Biology and Ecological Impacts of the European Green Crab, *Carcinus maenas*, on the Pacific Coast of Canada

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Green Crab (*Carcinus maenas*)

- Arrived in San Francisco Bay in 1989 (packing material)
- Slowly expanded northward into Pacific Northwest
- Arrived in BC through larval transport during 1998/99 El Nino
- Relatively few public reports after 1999
- No surveys until 2006

Data Sources

- Public records 1999-present
- Exploratory trap surveys 2006-2008
- Directed studies in Pipestem Inlet 2007-2008

Traps

- Fukui folding fish traps
  - 63 x 46 x 23 cm frame, 1.6 cm mesh
  - Standard Scotty plastic bait jar, top of trap
  - Frozen herring bait
- Traps set in strings of 6 or more on groundlines
  - Generally set from shallow to deep across intertidal into subtidal zone in exploratory work
  - Occasionally set along contours for tagging work

Sites

- Site selection through examination of charts
  - Tied to intertidal surveys
  - Incorporated local knowledge when available
- Developed “search image” to target specific micro-habitats
  - Adjacent to or in stream or tidal channels
  - Adjacent to cover (rocks, eelgrass)
- Some directed sampling in Georgia and Queen Charlotte Straits
  - Targeted wet storage sites for WCVI shellfish
  - Response to public reports

Data Collection

- Catches recorded by trap (target species and bycatch)
- Crab carapace width measured (nearest mm)
  - Both notch and point width recorded
- Sex determined
  - Male, female, ovigerous female, spent female
- Shell condition
- Injuries
  - Missing or regenerating limbs, torn abdomen, shell damage

Tagging

- Tagging study at Pipestem Inlet
  - Applied 3” and ¾” Floy anchor tags
  - Inserted into right gill chamber along suture line
- Final day catches used to produce population estimate
- Subsequent recoveries to estimate moult increment

