Myctophids in the neritic and offshore areas of the subarctic NPO

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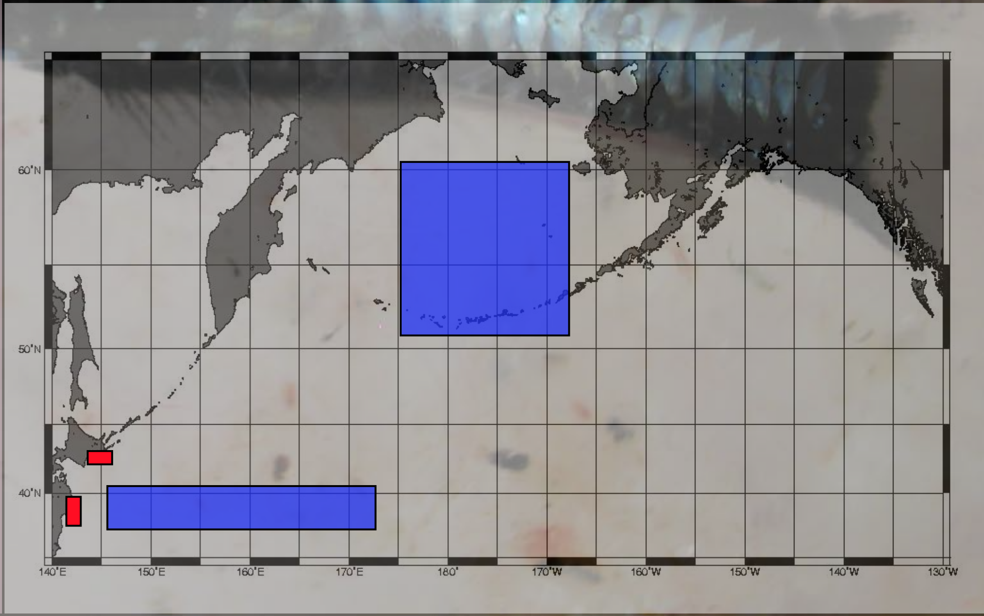
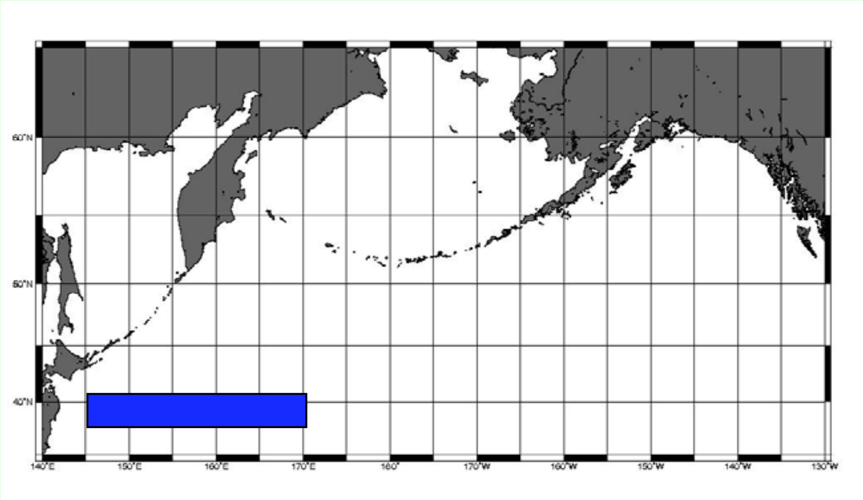
- Important due to:
  - substantial biomass
  - ubiquitous occurrence
  - intermediate body sizes
- Species composition and density
- Life history of dominant species
- Trophic relationships
- Role as an interface between neritic and offshore waters



