

Classification of Gender and Maturity Status in Chinook Salmon by Short Wavelength Near Infrared spectroscopy

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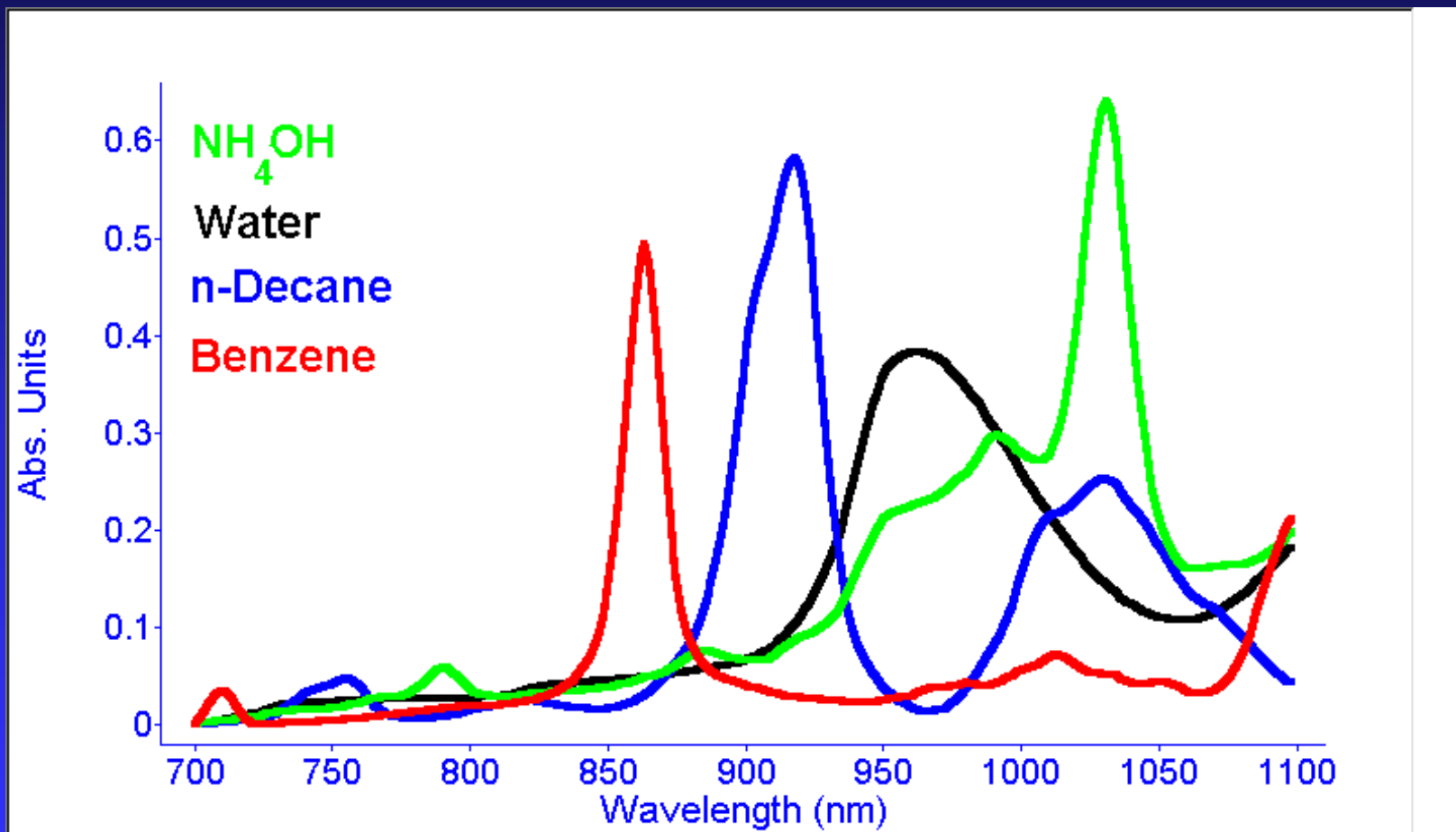
Goals

- Develop a means to classify fish according to their maturation status (immature or maturing) and gender at the earliest possible date.
- Devise the method based on a non-invasive approach.

