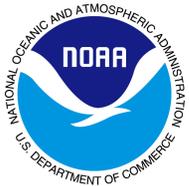
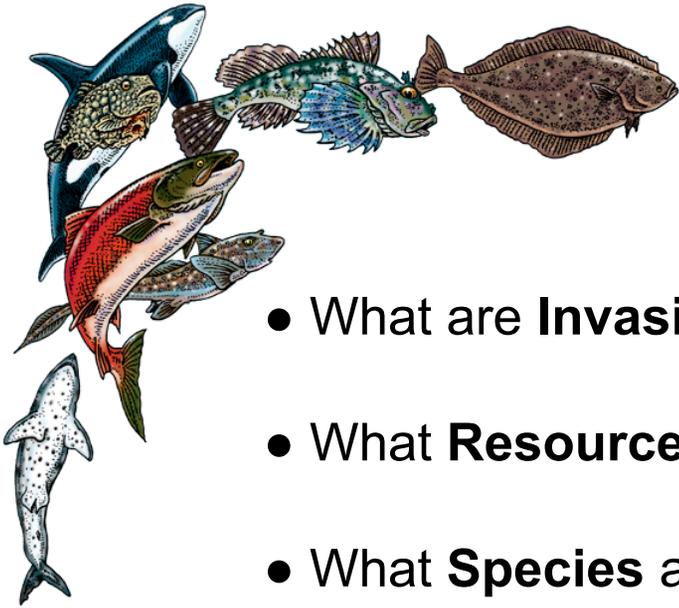


# *Marine Invasive Species:* Alaska Overview



**Linda Shaw, National Marine Fisheries Service  
Alaska Forum on the Environment  
February 7, 2011**





- What are **Invasive Species** and what **Impacts** do they have?
- What **Resources** do they put at **Risk** in **Alaska's Marine Waters**?
- What **Species** are of **Concern** for **Alaska's Marine Waters**?
  - Species that are already in Alaska*
  - Species that are at risk for spreading to Alaska*
- How do they **Get Here**?
- What are we **Doing About It**?
  - Statewide Monitoring Efforts*
  - Sitka Bioblitz/D. vex response*
- What could **You** do about it?



# What is an “Invasive Species”? \*

**"Invasive species"** means an **alien** species whose introduction does or is likely to cause **economic** or **environmental harm** or **harm to human health**.

**"Alien species"** means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is **not native to that ecosystem**.

\*Executive Order 13112 signed by President William Clinton on February 3, 1999

**Example: The Alien Monster**

**Not Native To Earth, i.e. from Outer Space**

**+**

**Threat to Human Health**

**= Invasive Species**



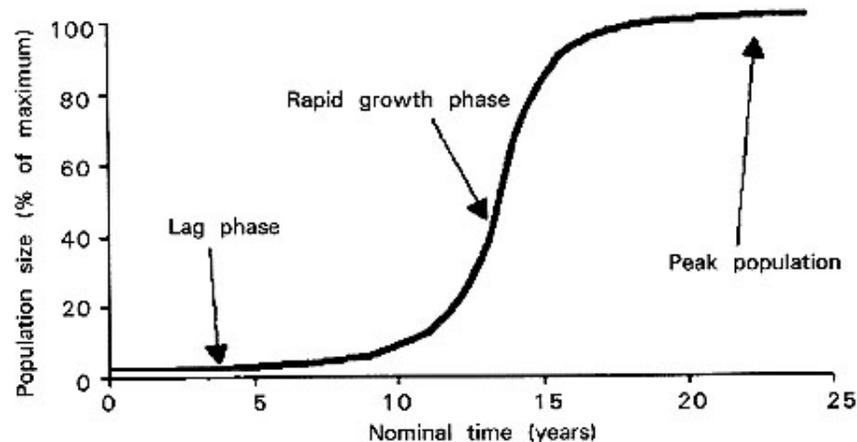


*"It is not the strongest of the species that survive, nor the most intelligent, but the one most responsive to change."* **Charles Darwin**



# Impacts of Invasive Species

- Out-Compete, Predate On and Avoid Predation by Native Organisms
- Often Tolerate and Thrive in Disturbed or Polluted Habitats
- May be present for years in a Lag Phase before an environmental “trigger” explodes their populations
- May have synergistic impacts with other invasives: “Invasion Meltdown” Green Crab
- They may be “keystone” species, which completely change ecosystem structure: a native example, sea otter predation on sea urchins results in growth of kelp forests.



# Marine Resources at Risk from the Impacts of Marine Invasive Species in Alaska

**Fishing:** Half of U.S. Seafood produced in Alaska  
Largest Private Sector Employer in Alaska  
Alaska Ports rank among the Top in US for Landings and Value  
Provides significant subsistence and recreational resources

**Mariculture:** Potential \$100 million industry in Alaska, based on shellfish and seaweed. Alaska currently has 25 operating shellfish farms, 15 in Southcentral and 10 in Southeast with oysters as the primary crop.