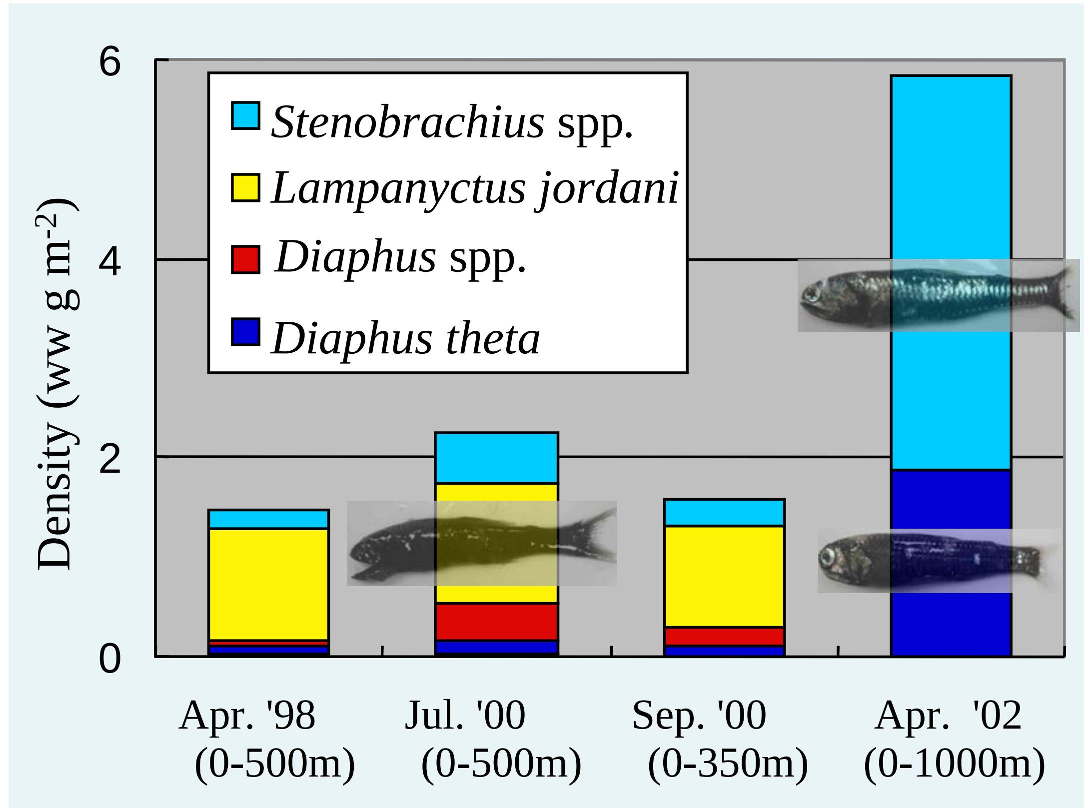
Species composition and density
- Offshore transitional area-

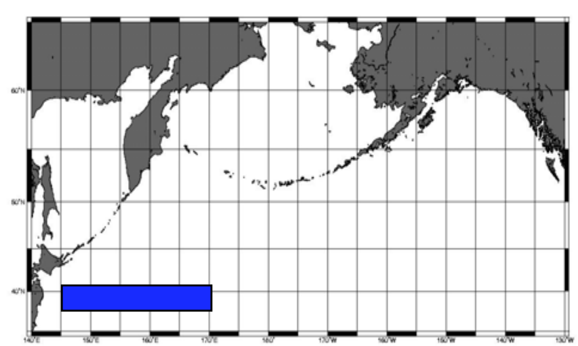
- Apr., Jun. and Sep., 1998 - 2002
- Transitional western NPO
- $4m^2$ MOCNESS
- 5 - 8 tows per cruise

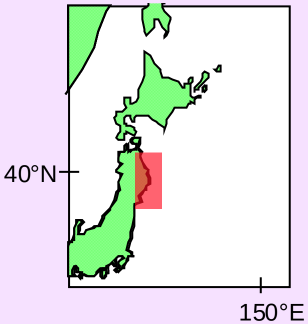


Species composition and density
-offshore transition waters-

- ≤500m
  - *L. jordani*
  - **2 g wwt m^{-2}**
- >500 m
  - *Stenobrachius* spp.
  - *D. theta*
  - **6 g wwt m^{-2}**
- **NO OBVIOUS SEASONAL PATTERN**
- More biomass in >500m depths







Transition neritic area

- Biannual bottom trawling surve
  bottom fishes (area-swept met
- 200 - 800m bottom depths
- ~ 4 g wwt m^{-2}: **conservative**
- **Subarctic**: ***D. theta***
  - Dominant during spring
- **Subtropical**: ***D. watasei***
  - Dominant during autumn
- **Transitional**: ***L. jordani***
- Responses to physical enviro
- Life history

Life history of *Diaphus theta* **(Moku et al., 2003)**

- Spawn in the TR (May-July)
- Enter the SA by passive transport
- Feed and grow
- Benefit from
  - extended period of warmer temp. for reproduction
  - higher productivity during feeding season
  - Appear to utilize neritic area (i.e. shelf edge) as nursery ground
- Similar patterns: *L. jordani* and *S. nannochir* (Sassa et al., in press)

