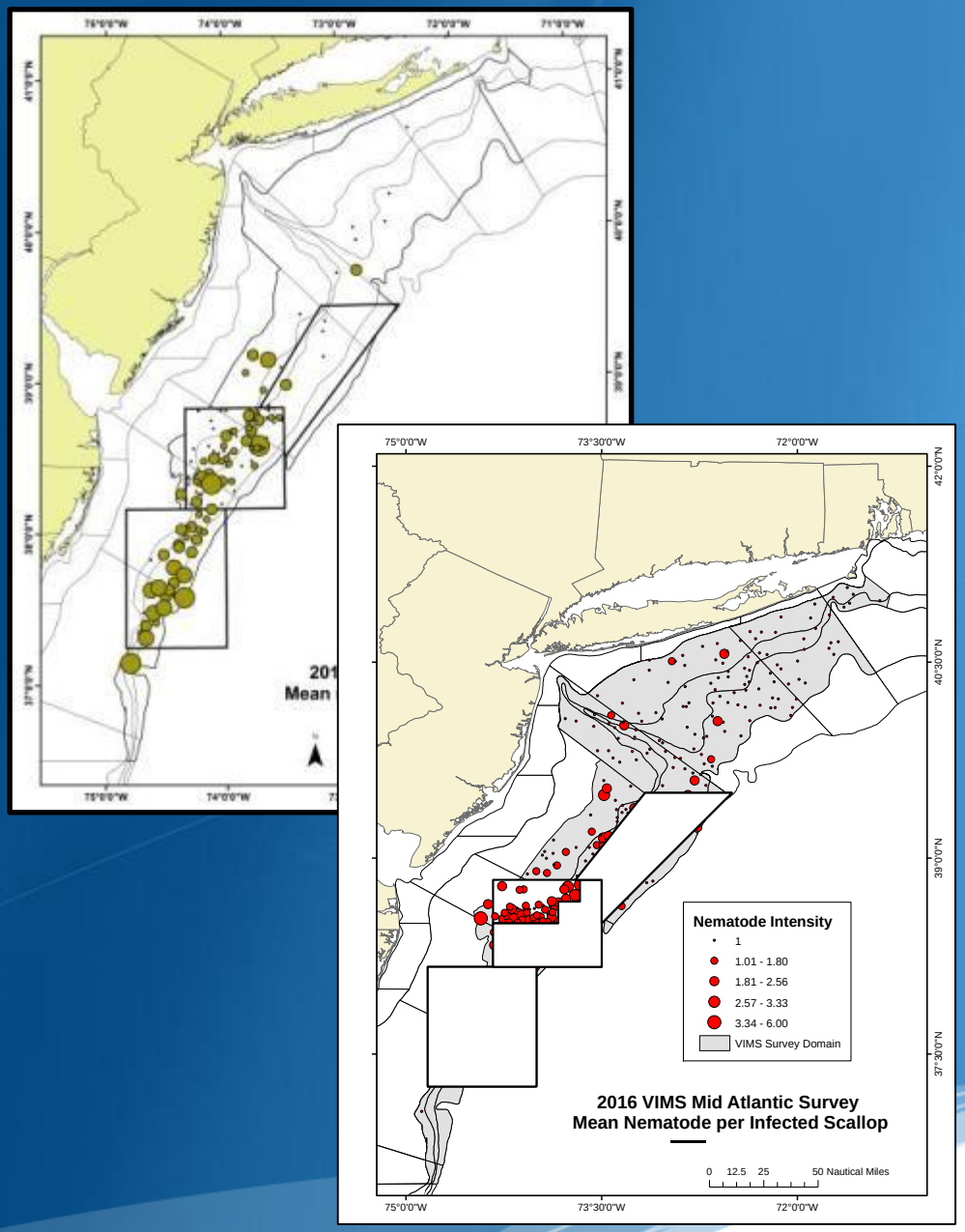
Nematode Intensity



- Spatial distribution of the intensity of the parasite in the sampled scallops.
- For each positive identification at a given station, the mean number of nematodes per scallop was calculated.
- Intensity appears to increase as a function if decreasing latitude.
- Intensity in northern areas is also increasing compared to 2015.