Tagging

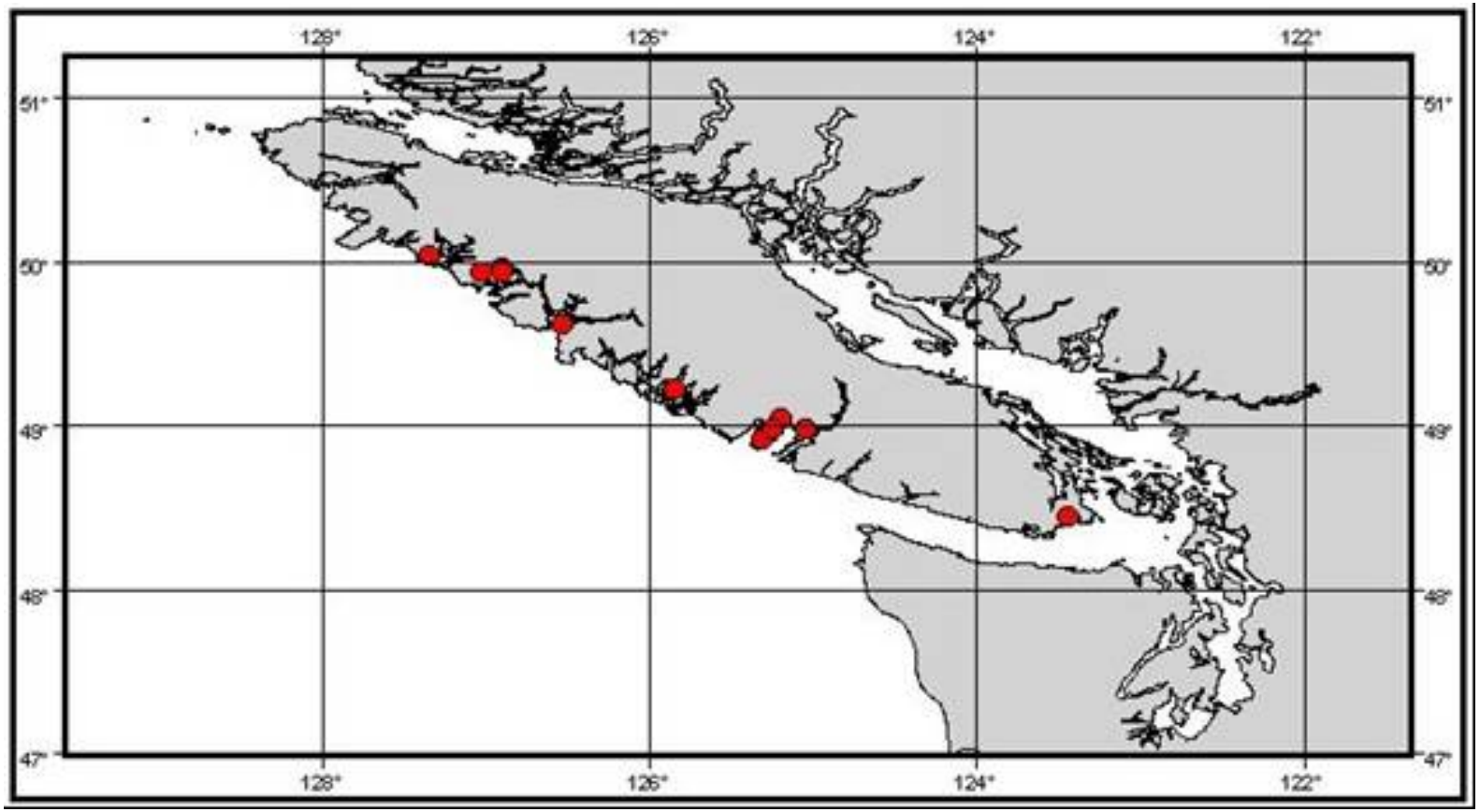
Tagging

Results

Historical Records

- First reports from Barkley Sound and Esquimalt in 1999
- Subsequent records from further north 2000-2003
- Surveys begun in 2006

Historical Records



Green Crab Catch Rates 2006-08

Location	Year	# traps	*Carcinus*/trap
Quatsino Sound	2007	108	0.3
Winter Harbour	2007	96	12.5
Klaskino Inlet	2007	35	1.8
Kyuquot Sound	2007	37	0.4
Mary Basin	2007	36	0.3
Nootka/Esperanza	2006	148	0.4
Tlupana Inlet	2007	30	0.0
Clayoquot Sound	2006	205	0.2
Sydney Inlet	**2006**	**12**	**1.4**
Sydney Inlet	**2007**	**42**	**1.5**
Barkley Sound	2006	162	1.7
Barkley Sound	2008	174	1.2
Pipestem Inlet	**2006**	**120**	**2.3**
Pipestem Inlet	**2007**	**49**	**22.0**
Pipestem Inlet	**2008**	**180**	**21.1**

Green Crab Catch Rates 2006-08

Location	Year	# traps	*Carcinus*/trap
QC Strait	2007	192	0.0
QC Strait	2008	54	0.0
Johnstone Strait	2006	101	0.0
Desolation Sound	2006	90	0.0
Discovery Passage	2006	30	0.0
Baynes Sound	2007	27	0.0
Saanich Inlet	2006	36	0.0

