



# Screening of Pacific Fishery Regulations (PFR) Schedule VIII species for risk of invasiveness

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# Background

- Aquatic Invasive Species (AIS) Regulation in the Canadian *Fisheries Act*
  - Published in Canadian *Gazette* June 17, 2015
  - <http://gazette.gc.ca/rp-pr/p2/2015/2015-06-17/html/sor-dors121-eng.php>
- However, the Pacific Fishery Regulations Schedule VIII was not “grandfathered” into these new AIS Regulations



# Background

- The Pacific Fishery Regulations (PFR) Schedule VIII contains a list of aquatic taxa that are prohibited from live import into BC.
- However:
  - the list is large;
  - out of date; and
  - taxonomically confounded
- Further:
  - genesis and full intent of PFR Schedule VIII is unclear



# PFR Schedule VIII

## Schedule VIII (Section 5), Prohibited Import Live Fish

Item	Column I Common Name of Species	Column II Scientific Name of Species
1	Bass, Blue Gill sunfish	<i>Acantharchus, Ambloplites, Centrarchus, Enneacanthus, Lepomis, Micropterus, Morone, Perca, Percina, Pomoxis and Stizostedium</i>
2	Blackfish (Sacramento)	<i>Orthodon</i>
3	Bowfin	<i>Amia calva</i>
4	Buffalo fish	<i>Ictiobus</i>
5	Carp	<i>Catla, Cirrhina, Ctenopharyngodon, Cyprinus, Hypenthal michthys, Labeo and Mylopharyngodon</i>
6	Catfish	<i>Clarias, Ictalurus and Noturus</i>
7	Drum (Sheepshead)	<i>Aplodinotus</i>
8	Eel	<i>Anguilla</i>
9	Minnow (Fathead)	<i>Pimephales</i>
10	Gars	<i>Lepisosteus</i>
11	Lamprey	<i>Ichthyomyzan, Lampetra and Petromyzon</i>
12	Pike	<i>Esox</i>
13	Quilback and Carpsucker	<i>Carpiodes</i>
14	Roach	<i>Leuciscus</i>
15	Rudd	<i>Scardinius</i>
16	Shad and Alewife	<i>Alosa and Dorosoma</i>
17	Stickleback	<i>Apeltes, Culaea (Eucalia), Gasterosteus steus and Pungitius</i>
18	Sucker	<i>Catostomus, Cycleptus, Erimyzon, Hypenelium, Minytrema and Moxostoma</i>
19	Tilapia	<i>Tilapia</i>
20	Moon snail	<i>Polinices</i>
21	Oyster crab	<i>Pinnotheres</i>
22	Oyster drill	<i>Thais, Ocenebra and Urosalpinx</i>
23	Rock lobster	<i>Jasus</i>





# Background

- There is a desire to ensure consistency between taxa listed under PFR Schedule VIII and those listed (or to be listed) in the Federal Aquatic Invasive Species (AIS) Regulations.
- To ensure that the risk results can be compared effectively across all taxa contained in PFR Schedule VIII species are being assessed using a single screening-level risk assessment tool (CMIST).





# Screening-Level RA Tools (SLRA)

- SLRA tools can be applied quickly with available data (which may be limited)
- Score-based tools, like CMIST, can prioritize AIS based on rank score
- SLRAs provide a risk-based approach that could be used to add species to the AIS Regulations



# Screening Level RA Tool (CMIST)

- CMIST has 17 questions that are generalized to the invasion process and resulting impacts
    - Present status in the area
    - Introduction
    - Survival
    - Establishment
    - Spread
    - Impact
-  Likelihood of Invasion
-  Impact of Invasion

RISK





# Screening Level RA Tool (CMIST)

- Each question scored 1 (Low) to 3 (High)
- This tool could be applied to other taxa and at different spatial scales
- Guidance document ensures standardized application
- Explicitly captures assessor uncertainty in the final risk score *via* a Monte Carlo procedure