SW-NIR Spectroscopy

- Wavelength Region
 - ◆ 600-1100 nm
- Overtone and Combination Bands of:
 - ◆ O-H C-H N-H
- Low Energy Electronic Transitions
 - ◆ chlorophyll
 - ◆ hemoglobin
 - ◆ other highly conjugated systems

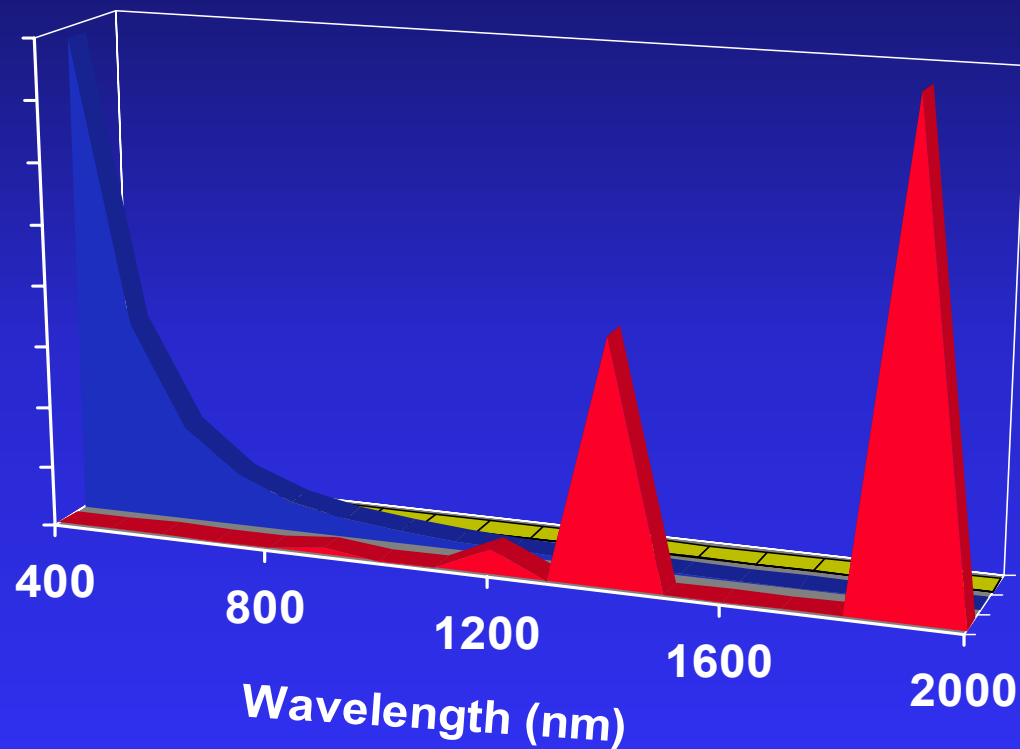
Common SW-NIR Spectral Features



Advantages of SW-NIR

- Little or no sample preparation
- Very short measurement time
- Long path lengths (1-100 cm)
- Non-destructive
- Excellent signal to noise
- Rugged instrumentation
- Inexpensive fiber optics

Comparison of scattering and absorbance in the NIR



Disadvantages of SW-NIR

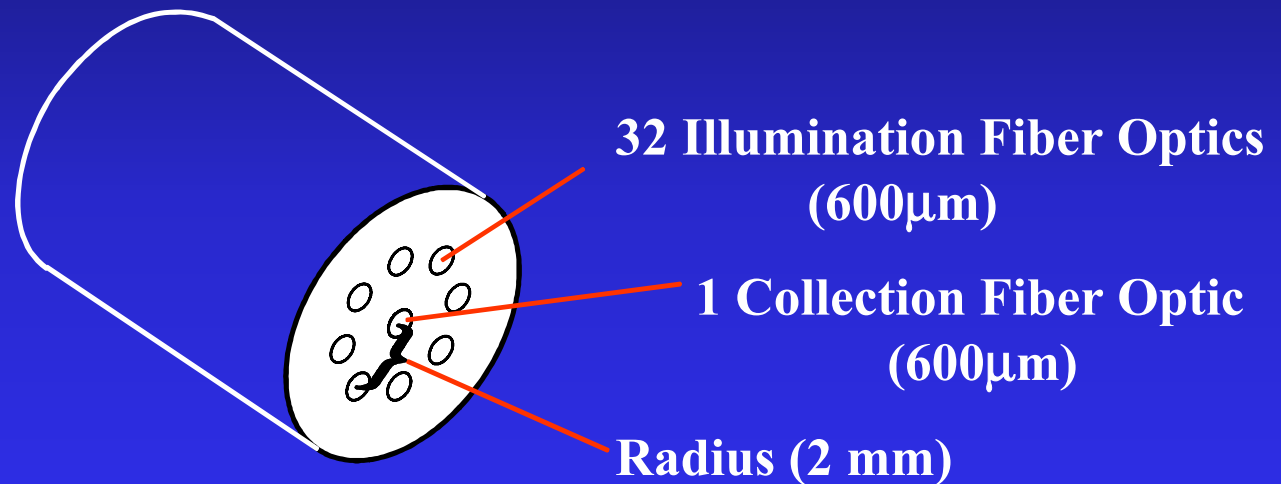
- low sensitivity
 - ◆ useful for components at concentrations $> 1\%$
- limited scope of functional groups
 - ◆ absorption caused by C-H, N-H, O-H vibrations
- absorption bands overlap
 - ◆ instrument requires complicated calibration