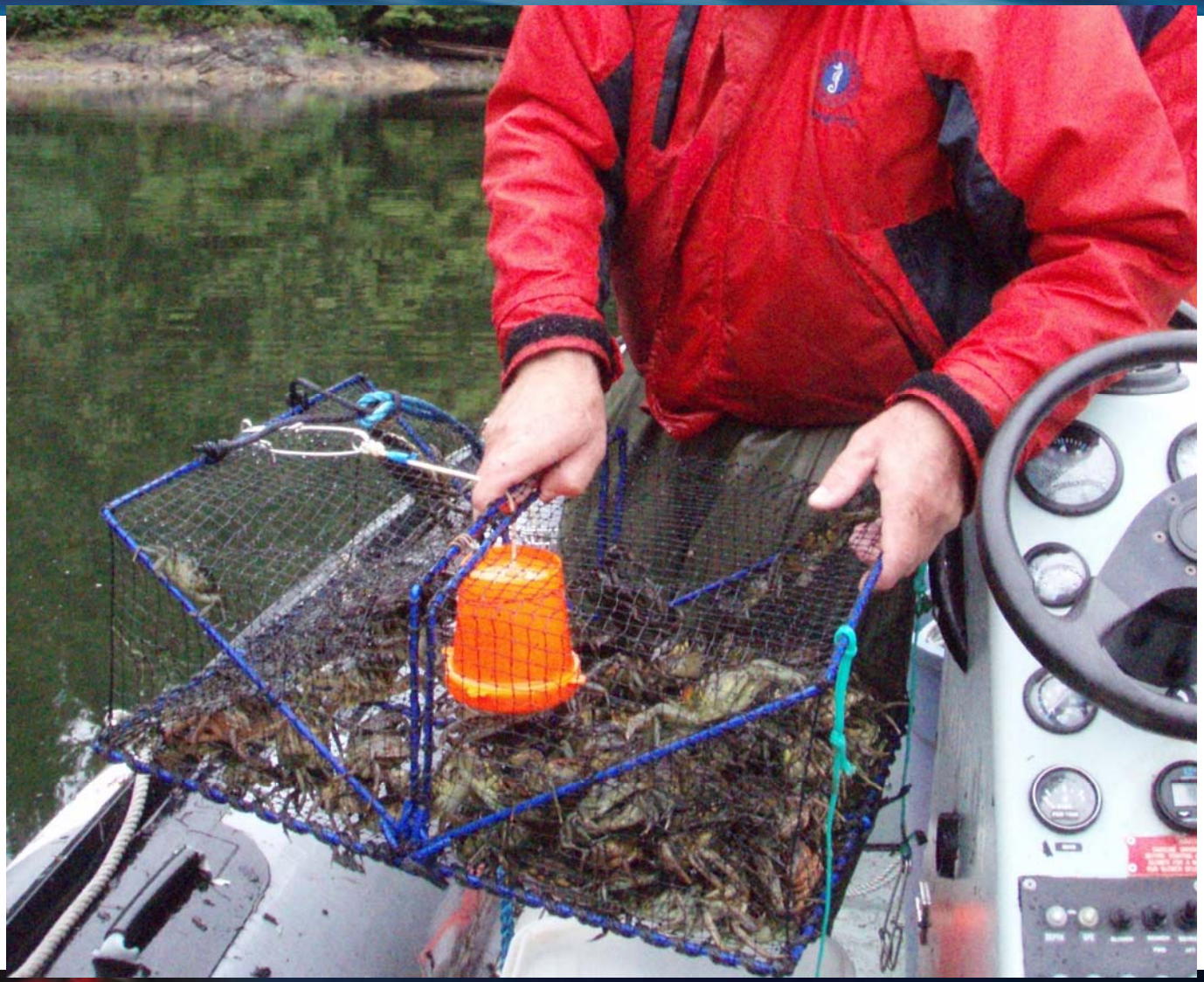
Green Crab Catch Rates 2006-08

Location	Year	# traps	*Carcinus*/trap
Lewis Passage	2008	59	0.0
Gardiner Canal	2008	112	0.0
Devastation Channel	2008	57	0.0
Whale Channel	2008	47	0.0
Douglas Channel	2008	111	0.0
Laredo Inlet	2008	51	0.0
Port Blackney	2008	42	0.0
Gale Passage	2008	45	0.0
Bella Bella	2008	100	0.0
Cooper Inlet	2008	50	0.0
Fisher Channel	2008	89	0.0
Spider Anchorage	2008	41	0.0
Fish Egg Inlet	2008	48	0.0
Rivers Inlet	2007	82	0.0
Smith Sound	2007	47	0.0

WCVI Catches (crabs/trap)

Site	1999	2000	2001	2002	2003	2004	2005	2006	2007
Quatsino									0.34
Winter Hbr									12.54
Klaskino									1.83*
Kyuquot				P			P	0.53	0.38*
Esperanza			P	P	P		5*	0.46	0.33*
Nootka		P						0.03	0.03*
Clayoquot		P						0.2	1.50*
Barkley	P						P	1.72	22.02*
Esquimalt	P								