# CMIST Likelihood of Invasion Qs

**Table 1** Questions of CMIST and description of potential scores

Question	Score		
	1 (Low)	2 (Moderate)	3 (High)
<i>Present status</i>			
1 Is the species established in the assessment area?	No	Observed but not reported as established	Yes
<i>Rate of introduction</i>			
2 How frequently and in what numbers is the species expected to arrive into the assessment area?	Infrequently in low numbers of individuals	Frequently in low numbers or infrequently in high numbers	Frequently in high numbers
<i>Survival</i>			
3 How much of the assessment area offers suitable habitat for the species?	Negligible proportion of the assessment area	Moderate proportion of the assessment area	Most of the assessment area
4 How much of the assessment area offers suitable environmental conditions for the species to survive?	Negligible proportion of the assessment area	Moderate proportion of the assessment area	Most of the assessment area
<i>Establishment</i>			
5 Are the species' reproductive requirements available in the assessment area?	Almost never	Sometimes	Almost always
6 To what extent could natural control agents slow the species' population growth in the assessment area?	Likely to severely restrict population growth	Could slow population growth	Unlikely to affect population growth
<i>Spread</i>			
7 What is the range of the species' potential natural dispersal in the assessment area?	Very limited range	Moderate range	Wide range
8 What is the range of the species' potential dispersal in the assessment area from anthropogenic mechanisms?	Very limited range	Moderate range	Wide range



# CMIST Impact of Invasion Qs

**Table 1** Questions of CMIST and description of potential scores

Question	Score		
	1 (Low)	2 (Moderate)	3 (High)
<b>Impact</b>			
9 What level of impact could the species have on population growth of other species in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
10 What level of impact could the species have on communities in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
11 What level of impact could the species have on habitat in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
12 What level of impact could the species have on ecosystem function in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
13 What level of impact could the species' associated diseases, parasites, or travellers have on other species in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
14 What level of genetic impact could the species have on other species in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
15 What level of impact could the species have on at-risk or depleted species in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
16 What level of impact could the species have on aquaculture and commercially fished species in the assessment area?	Low or no impact	High impact in few areas or moderate impact in many areas	High impact in many areas
17 Is the species known or generally considered to be invasive anywhere in the world?	No	No, but has traits related to invasiveness	Yes





# CMIST Application to PFR Schedule VIII

- First step was to identify species PFR Schedule VIII could apply to including taxonomic revisions/changes since inception of this list
- PFR Schedule VIII includes primarily fishes (1161 sp. – most FW) and marine invertebrates (375 sp.)



# PFR Schedule VIII Species

- 1161 fish species
  - 1049 are FW
  - 112 are not FW
- 375 invertebrate species
  - 145 crustaceans
  - 230 molluscs
- NO algae/plants, viruses, etc.



# CMIST Application

- Potential climate match to BC was determined first
- PFR Schedule VIII species that were determined to be temperate would be scored with CMIST while species without a climate match would not be scored with CMIST
- **NOTE:** here we included some non-temperate species (30 FW fish species) for tool verification.