NIR Calibration - Multivariate Analysis

- Classification methods:
 - ◆ Principal Components Analysis (PCA)
 - ◆ Soft Independent Modeling of Class Analogy (SIMCA)

Fiber Optic Probe Design

Fiber Probe End







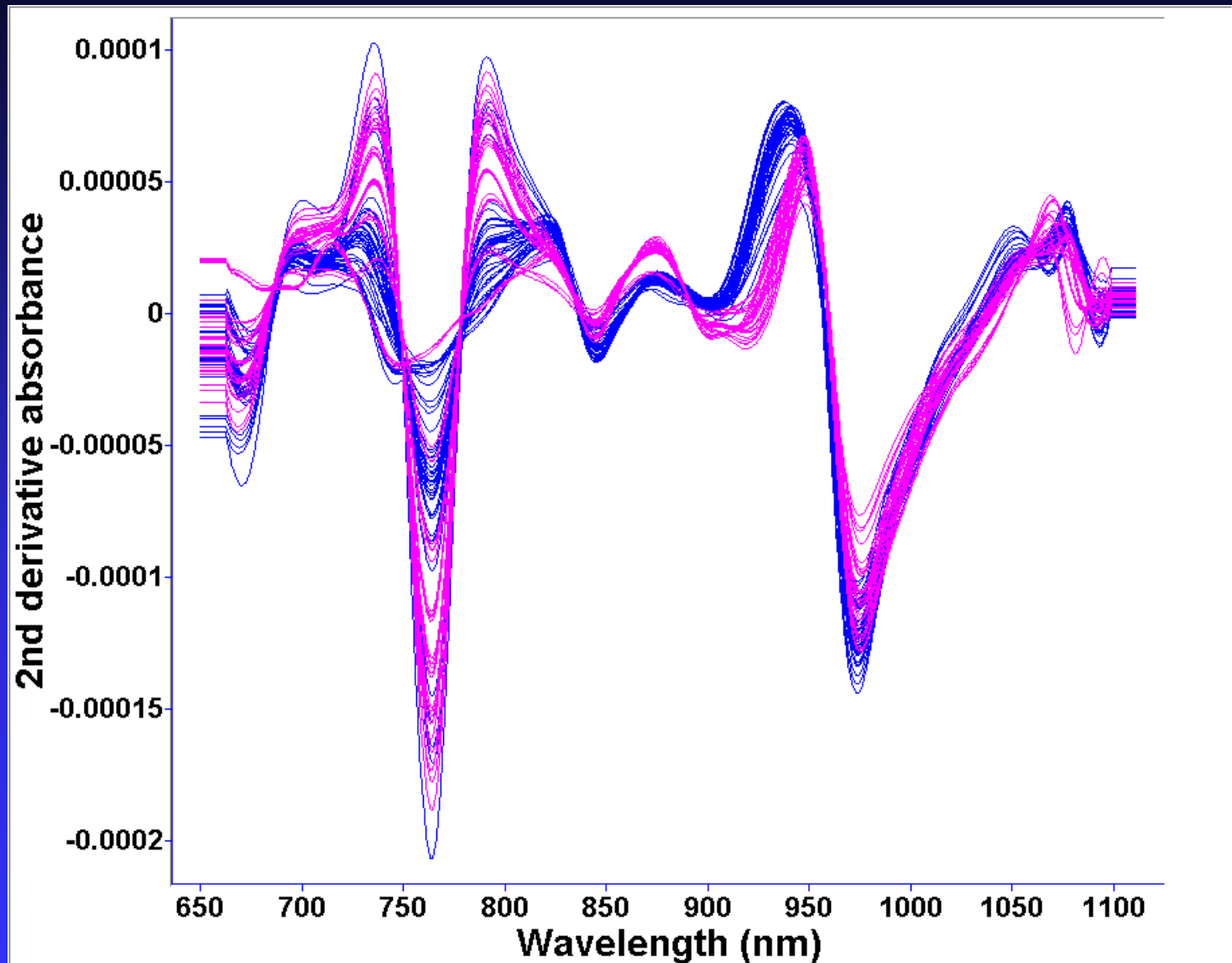
Spectra collection

- 170 spectra were collected at Bonneville in May 2002
- 750 spectra were collected at Manchester in March 2003
- 360 spectra were collected at Bonneville in April 2003
- 160 spectra were collected at Bonneville in June 2003

