Building Early Ontogeny Pelagic Exposure Profiles for GOA-IERP Species based on Historical Ichthyoplankton Data—Rockfish

GULF of ALASKA

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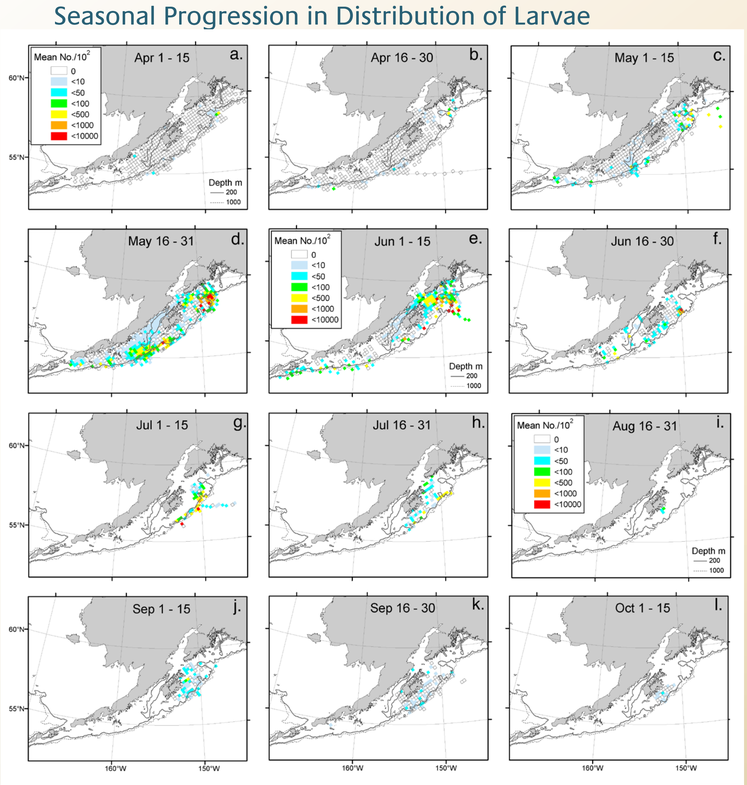
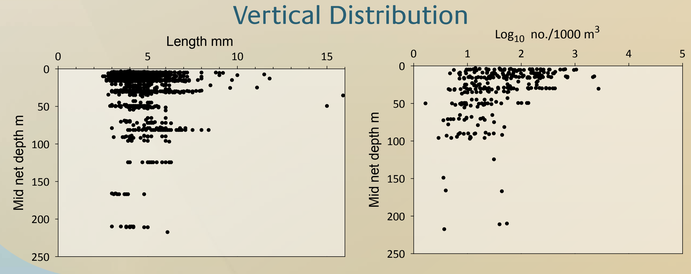
Seasonal Patterns

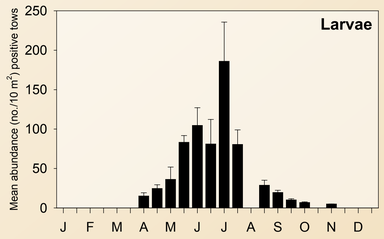
Seasonal Progression in Distribution of Larvae

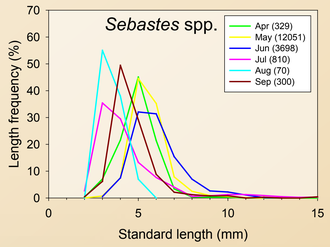


Vertical Distribution



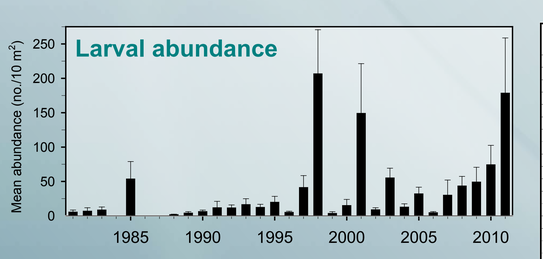
Larval abundance x half month





- Rockfish larvae occur in plankton samples from April through November with a peak in abundance during June and July. Larvae >15 mm are not sampled efficiently by 60 cm Bongo nets.
- Larvae are common in the upper 100 m of the water column but are most abundant above 50 m. A few recently hatched larvae have been sampled below 100 m.
- Length frequency distributions indicate the existence of a separate and smaller sized cohort of larvae (different species) in the summer relative to spring.
- Larvae are common during spring and summer months throughout the WGOA but are most abundant over the continental slope and particularly in association with Amatuli Trough and outer Shelikof Sea Valley which seem to be significant regions of cross shelf transport of larvae. The appearance of larvae in Shelikof Strait seems to result from ingress of larvae in these locations.