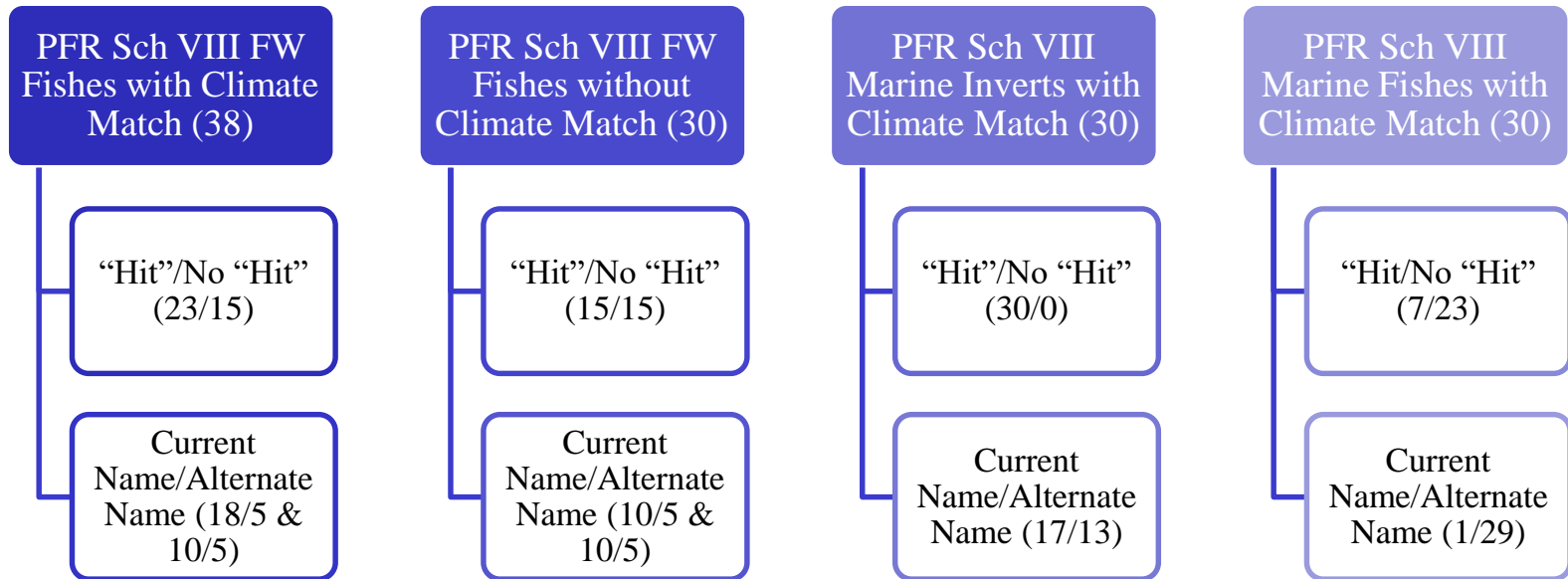


# CMIST Application

- To prioritize the temperate species to be assessed with CMIST we also considered:
  - Is the species regulated/prohibited/watch-listed in neighboring jurisdictions?
  - Geographical proximity to BC (given lack of specific vector information for any PFR Schedule VIII species)
- **128** PFR Schedule VIII species used here



# CMIST Application

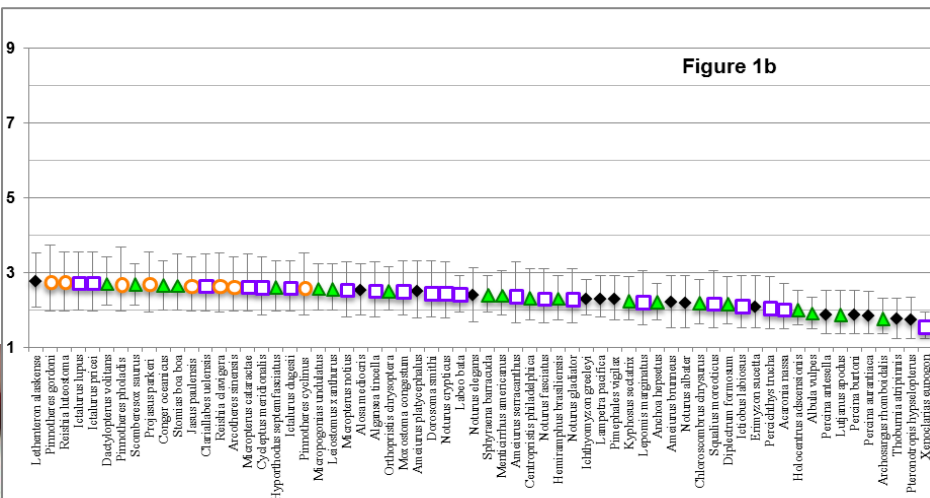
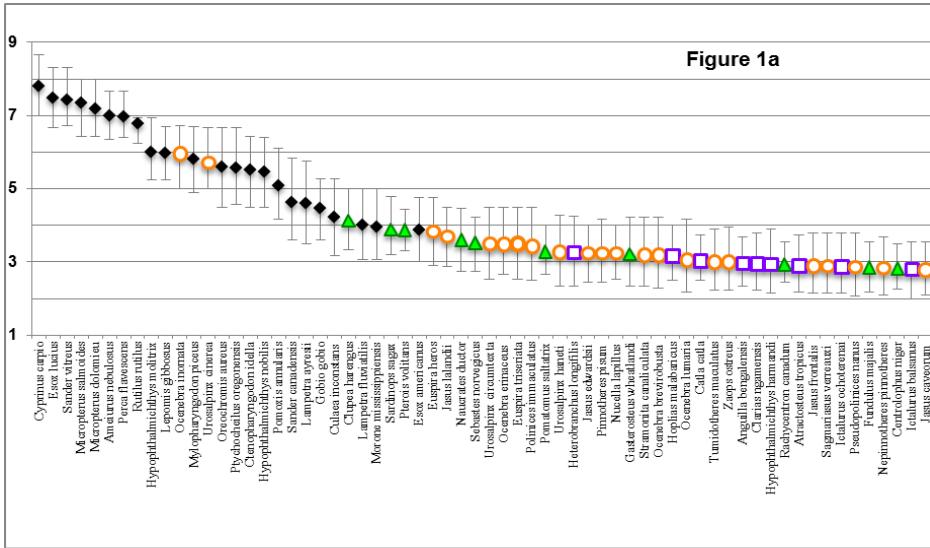