Note: P = presence confirmed (non-survey), * = < 50 traps set



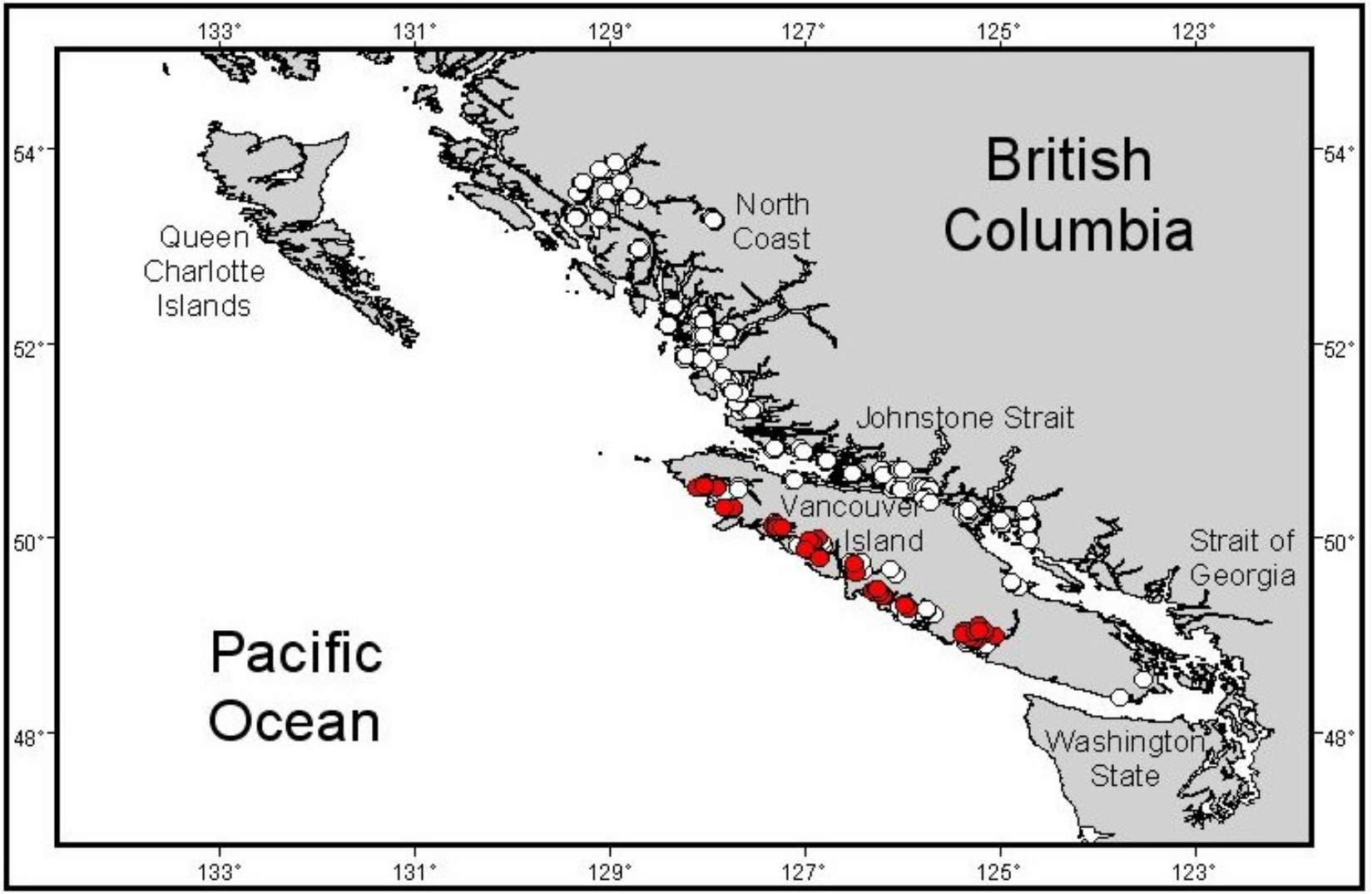
Tagging

- Large Floy tags not suitable
  - High incidence of tag loss
  - Crabs pulling tags out leaving large holes in gill chamber
- To date 349 crabs recovered with tags
  - 165 recovered within days of initial tagging
  - 57/184 (~30%) moulted
  - Longest liberty without moult 407 days
- Population estimates not yet calculated
  - Perhaps compare tag recovery estimate to depletion estimate?