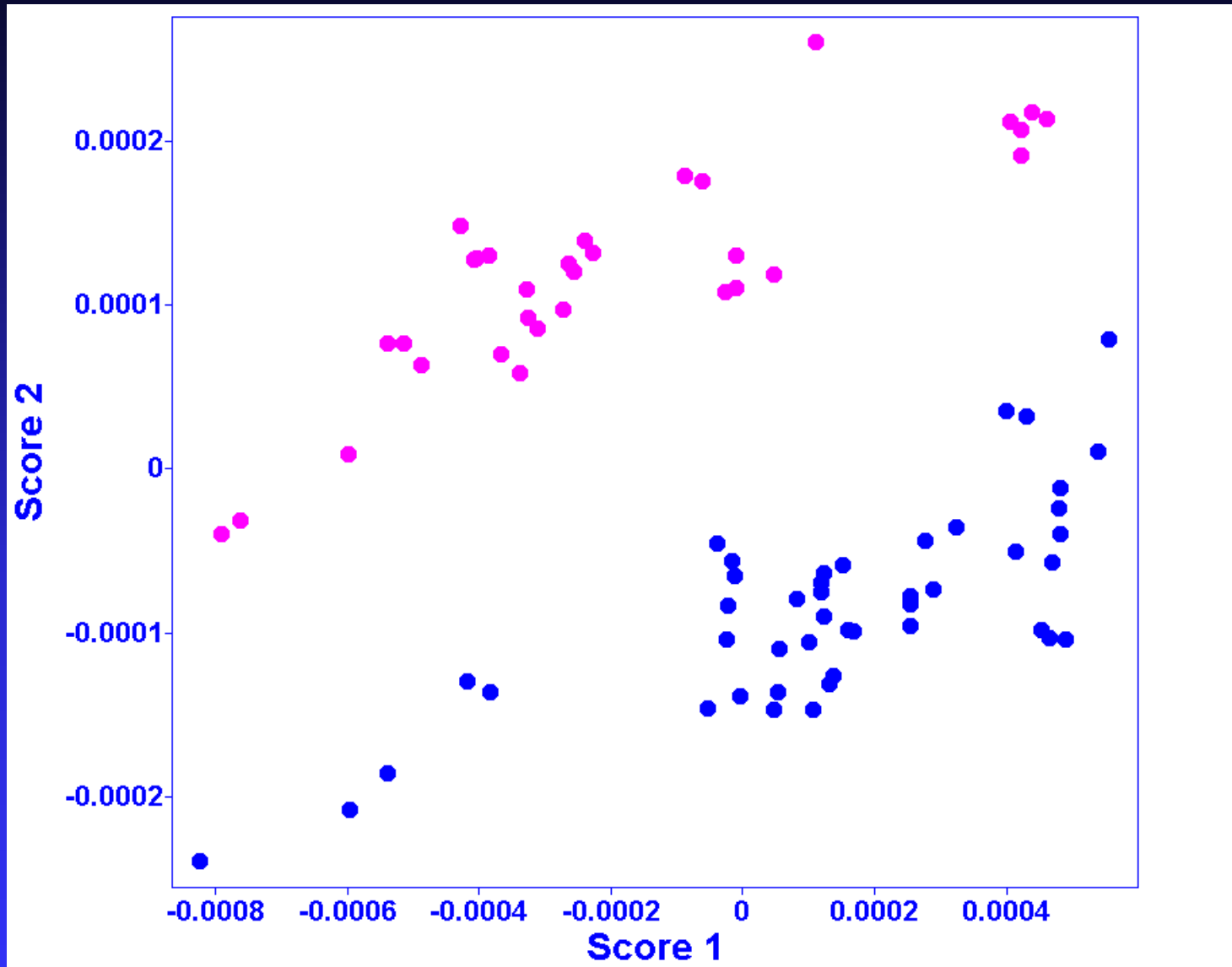
Summary of SIMCA classification Bonneville 2002

Probe Position	Base Pop. for Model	% correctly classified	% incorrectly classified
Belly 1(B1)	Mature Female	79.40% 79.70%	23.80% 38.50%
Belly 2 (B2)	Mature Female	91.41% 80.39%	9.10% 11.67%
Dorsal (D1)	Mature Female	75.30% 77.20%	42.90% 46.20%