And some  
marine/brackish fishes





# CMIST Scores for 128 PFR Species



Higher risk species identified here were temperate FW fish or invertebrates

- 38 temperate freshwater fish (filled diamond)
- 30 sub-tropical/tropical freshwater fish (open square)
- 30 temperate marine invertebrates (open circle)
- 30 temperate marine fish (filled triangle)





# CMIST App'n to PFR Schedule VIII

Common Name	Latin Name	Taxa	Climate Match	"Hit List"	Status	Adj. Likelihood	Adj. Impact	Adj. CMIST Score	
Common carp	Cyprinus carpio	F	C	H	P	3	2.61	7.83	←
Northern pike	Esox lucius	F	C	H	P	2.79	2.68	7.49	←
Largemouth bass	Micropterus salmoides	F	C	H	P	2.84	2.58	7.31	←
Brown bullhead	Ameiurus nebulosus	F	C	H	A	2.96	2.36	6.98	←
Roach	Rutilus rutilus	F	C	H	A	2.46	2.74	6.75	←
Blue tilapia	Oreochromis aureus	F	C	N	A	2.43	2.3	5.6	
Northern pikeminnow	Ptychocheilus oregonensis	F	C	N	A	2.79	2.01	5.6	
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Dollar sunfish	Lepomis marginatus	F	NC	N	P	1.8	1.25	2.26	
Stymphalia chub	Squalius moreoticus	F	NC	N	A	1.63	1.34	2.19	
Fleshylip buffalo	Ictiobus labiosus	F	NC	N	P	1.55	1.38	2.14	
Creole perch	Percichthys trucha	F	NC	N	A	1.61	1.28	2.07	
Bigeye (Peruvian dwarf) cichlid	Acaronia nassa	F	NC	N	A	1.59	1.27	2.02	
Lake Victoria deepwater catfish	Xenoclarias eupogon	F	NC	H	A	1.48	1.06	1.57	

Northern Pike and Largemouth Bass were previously identified as High Risk invaders in BC. Carp, Brown Bullhead and Roach known AIS.





# CMIST App'n to PFR Schedule VIII

Common Name	Latin Name	Taxa	Climate Match	"Hit List"	Status	Adj. Likelihood	Adj. Impact	Adj. CMIST Score
Asian (Japanese) oyster drill	Ocenebra inornata	I	C	H	P	2.53	2.35	5.95
Atlantic Oyster Drill	Urosalpinx cinerea	I	C	H	P	2.47	2.3	5.69
northern moon snail	Euspira heros	I	C	H	A	2.31	1.66	3.83
Cape rock lobster	Jasus lalandii	I	C	H	P	2.02	1.81	3.66
<hr style="border-top: 1px dashed orange;"/>								
St Paul rock lobster	Jasus paulensis	I	C	H	P	1.95	1.36	2.66
Reishia clavigera	Reishia clavigera	I	C	H	A	1.87	1.42	2.66
a pea crab	Arcotheres sinensis	I	C	H	A	1.87	1.42	2.64
a pea crab	Pinnotheres cyclinus	I	C	H	P	1.88	1.38	2.59