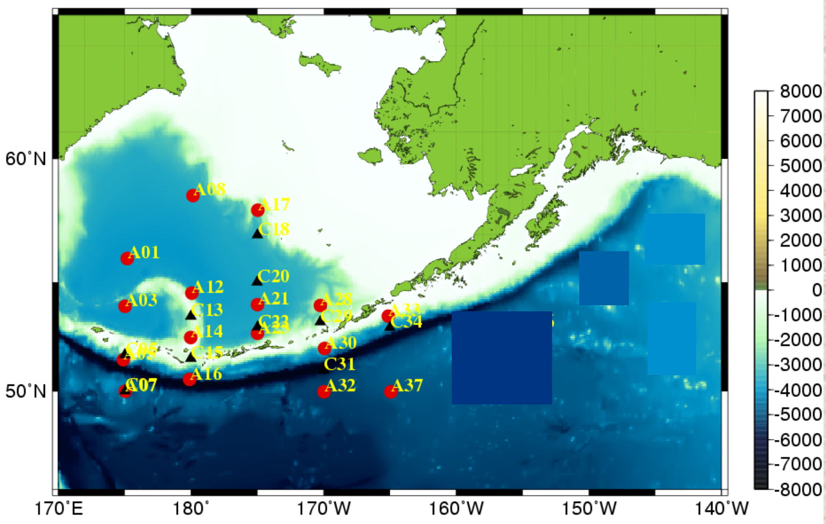
SA

TR

ST

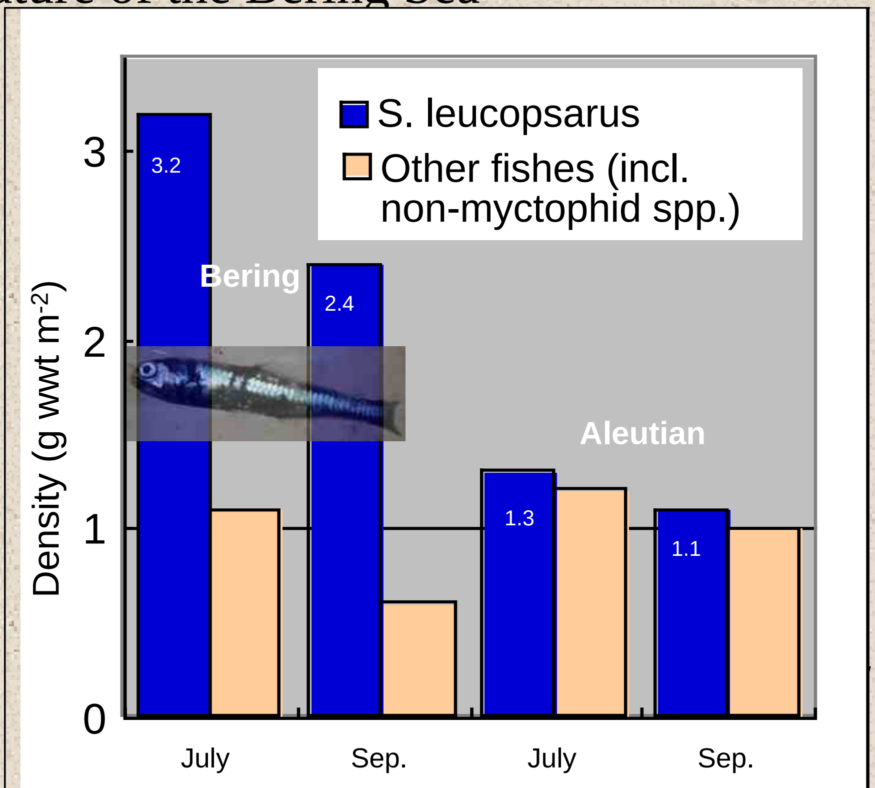
Myctophids in the central Bering Sea

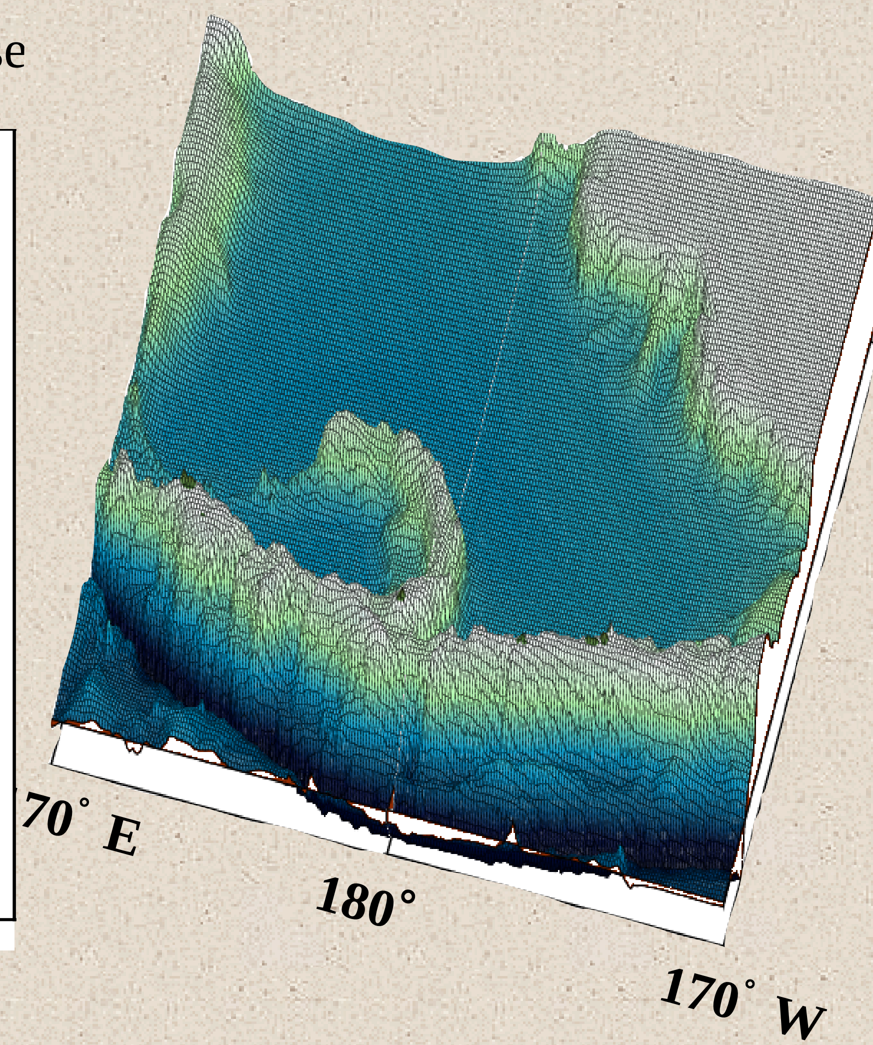
- Feeding ground for Pacific salmon
- Myctophids: potential prey and competitor
- July/September, 2003
- 22 stns., a 12m^2 rectangular midwater trawl net,
- Oblique tow aimed at 500m depth



Myctophids in the central Bering Sea

- *Stenobrachius leucopsarus*: higher density in the central Bering Sea:**2.4 - 3.2g wwt m^{-2}**
- Maintain unique fauna by the semi-enclose nature of the Bering Sea