Interannual Patterns: Late-Spring Shelikof Time-Series



- The late-spring GOA time-series for rockfish larvae is characterized by low levels of abundance through 1996, and subsequent dramatic fluctuations with increasing abundance overall and highest positive anomalies in 1998, 2001 and 2011.
- Doyle et al. (2009) have identified a positive association between late spring larval abundance and warm spring temperatures.
- Interannual variation in larval length frequency distributions indicate stability in timing of release of larvae into the plankton over the time-series. The weak negative relationship between larval length and temperature suggests that larvae tend to be slightly larger overall during colder years, which seems counter-intuitive.

Interannual Variation in Larval Length Distributions

Year	Mid-Cruise Julian Day	Mid-Cruise Shift (JD)	N	WML	J-M SST Cumulative mean	% Frequency of catch by larval length bins (mm): Rockfish 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	WMA
1981	144	-4	68	5.32			5.61
1982	147	-1	53	4.82	22.56		6.69
1983	145.5	-2.5	83	5.59	24.15		8.63
1985	148	0	541	5.36	22.86		53.81
1987	142	-6	0		25.03		0.00
1988	150	2	103	5.25	24.43		1.90
1989	152.5	4.5	108	5.70	19.51		4.19
1990	152	4	83	6.62	20.91		6.34
1991	141.5	-6.5	107	6.01	19.67		12.01
1992	143.5	-4.5	191	5.91	23.22		11.65
1993	148.5	0.5	356	6.06	23.04		16.51
1994	148	0	182	6.14	23.58		12.48
1995	145	-3	191	6.40	20.99		19.83
1996	149	1	117	6.25	23.21		5.19
1997	147	-1	410	5.87	23.31		41.29
1998	146	-2	1484	5.87	28.53		206.79
1999	149	1	612	7.25	20.06		3.62
2000	151.5	3.5	207	5.47	23.25		15.20
2001	149	1	1000	5.72	25.31		149.24
2002	148	0	192	6.18	23.07		8.97
2003	149.5	1.5	743	5.46	27.56		55.27
2004	149.5	1.5	546	5.76	22.70		12.87
2005	148	0	1097	6.68	25.31		32.12
2006	147	-1	564	6.70	23.23		4.71
2007	144	-4	141	6.34	18.88		30.25
2008	147	-1	476	6.04	20.15		43.66
2009	152.5	4.5	569	6.42	18.69		49.31
2010	147	-1	1418	6.02	24.28		74.41
2011	156.5	8.5	518	6.37	22.56		178.71

N = number of larvae measured
WMA = weighted mean abundance (no./10 m²)
WML = weighted mean length mm,
Time-series (May 16-Jun 9) Julian Day mid-point of sampling coverage: 148
J-M SST = Cumulative mean SST for Jan through May from monthly mean values NOAA Optimum Interpolation (OI) SST V2; at Long 155.5, Lat 57.5 (color coded: light blue coldest to dark green warmest)

% Frequency: 0 >0<1 1<5 5<10 10<15 15<20 20<25 25<30 30<35 35<75

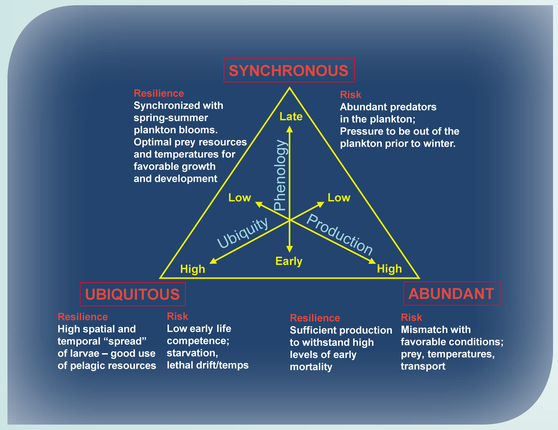
Correlations:
WML vs WMA: -0.01 **WML vs Cum J-M SST:** -0.35 **WML vs. Mid-cruise Shift:** -0.02
WMA vs Cum J-M SST: 0.41 **WMA vs. Mid-Cruise shift:** 0.25