- 2008 tagging used ¾” Floy anchor tags

Discussion

Geographic Distribution

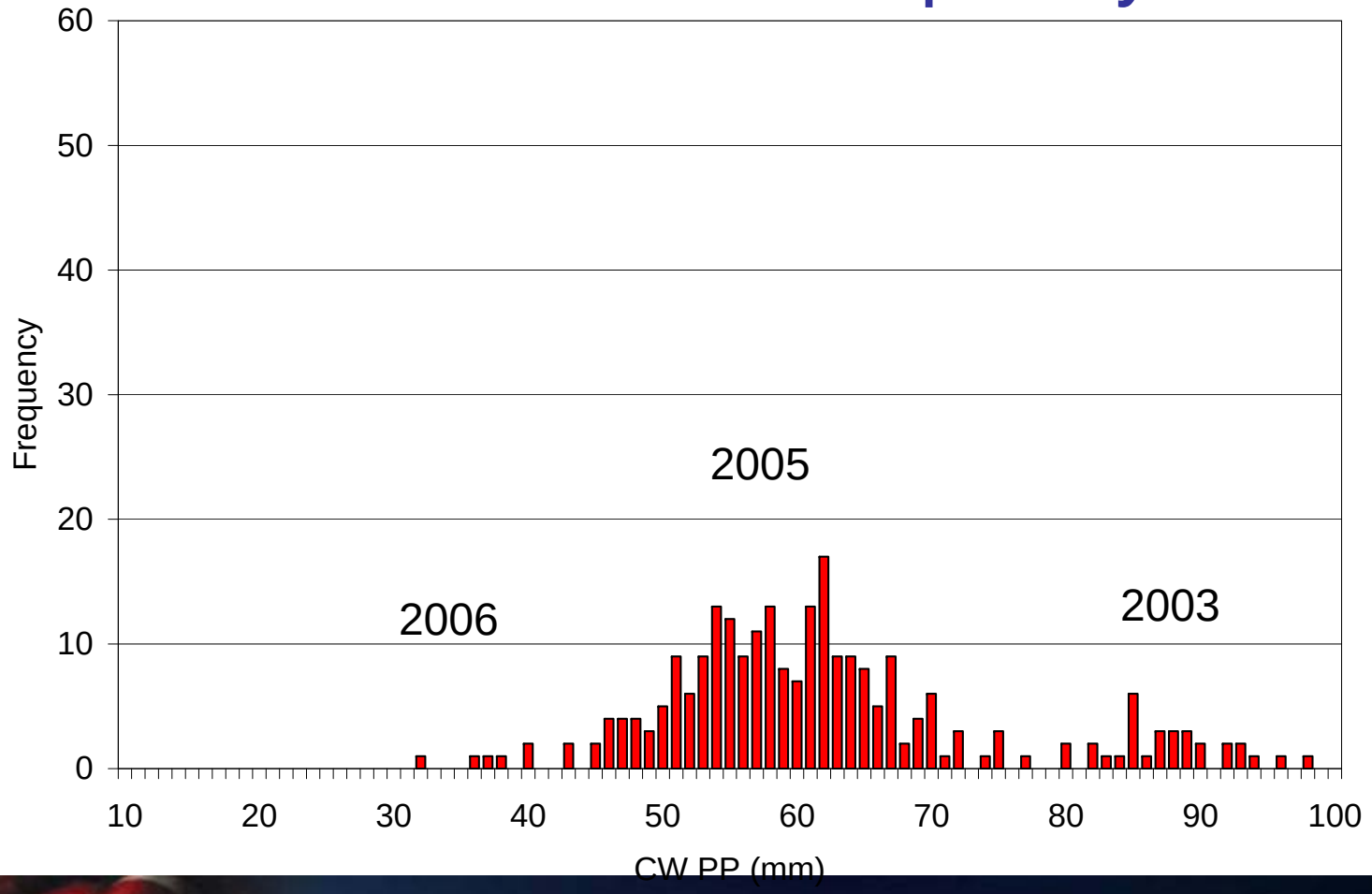
- Green crabs distributed throughout the west coast of Vancouver Island
  - High density sites at both northern and southern limits
    - Winter Harbour and Pipestem Inlet, respectively
  - Some evidence of increased abundance (inferred from catch rates) from 2006 to 2008, particularly in Pipestem Inlet
- High catch rates correlated with decreased salinity
- No green crabs from inside or mainland waters