N. Tanimata

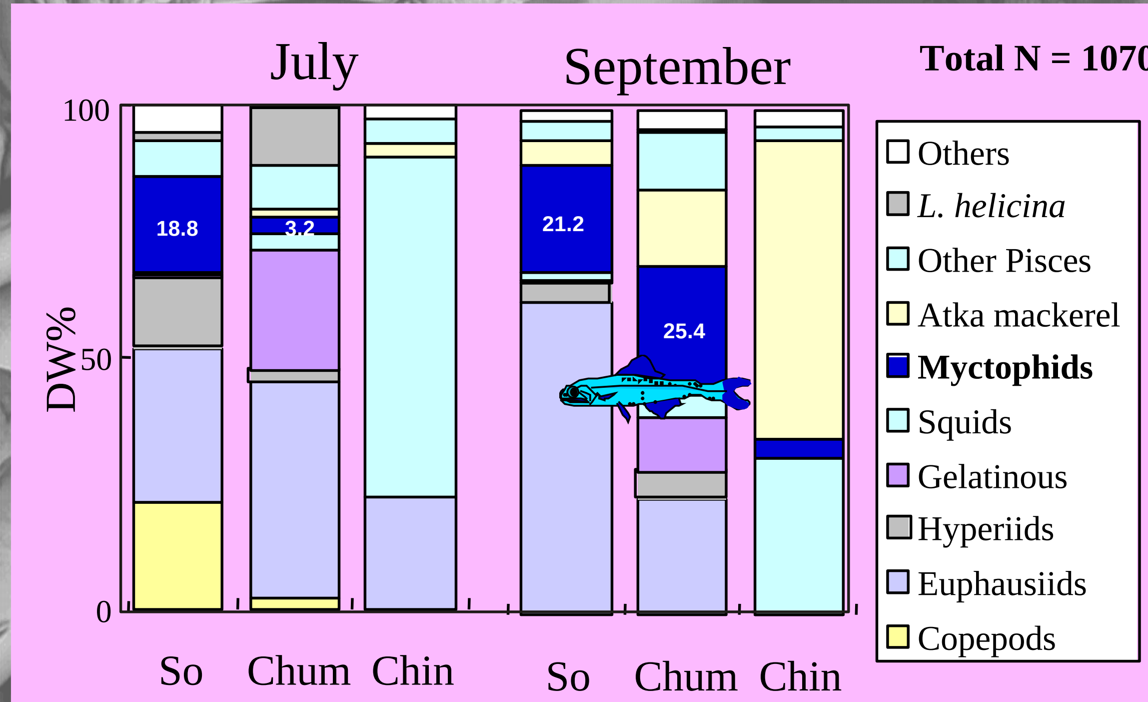
Summary for species composition and density in the neritic/offshore subarctic

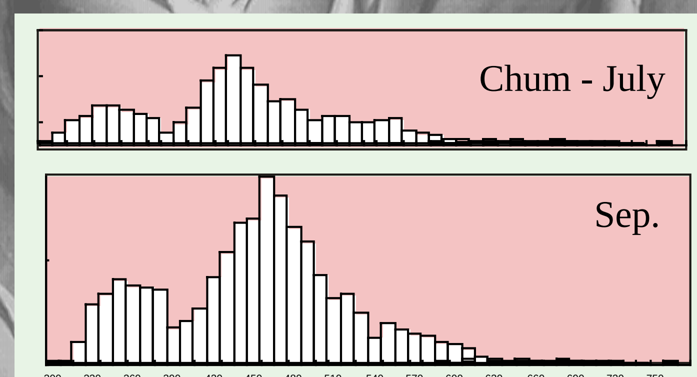
- Offshore/neritic transitional waters (even the Bering Sea) share the dominant species in common
  - *Diaphus theta*
  - *Lampanyctus jordani*
  - *Stenobrachius leucopasarus*
- Few endemic species in the neritic waters (e.g. *Diaphus watasei*)
- Average density of **<6 g wwt m^{-2}** (i.e. <6 t km^{-2})
- **Conservative** estimate
- Need more reliable estimate in neritic areas
- Need to consider **net avoidance, sampling efficiency** and to establish an acoustic sampling method

Trophic role

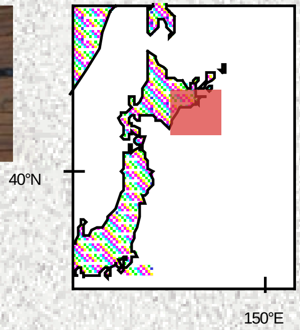
-Salmon diets in the Bering Sea-

- 19-21%DW for sockeye
- Chum: Increase from 3% to 26%
- Reflects decrease in relative (per captita) abundance of zooplankton prey
- Smooth seasonal variation in prey availability