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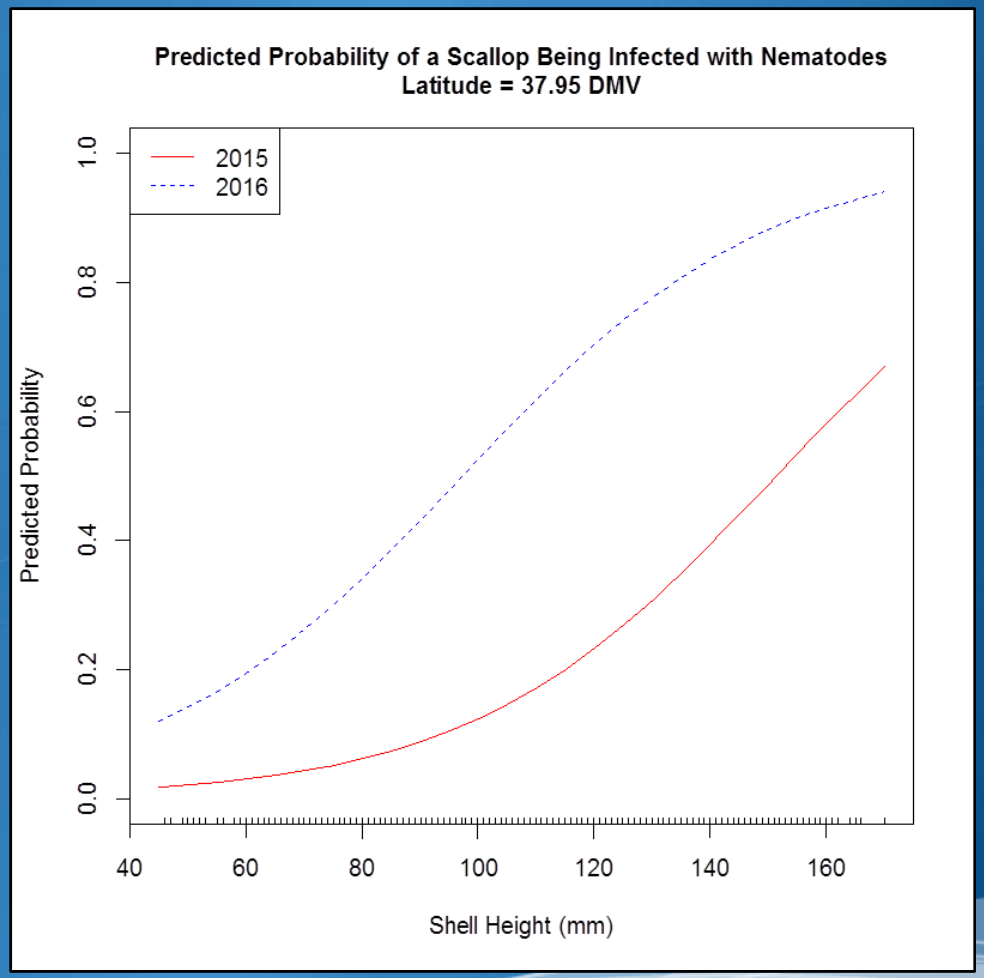
Logistic Regression for Nematode Presence

- Logistic regression was developed to predict the probability of a scallop being infected with nematodes.
- Significant predictor variables included year (2015 & 2016), latitude & shell height.
- The overall probability of a scallop being infected increased as a function of shell height and decreased as a function of latitude.
- All else being equal, P(2016)>P(2015)
- Predictions are sensitive to the latitude value used.