133°
131°
129°
127°
125°
123°
54°
52°
50°
48°
British Columbia
North Coast
Queen Charlotte Islands
Johnstone Strait
Vancouver Island
Strait of Georgia
Pacific Ocean
Washington State

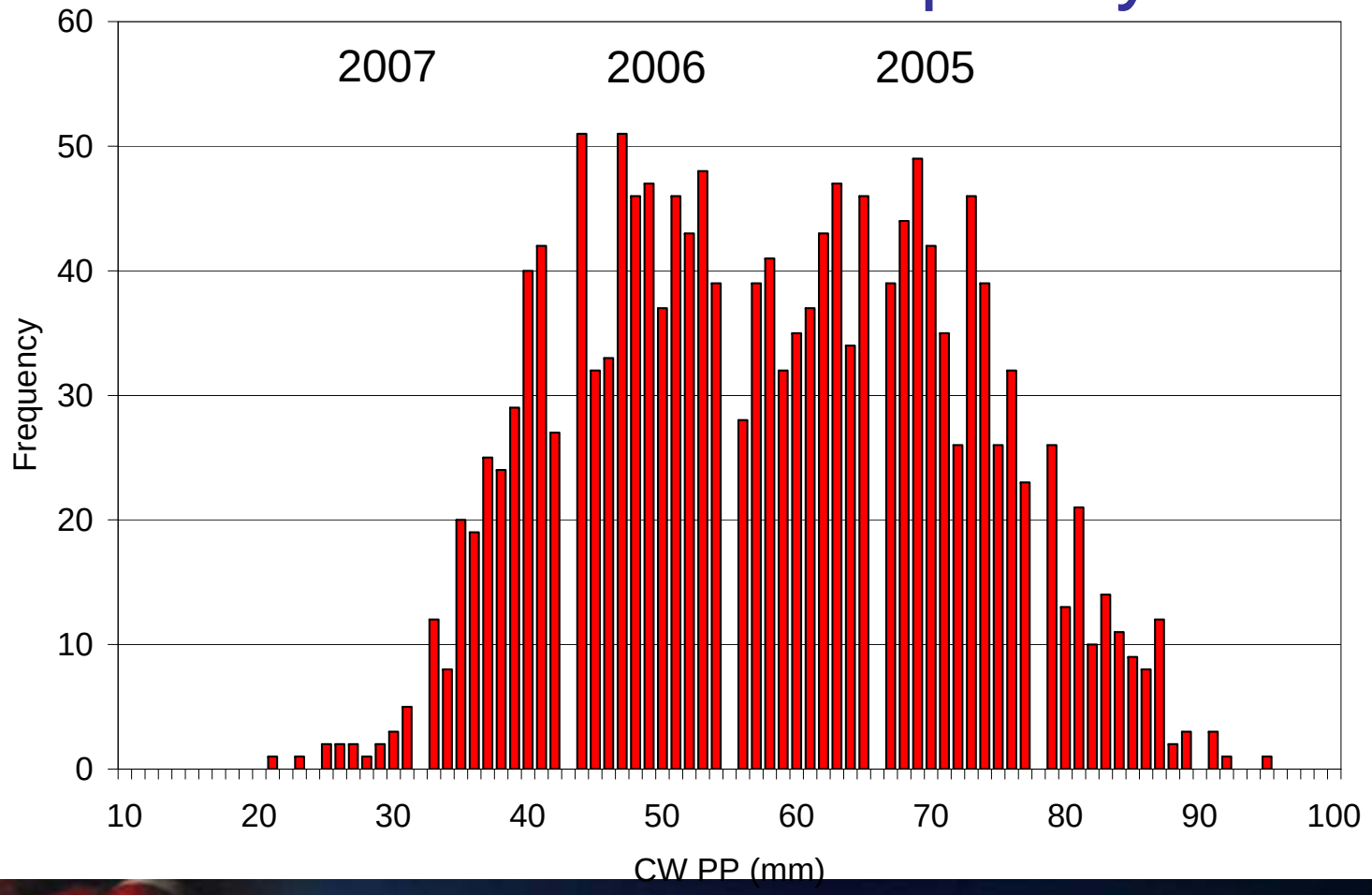
Evidence of Regular Recruitment

- 2006 survey indicated strong 2005 year class
  - Most male crabs 50-70 mm CW
- 2007 survey showed strong 2005 and 2006 year classes
  - 2005 mode roughly centered around 70 mm CW
  - 2006 mode roughly centered around 50 mm CW