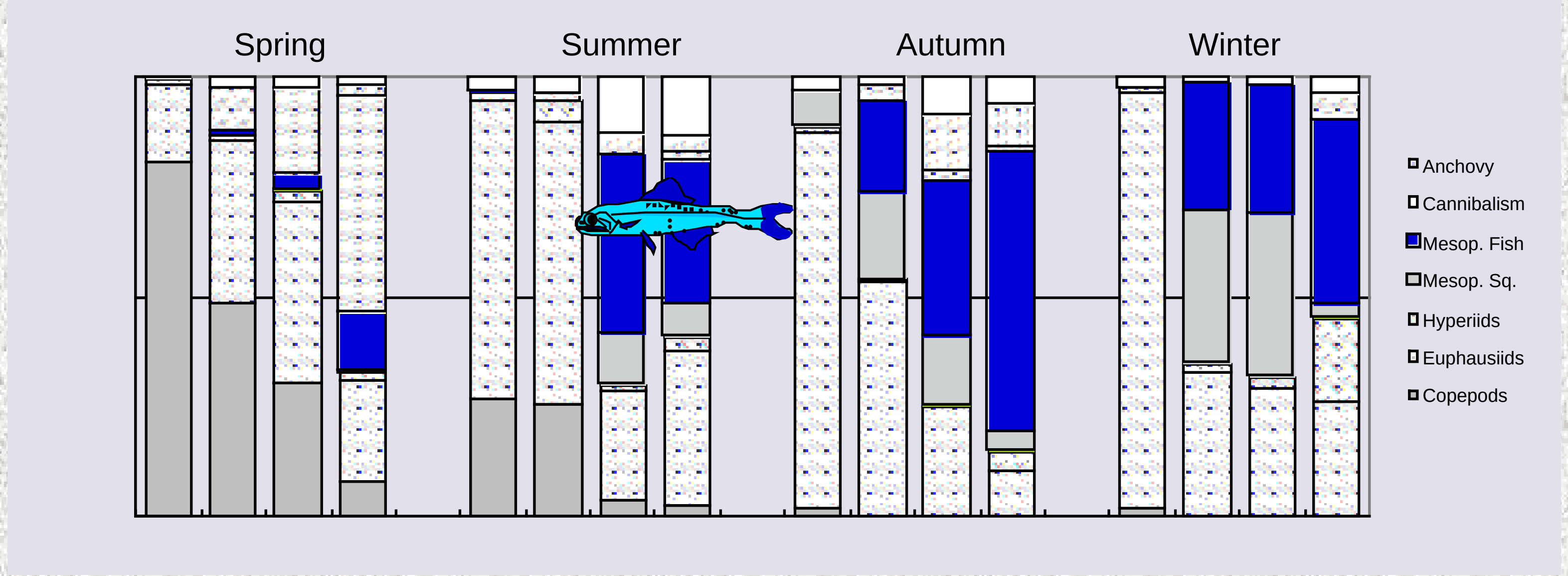




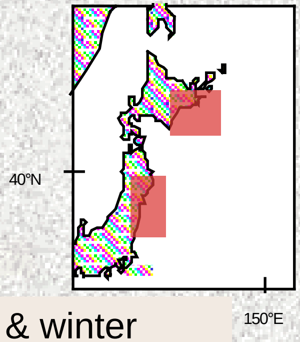
Trophic role in the neritic waters



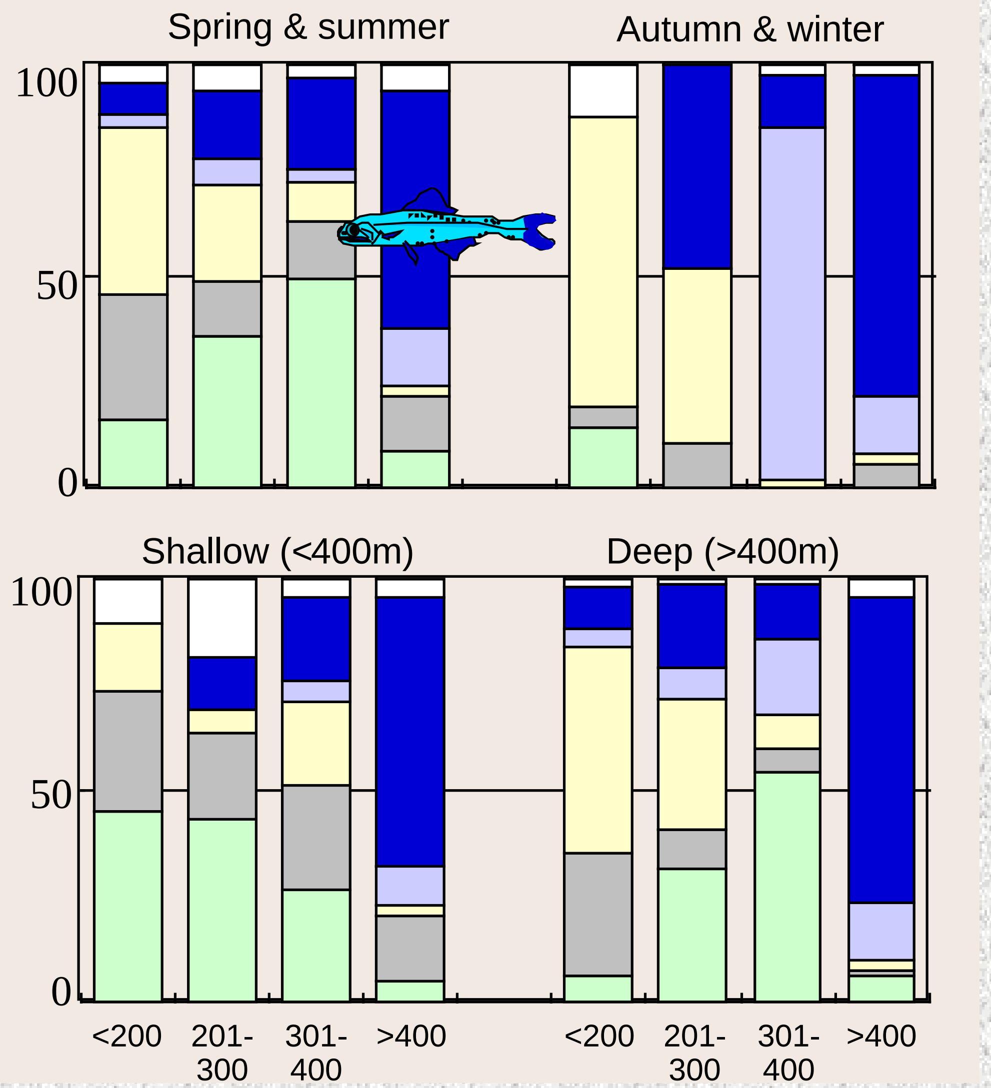
- Walleye pollock (N=6666)
- Distributed in lower shelf and upper slope (<250m)
- *Diaphus theta* : exclusive importance (ca. 80% in DW)
- Important for larger fish except for during spring
  - Reflects the **spawning migration** of *D. theta* and heavy pollock cannibalism during spring