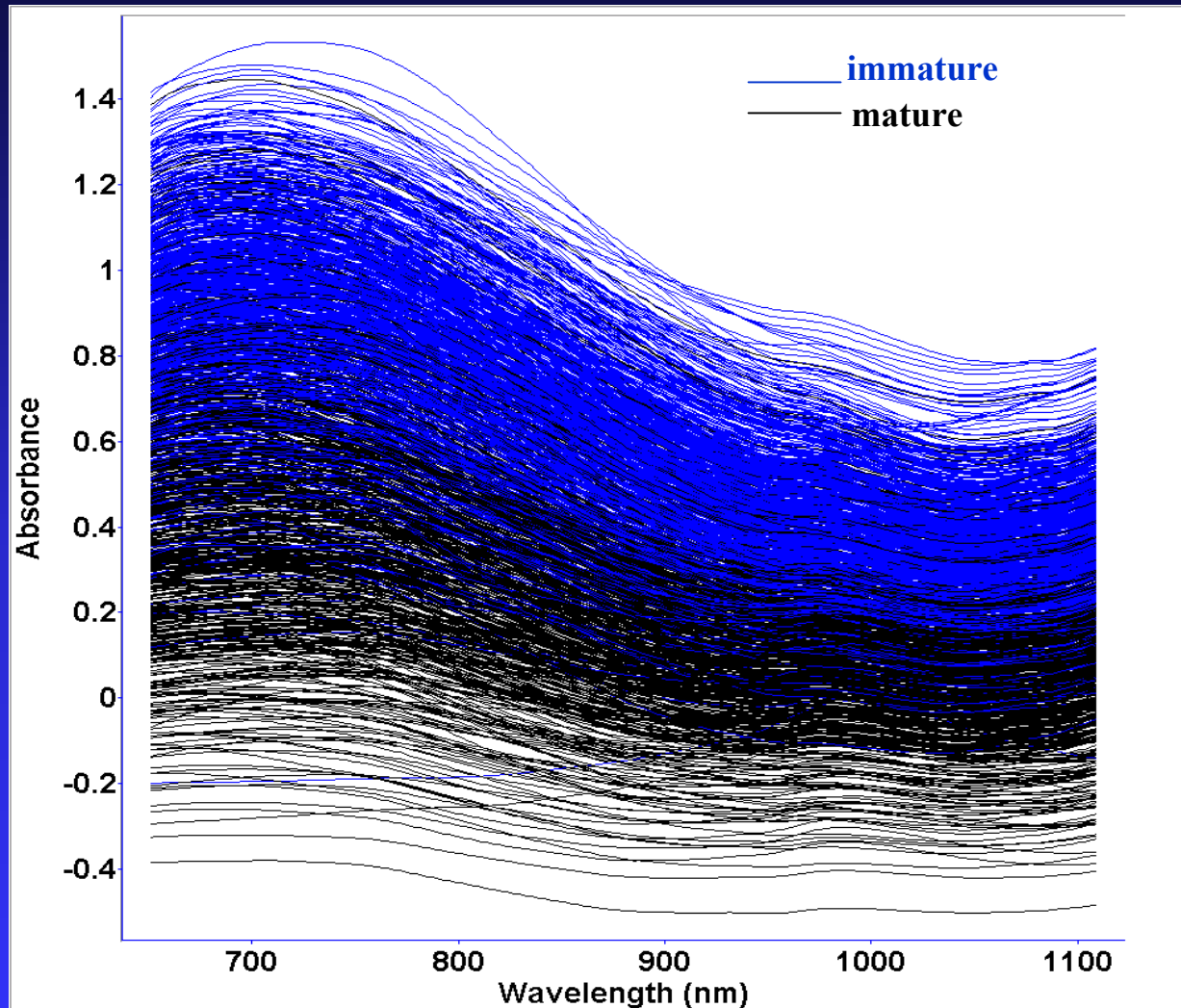
Spectra of eggs and testis



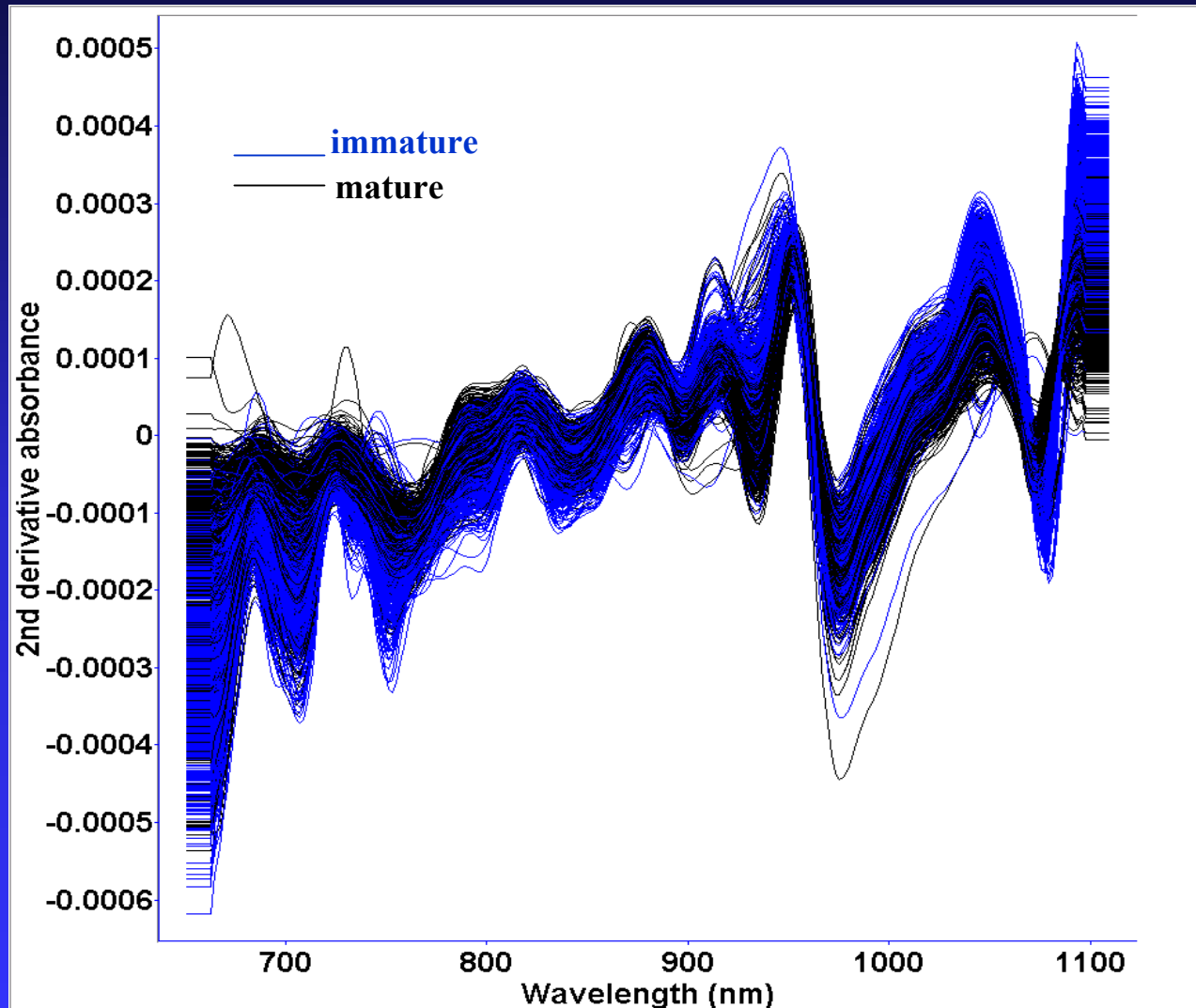