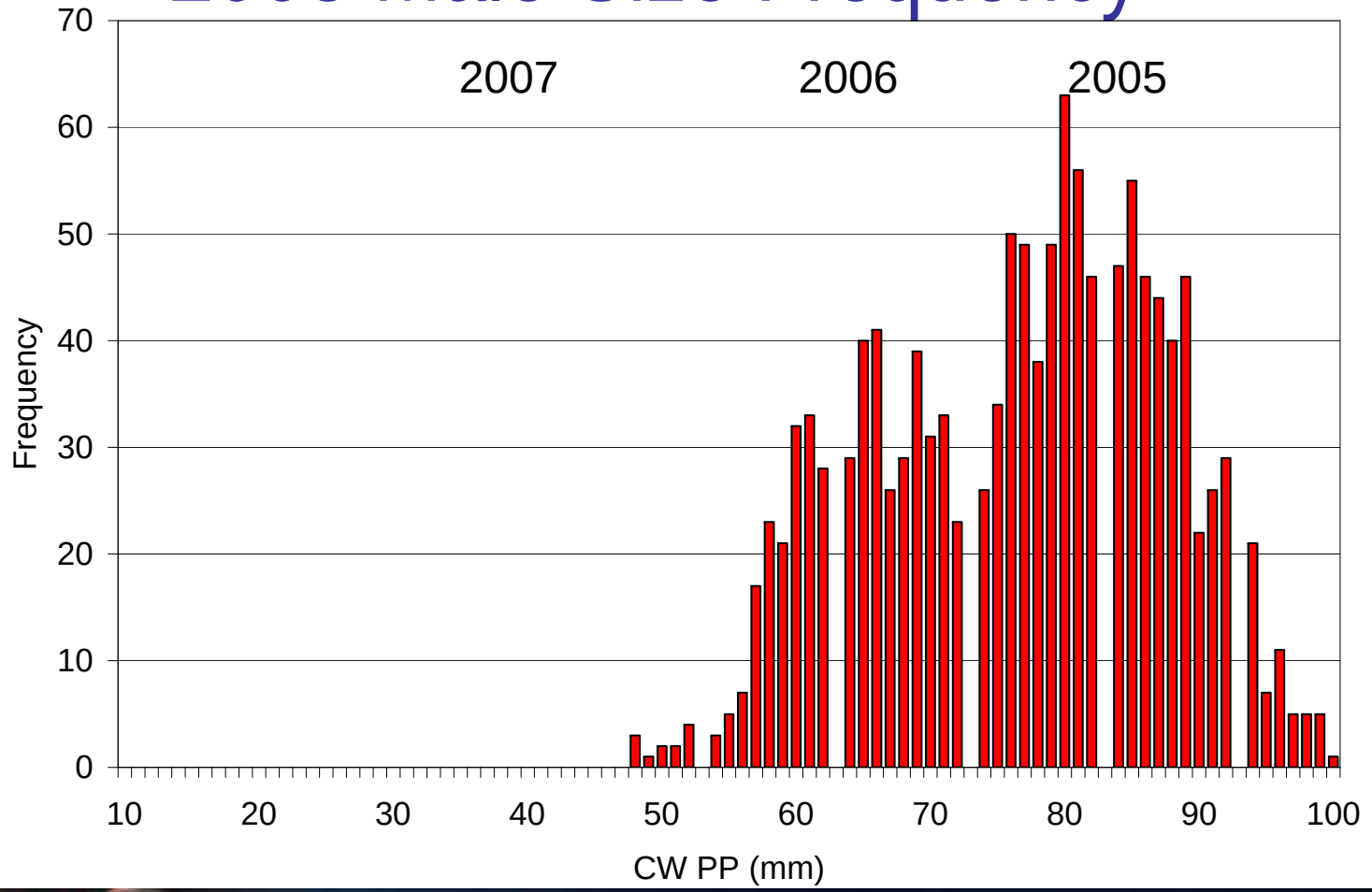
2006 Male Size Frequency



2007 Male Size Frequency



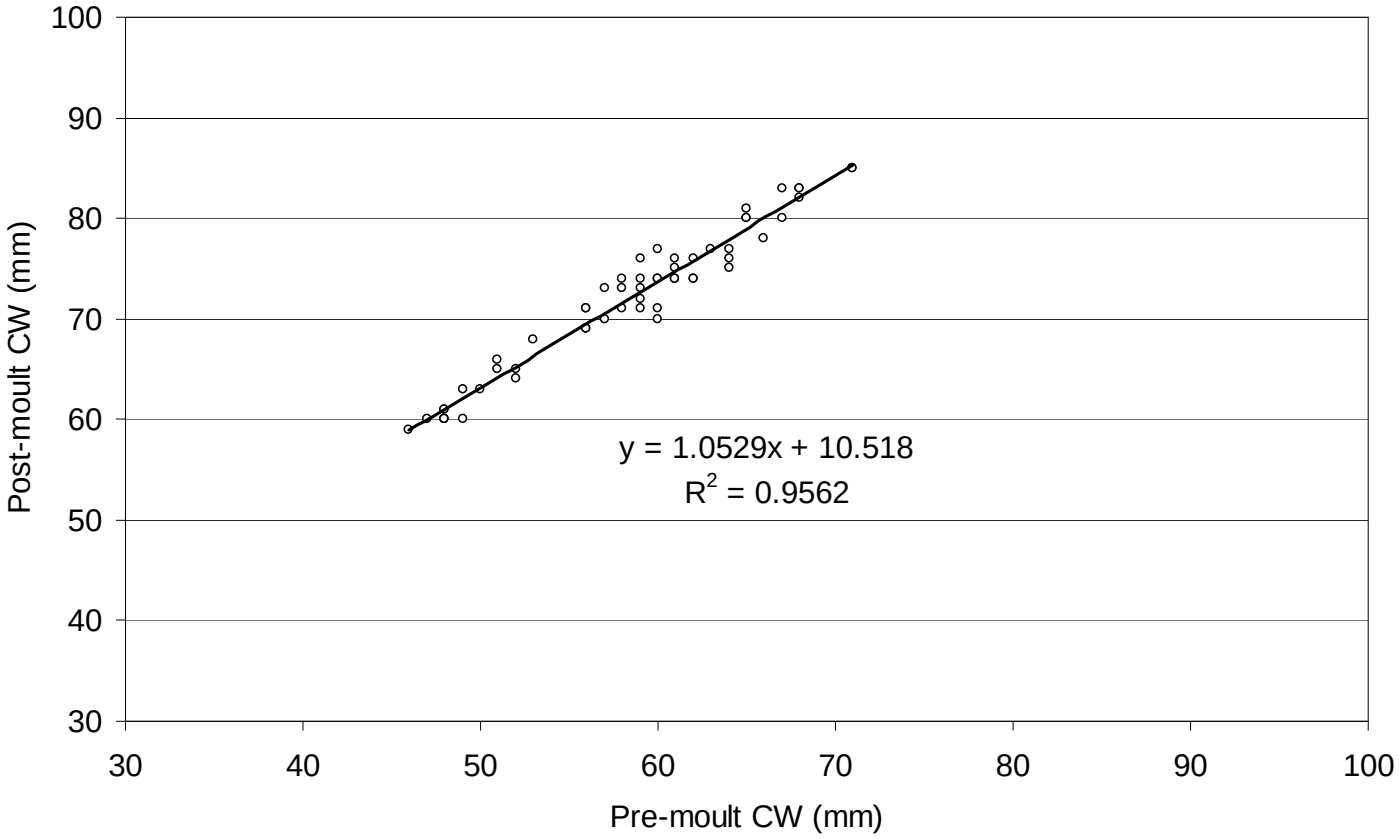
2008 Male Size Frequency



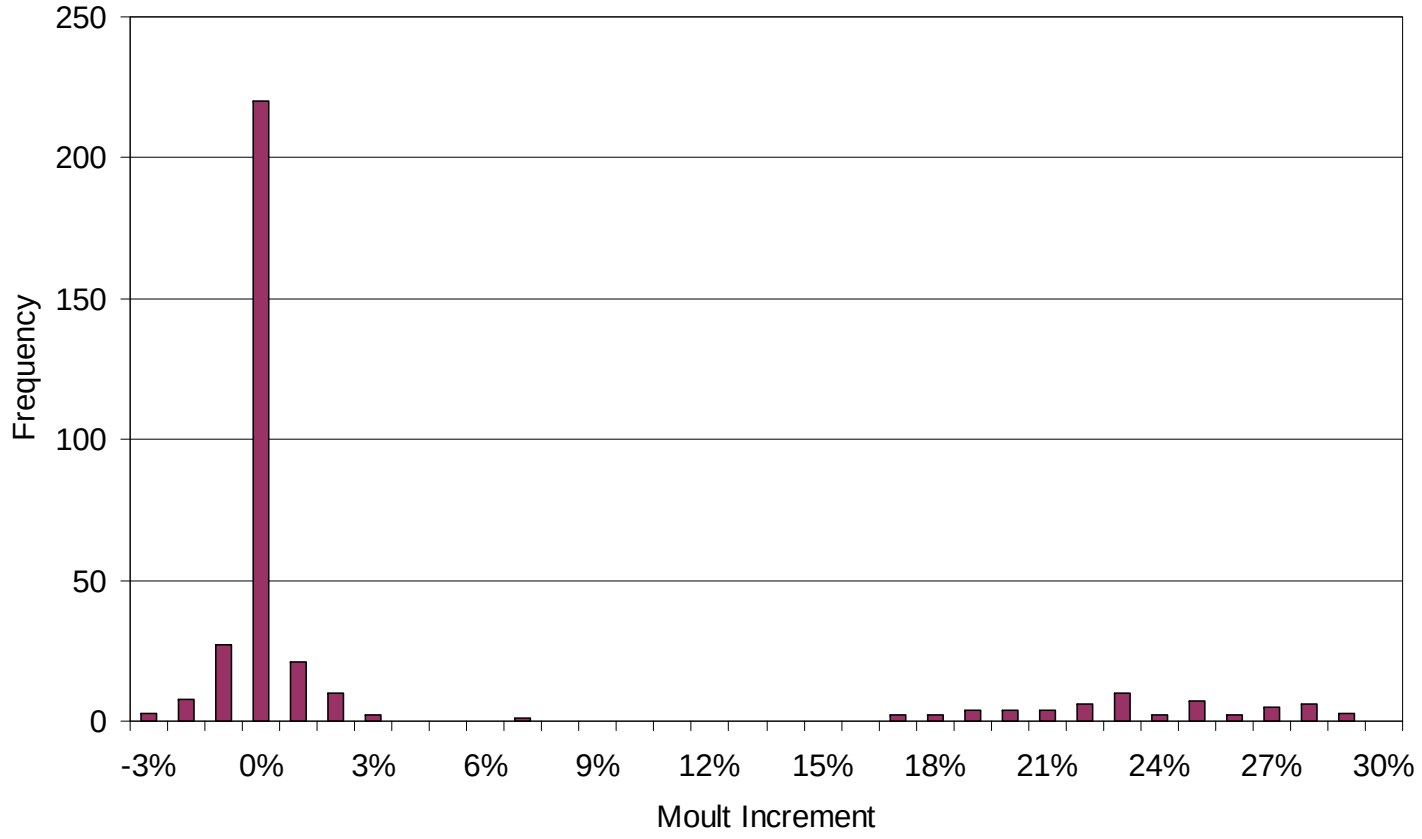
Evidence of Local Reproduction

- Mating pairs collected in summer
  - Pre-mating embrace; male clasps female with walking leg, leaving chelae free for foraging or aggression
- Ovigerous and spent females collected in spring

Moult Increments



Moult Increments



Conclusions

- Standardized survey protocols allow determination of distribution and allow inference regarding relative abundance based on catch rates
- Biological data collected used to infer age frequency and recruitment (from size data and size-age key), timing of moult and reproductive activities
- Tagging data provide population estimates and moult increment information
- Directed studies provide information on environmental and ecological tolerances

Green Crab Issues

- Bivalve shellfish products as potential vector
  - WCVI clam harvests and oyster shipments wet stored in Baynes Sound
  - ITC issued advisory that practice was not recommended
  - WCVI harvesters questioning requirement, beginning dialogue on mitigation
- WCVI populations can serve as larval pool
  - Potential for dispersal into northern BC and Alaska

Future Projects

- Experimental depletion of green crab population
  - Compare tagging and depletion estimates of population size
  - Assess effectiveness of regular trapping to decrease abundance

Future Projects

- Selective removal of female green crabs
  - Use pheromone baits in early summer to attract females to traps
  - Use habitat traps in winter to collect ovigerous females
  - Potentially reduce larval production

Future Projects

- Comparison of bycatch from areas with and without green crab
  - Could provide insight in to ecological impacts of green crab

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