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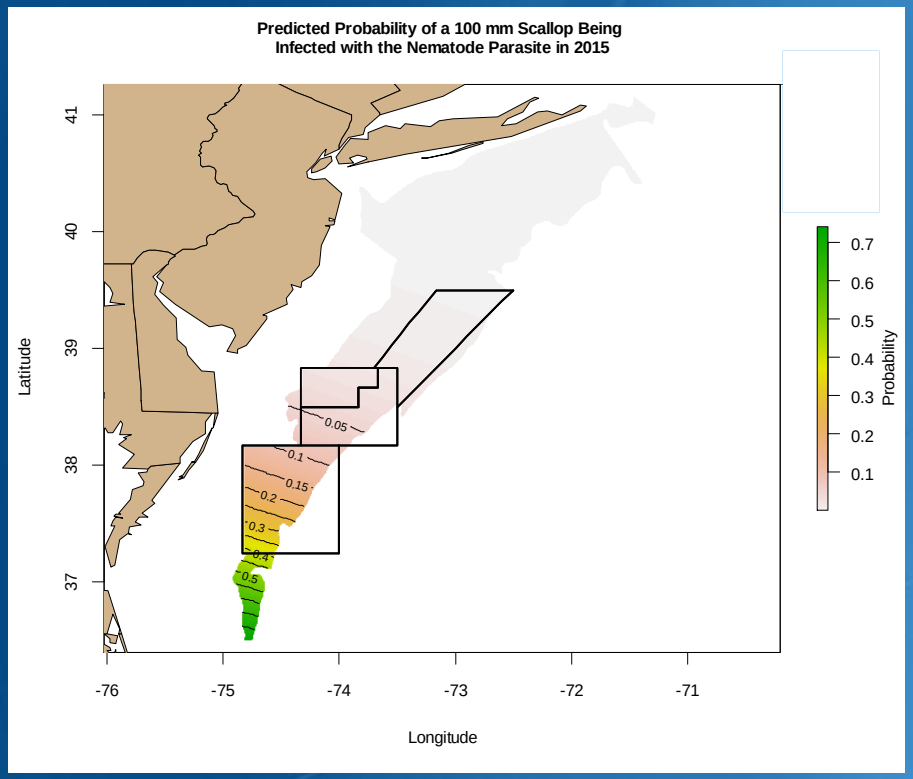
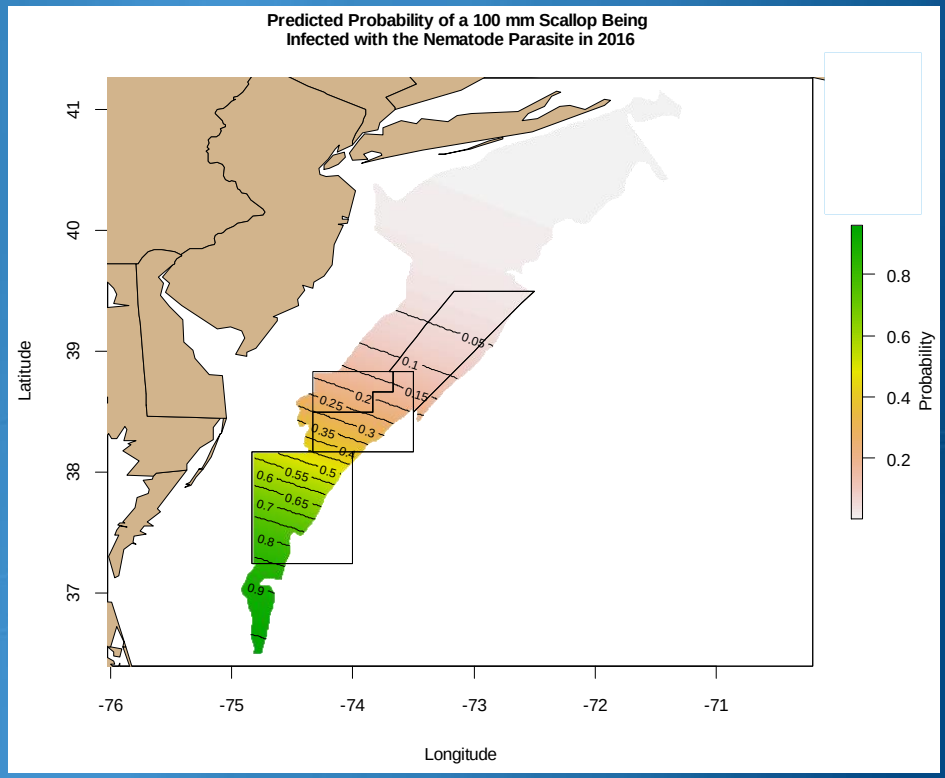
GAMM for Nematode Presence





- GAMM was developed to predict the probability of a scallop being infected with nematodes.
- Significant predictor variables included year (2015 & 2016), tensor product of latitude & longitude & shell height.

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Summary

- One parasite species (*S. sulcata*) has been positively identified using taxonomic and genetic techniques.
- Samples collected during the 2016 MAB survey will be further analyzed using histology and molecular approaches.
  - Same species of nematode
  - Population structure of nematode.
- Additional work being done to understand transmission as well as spatio-temporal dynamics of the nematode.
- Impact on fishery.
  - Clear overlap with the core of the current scallop biomass and the highest prevalence and intensity of the parasite.
  - In May of 2003, reports waned over time and there were no additional reported sightings until 2015.

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