PCA classification for eggs and testis



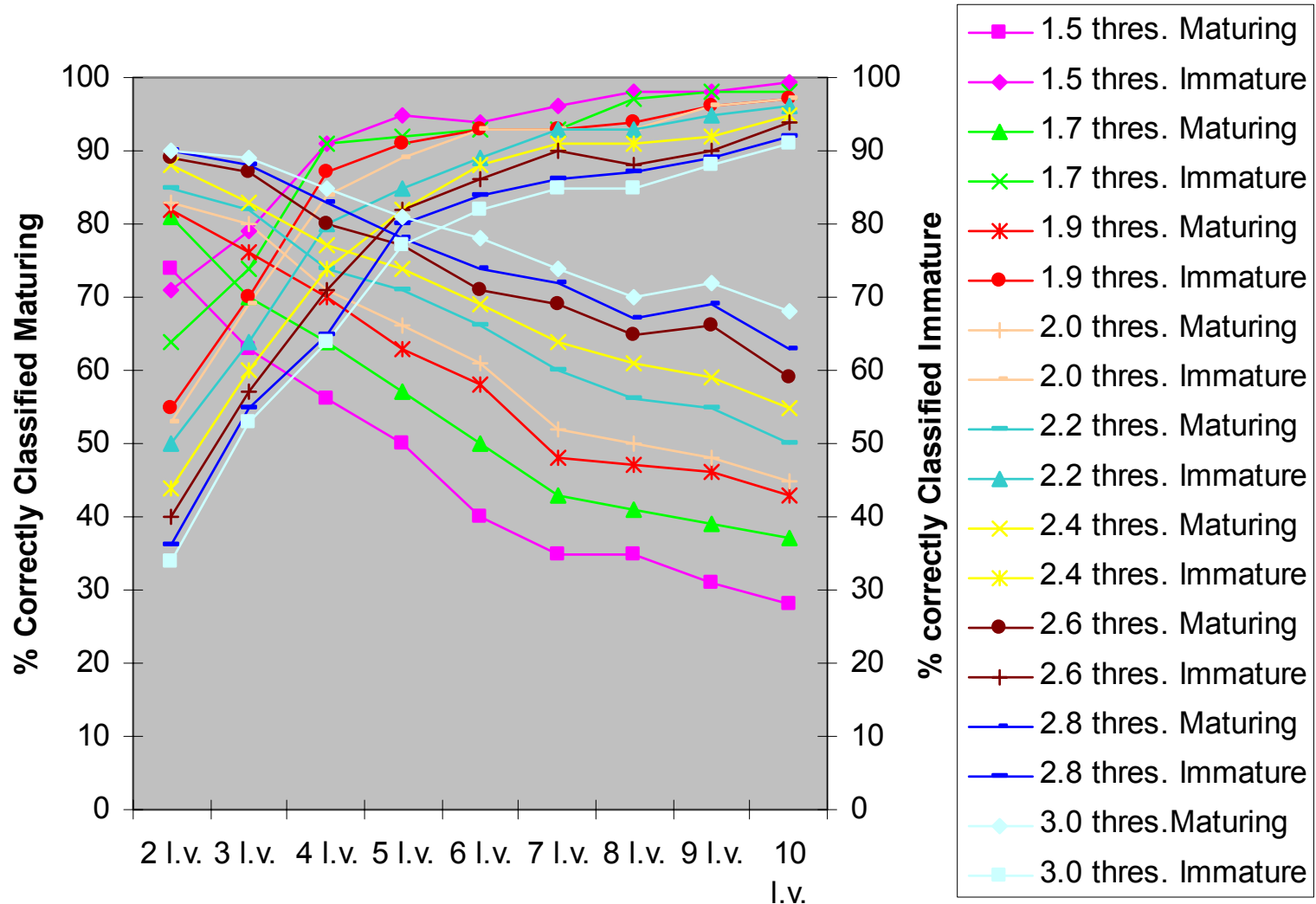
Absorbance spectra of mature and immature fish