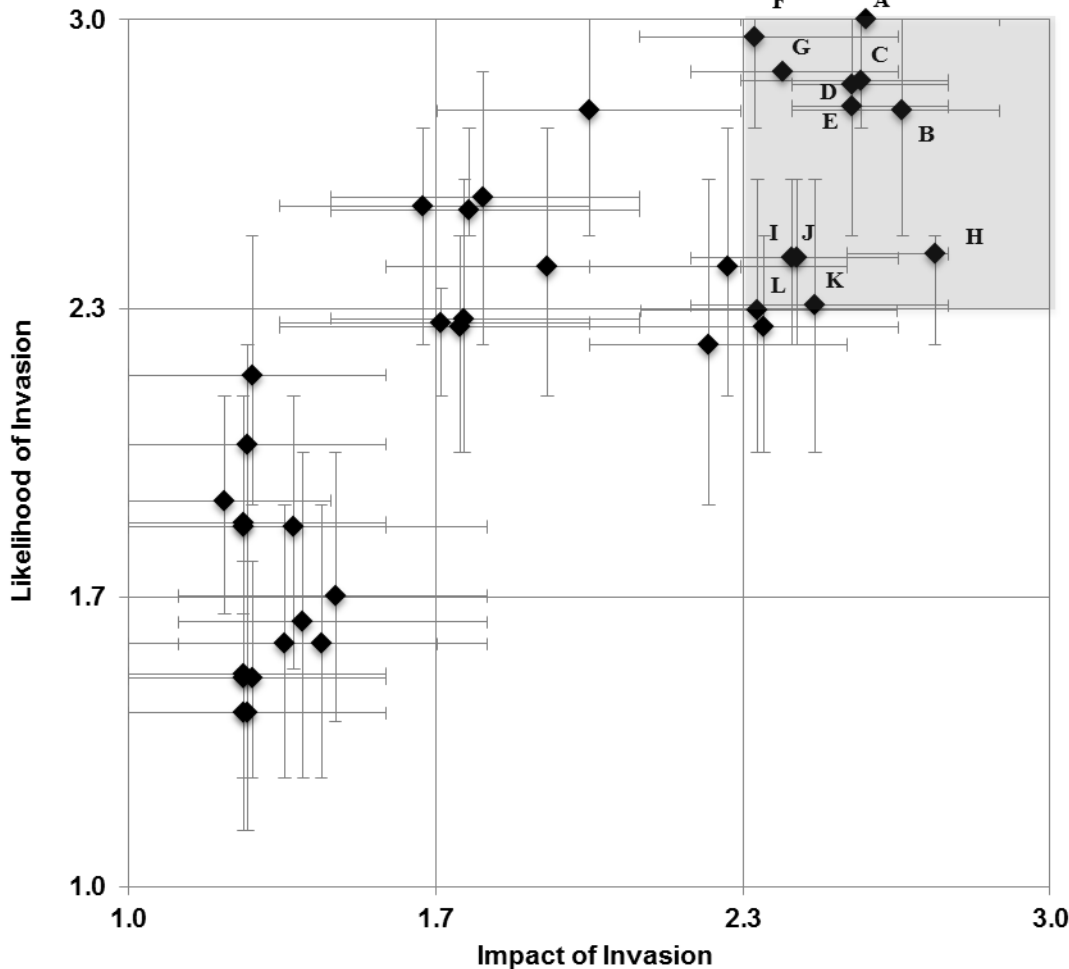
The two oyster drills were assessed for SoG during CMIST development and testing and had similar scores here