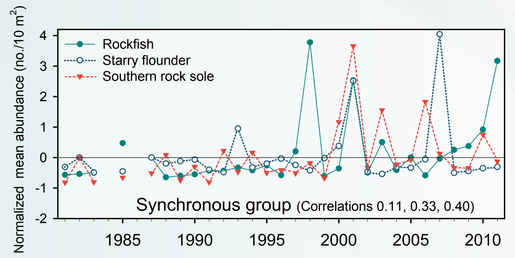
Expected tendency for smaller larvae to be more abundant than larger larvae not apparent.
Interannual variation in larval length negatively related to SST but not shift in sampling dates.

Multispecies Perspective

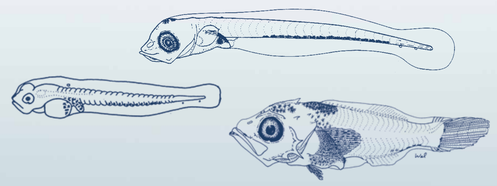
Early Life History (ELH) Exposure-Response Framework

Doyle and Mier 2012

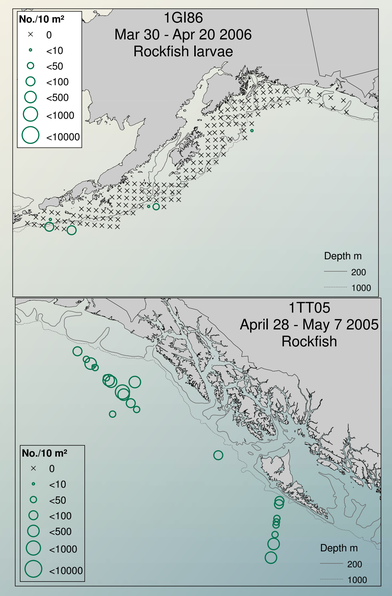




- Rockfish larvae belong to a slope assemblage of larval fish species that prevails during spring and summer in the WGOA (Doyle et al., 2002).
- Rockfish belong to an early life history strategy "Synchronous" (late spawning) group that is characterized by production of larvae that is synchronized well with peak spring production in the zooplankton (Doyle and Mier, 2012). Other members of this group include starry flounder and southern rock sole.
- Although interannual variation in larval abundance for these species is not as tightly synchronized as for the "Abundant" group, they share a pattern of increasing abundance overall across the time-series with occasional high anomalies in later years including a shared dramatic high in 2001.



Eastern vs. Western GOA



- During spring, rockfish larvae are abundant over the slope and in deep water in both the WGOA and the EGOA.

Synthesis

- **Temporal Exposure** of rockfish larvae is characterized by late spring to summer peaks in abundance that is synchronized well with the annual peak in zooplankton production in the GOA. Bothe the spring and summer cohorts of larvae are likely to encounter plentiful zooplankton prey.
- **Spatial Exposure** extends throughout WGOA and EGOA waters primarily along the continental slope and in deep water, with highest densities of larvae associated with troughs that likely facilitate on-shelf transport of larvae.
- **Vertical Distribution** of larvae indicates that circulation models representing the upper 100 m of the water column (shelf) are suitable for tracking larval drift, and that highest densities of larvae occur in the upper 50 m.
- The **Early Life History strategy** (ELH) common to rockfish, starry flounder and southern rock sole results in an early ontogeny pelagic phase that is well synchronized with abundant larval food resources in the plankton.
- **Pelagic exposure-response coupling:** The shared pattern of spring-summer pelagic "exposure" of these species may be reflected in the common trend of increasing larval abundance over the time-series (Doyle and Mier, 2012). A positive association between larval abundance and spring water temperatures is also shared by rockfish and southern rock sole (Doyle et al., 2009).
- Occurrence and abundance of larvae is comparable between the **EGOA** and **WGOA.**
- **Gaps in ELH knowledge:**
- Distinction among multiple rockfish species in the larval stage
  - ◊ Spawning areas and ELH habitat in the EGOA
  - ◊ Larval feeding ecology
  - ◊ Larval predation
  - ◊ Habitat and ecology of late stage and transitioning larvae
  - ◊ Age-0 through juvenile stage ecology

References

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