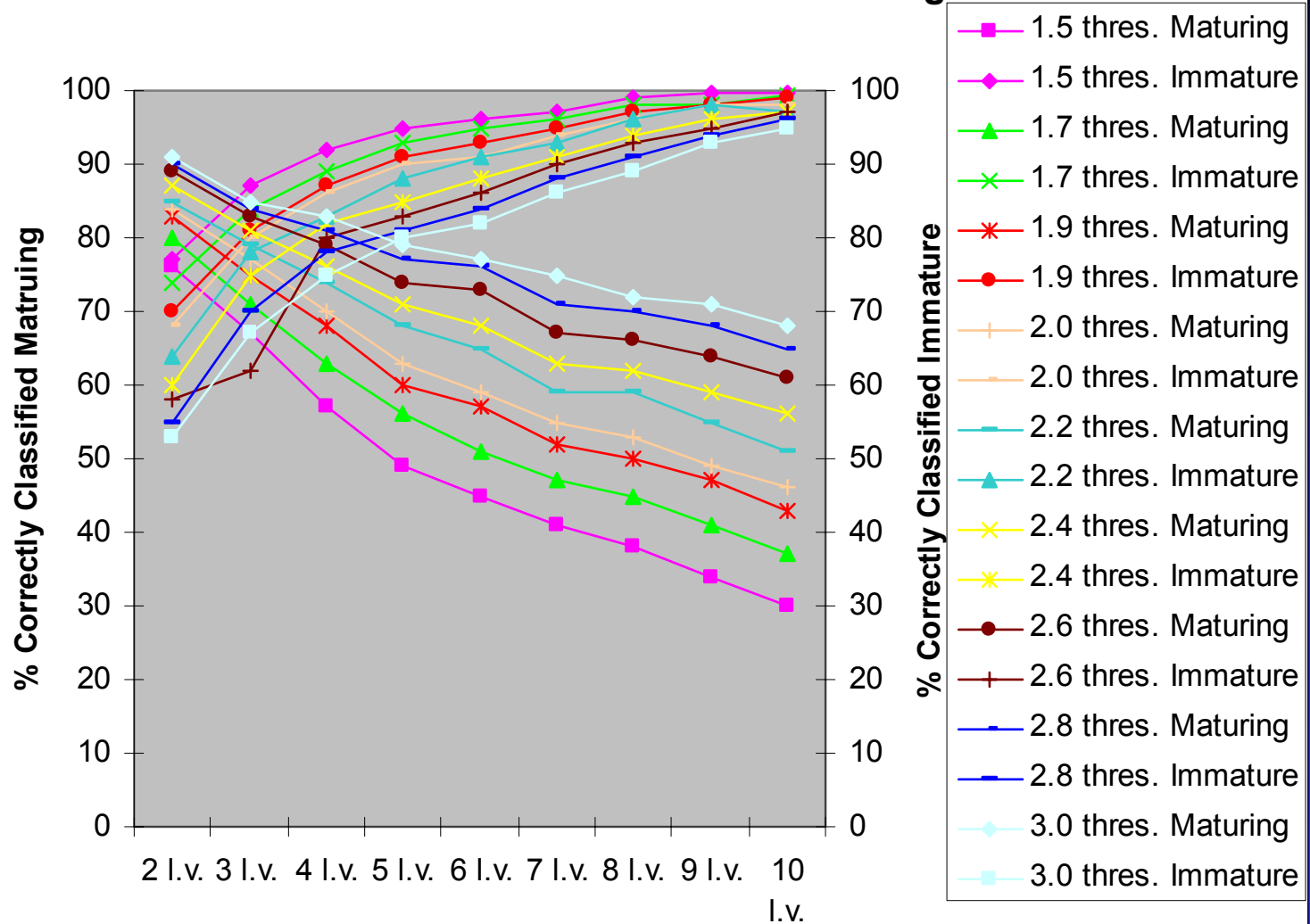
2nd derivative spectra of mature and immature fish