# Temperate FW Fishes

Figure 2a: Temperate freshwater fish



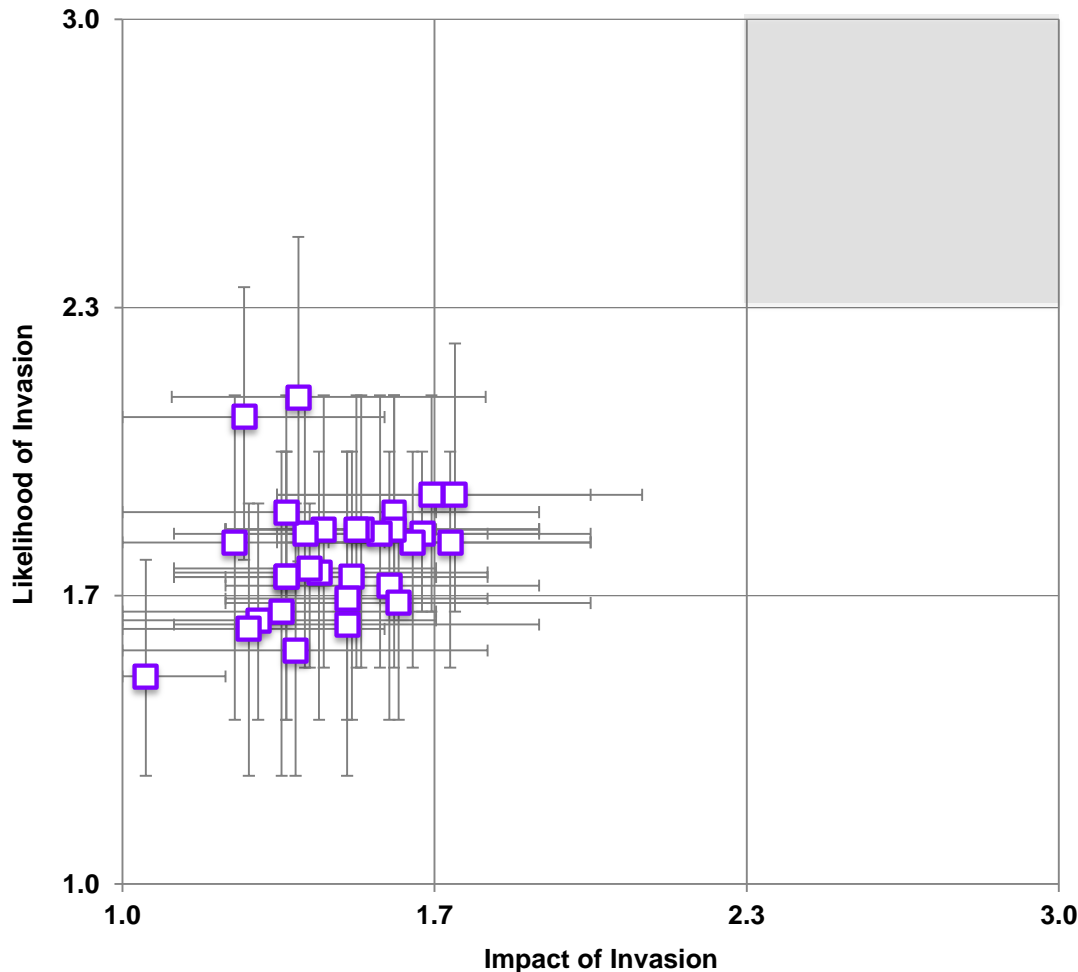
Higher risk species  
are in the upper right  
and lower risk  
species are in the  
lower left

A=*Cyprinus carpio*, B=*Esox lucius*, C=*Sander vitreus*, D=*Micropterus salmoides*, E=*Micropterus dolomieu*, F=*Ameiurus nebulosus*, G=*Perca flavescens*, H=*Rutilus rutilus*, I=*Hypophthalmichthys molitrix*, J=*Lepomis gibbosus*, K=*Mylopharyngodon piceus*, L=*Ctenopharyngodon idella*