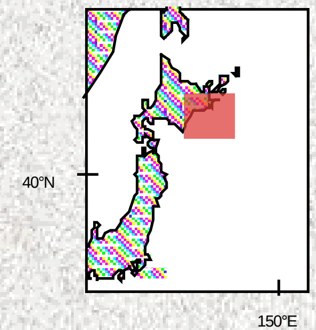
Theradfin hakeling *Laemonema longipes*



- Predominant over the **upper/mid slope** (300-1000m bottom depths) of the western Pacific
- N=1388
- Important for larger fish
  - *D. theta* (ca. 60% in DW)
  - *Lampanyctus* spp. (25%)
- Obscure **seasonal** and bathymetric difference:
  - Reflect ubiquitousness and seasonal stability



Estimating predation impact on myctophids by theradfin hakeling

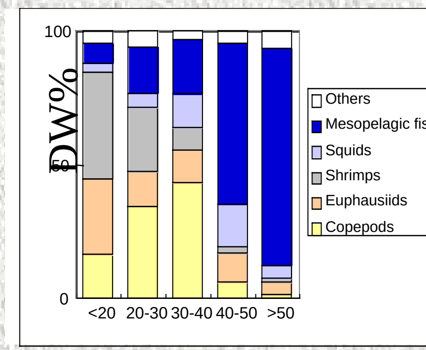


- Densely distributed over upper/mid-slope in the Doto area (7.9g m^{-2})
- Ca. 40% in overall diet
- Density: 7.9g m^{-2} (by trawl survey)
- Daily ration: 0.3%BW (*Stenobrachius nannochir;* Moku et al. 2000)
- **Annual consumption**

  = pred. density x prop. in diet x daily ration x 365

  = 7.9g m^{-2} x 0.4 x 0.3% d^{-1} × 365 d

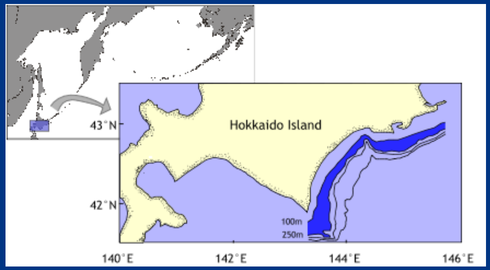
  = **3.46 g m^{-2} y^{-1}** (**total:** 3.46 x 6000km^2 = **20,800 t**)
- Considering average density of myctophids, <6 g wwt m^{-2}, this predation pressure is too heavy. So, **supplement by migration seems essential.**