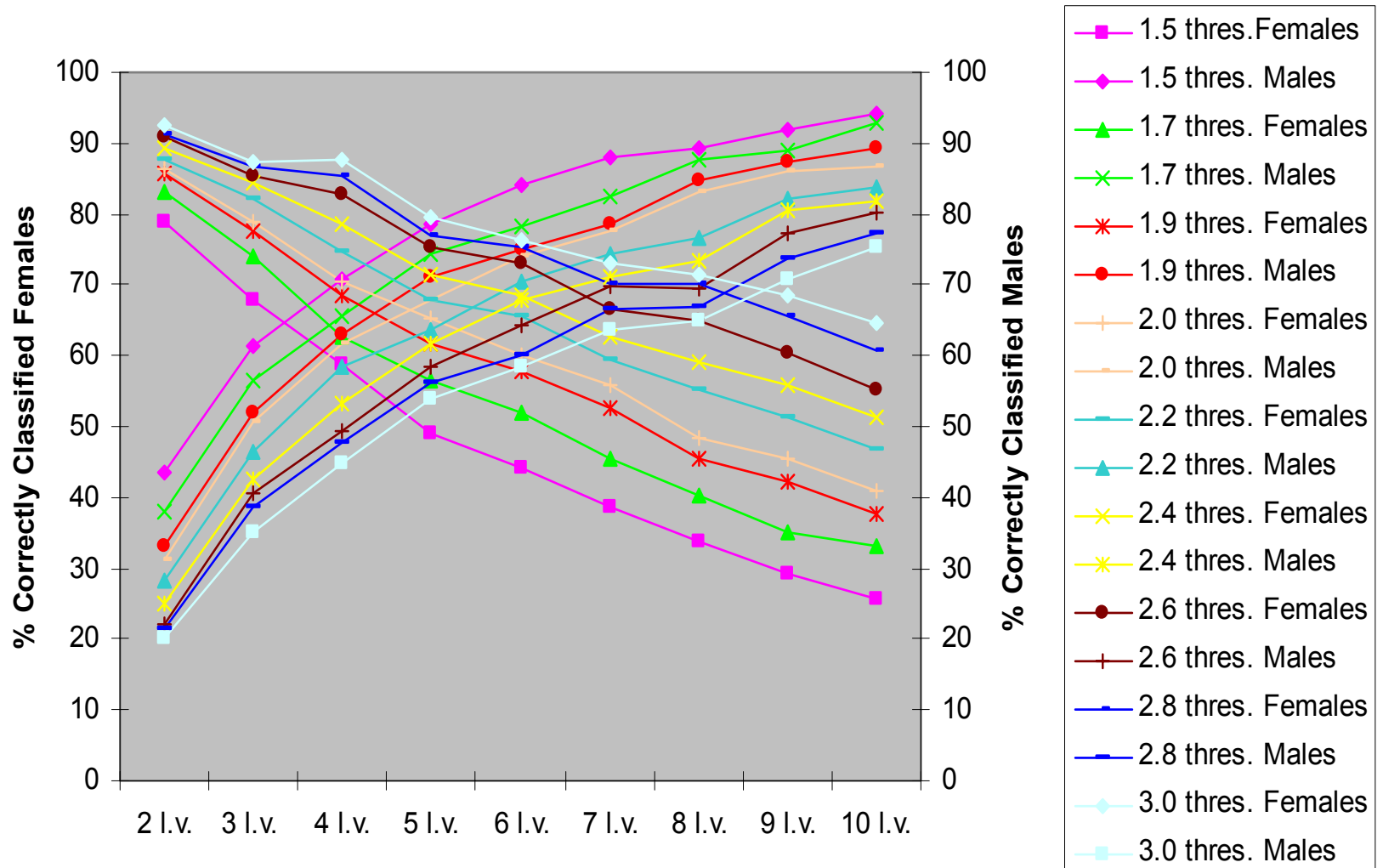
Manchester 2003 Maturity Determination Based on Maturing



Bonneville-Manchester Merged 2003 Maturity Determination Based on Maturing



Bonneville - Manchester 2003 Sex Determination Based on Females



Conclusions

- SW-NIR spectroscopy shows great promise for classifying maturity and gender at early stages.
- Experimental evidence confirms that light penetrates through skin and scales reaching gonadal tissues.
- Approximately 100% immature fish can be correctly classified.
- Results need to be validated with spawning observations.

Acknowledgments

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- DSquared Development, Inc.