# Subtropical/Tropical FW Fishes

Figure 2b: Sub-tropical/tropical freshwater fish

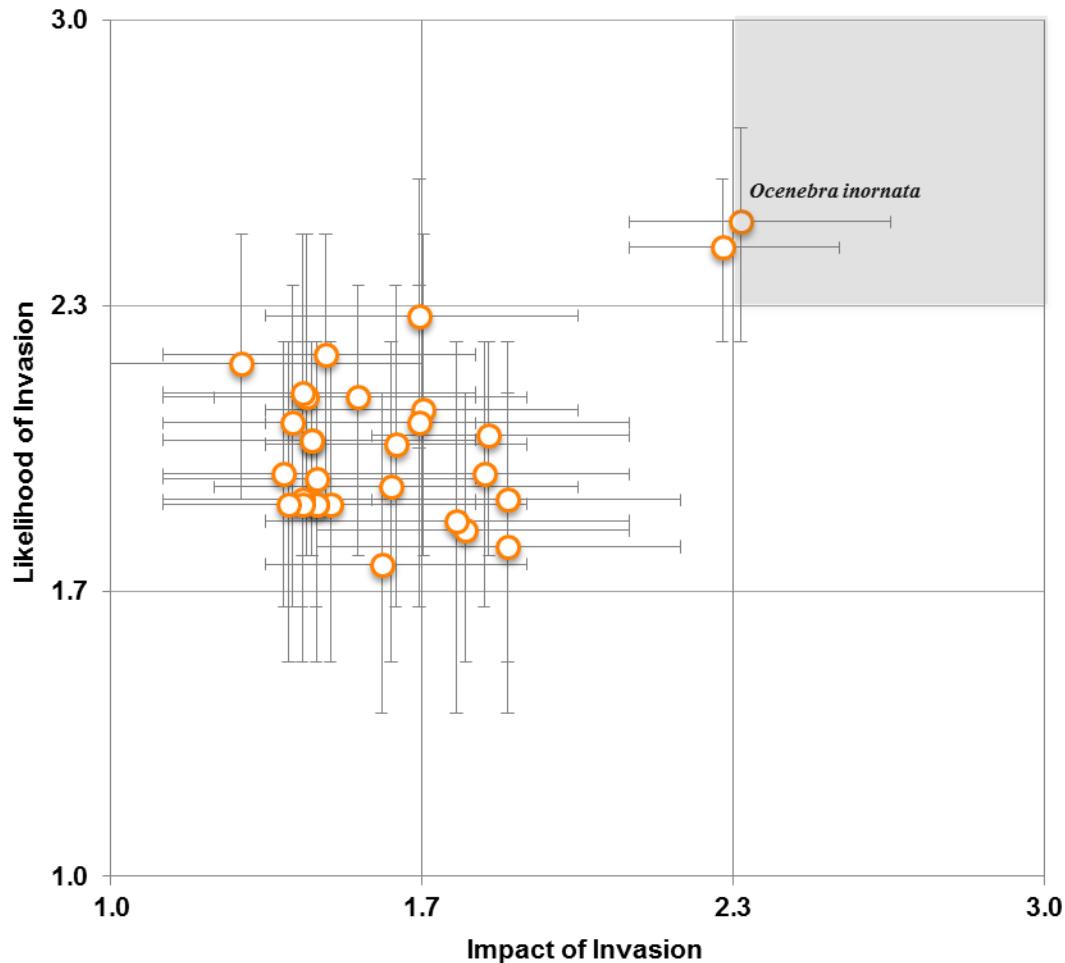


No higher risk  
species identified  
here



# Temperate Marine Inverts

Figure 2c: Temperate marine invertebrates

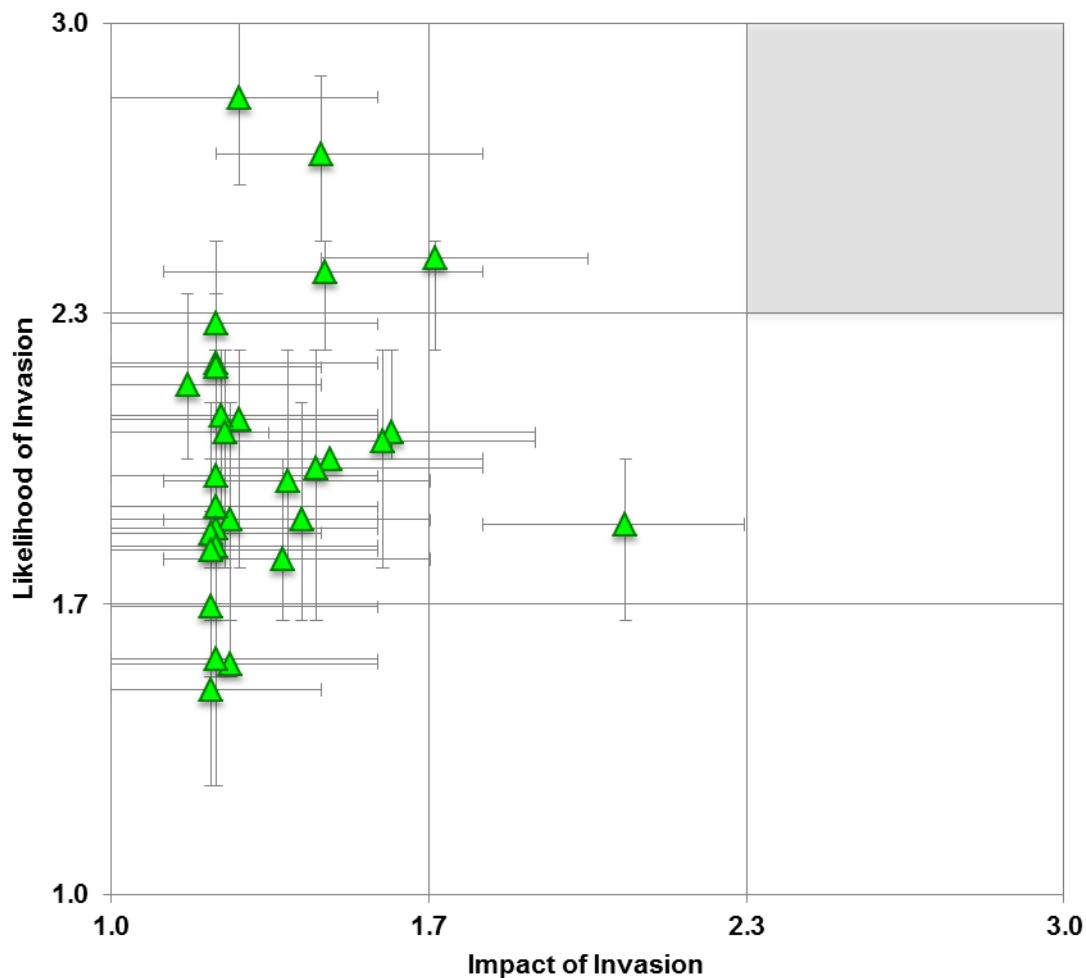


Only two oyster  
drills potentially  
higher risk species



# Temperate Marine Fishes

Figure 2d: Temperate marine fish



No higher risk  
species identified  
here



# Summary

- Application of CMIST to temperate PFR Schedule VIII species can identify higher risk species that could be considered in future changes to prohibited/control species in the AIS Regulations
- PFR Schedule VIII does not include some species identified as higher risk in BC (e.g., snakeheads – *Channa* spp.)



# Future Considerations

- Risk thresholds have not been identified for CMIST and should be the focus of future work
- Supporting information should be made available to managers and researchers via a searchable, accessible database
- Information on species in invasion vectors could help prioritize large lists like PFR Schedule VIII





# Conclusions

- CMIST can provide relative risk scores for species listed in PFR Schedule VIII
- The prioritized list could be used to identify species that might be included in future amendments to the AIS Regulations in the *Fisheries Act*
- CMIST has potential application to other species and/or ecoregions



# Acknowledgements

Funding was provided by DFO's Aquatic  
Invasive Species Program

## Questions?

# CMIST Questions

Is the species established in the assessment area?

- [1] No
- [2] Observed but not reported as established
- [3] Yes

How frequently and in what numbers is the species expected to arrive into the assessment area?

- [1] Infrequently in low numbers
- [2] Frequently in low numbers or infrequently in high numbers
- [3] Frequently in high numbers

How much of the assessment area offers suitable habitat for the species? [

- 1] Negligible proportion of the assessment area
- [2] Moderate proportion of the assessment area
- [3] Most of the assessment area

How much of the assessment area offers suitable environmental conditions for the species to survive?

- [1] Negligible proportion of the assessment area