Estimating Myctophid predation by pollock using an age-structured bottom-up model

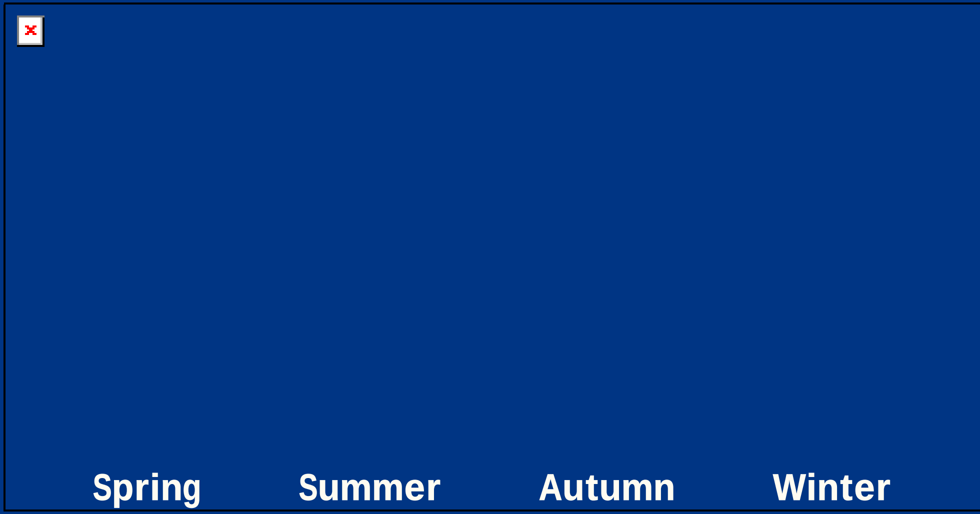
- Area modeled
  - Off SE Hokkaido Island
  - 100-250m depths (Doto area)
  - *ca.* 5000km^2
- Model components
  - Pollock (**10 age classes**)
  - Predators (generic & cannibal)
  - Fishery (Trawl & Gillnet)
  - Prey
    - **Copepods**
    - **Euphausiids**
    - **Myctophids**
    - **Squids**
    - **Pollock**
- Processes considered
  - Recruitment (i.e. Settlement)
  - Mortality
    - Predation
    - Cannibalism
    - Fishery
  - Growth
  - Feeding
  - Prey production

$$Pred(\mathrm{pol})_j = \sum_{i=1}^{10}\left(MaxI(T_i)\frac{\varphi_{ij} S_{ij}(B_j - P_j)_j}{H + \sum_{j=1}^{14}\varphi_{ij} S_{ij}(B_j - P_j)} \right)$$



Estimating Myctophid predation by pollock using an age-structured bottom-up model

- Model well imitated observed variation of pollock diet by season and fish size
- 83% concordance in average
- Predation pressure of pollock on mesopelagic fish (mainly *D. theta*) was calculated by Monte-Carlo simulation with population variability.
- Predation (6.3 $gm^{-2}y^{-1}$) well outstripped average biomass (1.5 gm^{-2}) and production (2.3 $gm^{-2}y^{-1}$) of myctophids.
- Supplement from offshore is essential to support pollock during autumn and winter



Property	*N. cristatus*	Euph.	Mycto-phids	Mesopel. squids	Pollock
Production ($g\ m^{-2}\ yr^{-1}$)	43.1±0.2	17.2±0.1	**2.3±0.1**	1.5±0.1	16.5±2.0
Avg. B ($g\ m^{-2}\ yr^{-1}$)	**7.7±0.2**	**10.1±0.2**	**1.5±0.1**	0.4±0.1	**40.9±4.9**
Advective supply ($g\ m^{-2}\ yr^{-1}$)	18.8±2.9	40.9±4.9	-	-	-
P/B	5.8	2.1	1.5	3.5	0.4
Predation by pollock ($g\ m^{-2}$	10.0±2.7	22.2±5.3	**6.3±1.6**	3.0±0.6	1.4±0.5
Pred. by micronekton ($g\ m^{-2}$ y	0.5±0.1	9.6±0.4	-	-	-

Conclusion - trophic role -

- Important for larger nekton during less productive seasons
- Smoothing seasonal variation in productivity
- Strong predation pressure when compared with myctophid density
  - Density estimate is conservative
  - Supplement from the offshore
    - Active migration
    - Intensification by biophysical coupling
- **Accumulating/transporting offshore production to the neritic area**