- [2] Moderate proportion of the assessment area
- [3] Most of the assessment area

# CMIST Questions

Are the species' reproductive requirements available in the assessment area?

- [1] Almost never
- [2] Sometimes
- [3] Almost always

To what extent could natural control agents slow the species' population growth in the assessment area?

- [1] Likely to severely restrict population growth
- [2] Could slow population growth
- [3] Unlikely to slow population growth

What is the range of the species' potential natural dispersal in the assessment area?

- [1] Very limited range
- [2] Moderate range
- [3] Wide range

What is the range of the species' potential dispersal in the assessment area from anthropogenic mechanisms?

- [1] Very limited range
- [2] Moderate range
- [3] Wide range

# CMIST Questions

What level of impact could the species have on population growth of other species in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

What level of impact could the species have on communities in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

What level of impact could the species have on habitat in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

What level of impact could the species have on ecosystem function in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

# CMIST Questions

What level of impact could the species' associated diseases, parasites, or travellers have on other species in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

What level of genetic impact could the species have on other species in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

What level of impact could the species have on at-risk or depleted species in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

# CMIST Questions

What level of impact could the species have on aquaculture and commercially fished species in the assessment area?

- [1] Low or no impact
- [2] High impact in few areas or moderate impact in many areas
- [3] High impact in many areas

Is the species known or generally considered to be invasive anywhere in the world?

- [1] No
- [2] No, but is noted outside of its native range
- [3] Yes (noted as invasive, or noted outside of native range with impacts)