**Marine-based Tourism:** About half of visitors marine based – sport fishing/whale watching/sightseeing



## Most Concerning Marine Invasive Species In Alaska in 2010

### Scientific name

### Common name

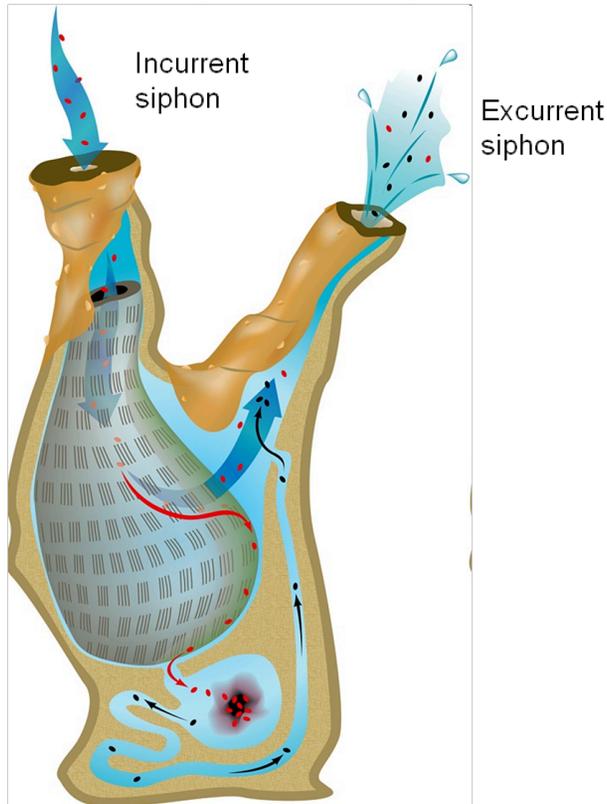
- *Botrylloides violaceus* Violet or chain tunicate
- *Botryllus schlosseri* Golden star tunicate
- *Didemnum vexillum* Glove Leather Tunicate\*/Marine Vomit
- *Vibrio parahaemolyticus* Seafood Gastroenteritis Bacterium

\*But first, What's a tunicate?



# What's a Tunicate?

- Commonly called *sea squirts*, tunicates are marine animals. They are born as a swimming larvae that settles to become an attached adult on hard surfaces (i.e., rocks, docks, or the undersides of boats). They reproduce both sexually (larvae) and asexually (budding or fragmentation). Fragments that fall or are broken off can establish new colonies. Larvae do not move far beyond the parent colony. Sea squirts differ from sponges by their gelatinous texture



**Tunicate Morphology  
Individual Zooid**



**Sea Peach – Solitary  
Tunicate Native to  
Alaska**

**Colonial Tunicate from  
Australia: *Polycitor giganteus***



**Corella Tunicate – Demonstrating origin  
of “sea squirt”, Native to Alaska**



# *Botrylloides violaceus* or Chain Tunicate

## Colonial Tunicate:

**Impacts:** By overgrowing seaweed, eelgrass, scallops and oysters they outcompete and suffocate filter feeding bivalves and other living organisms.

**Found IN:** Sitka, Ketchikan, Metlakatla, Homer (one record), Tatitlek (one record)



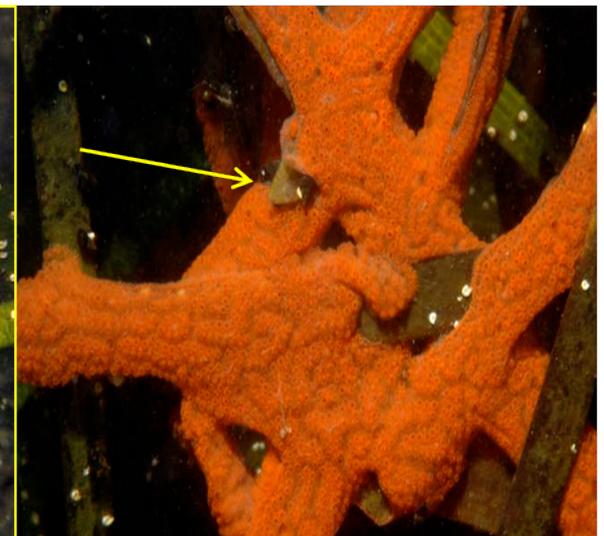
*Botrylloides violaceus* growing on a scallop; individual zooids visible and chain-like formation clear.

Photo: G. Freitag

Example from Northeast coast: *Botrylloides violaceus* will grow, merge and eventually smother the scallop to such an extent that it can no longer open to feed (see 4 colonies on the shell of the scallop, then smothered).



Photos and text: R. Karney



# *Botryllus schlosseri* or Golden Star Tunicate

## Colonial Tunicate:

**Impacts:** These tunicates grow on and can suffocate cultured shellfish including oysters and mussels, as well as grow on eelgrass and seaweeds. Impacts to mariculture products and habitats used by native organisms.

**Found IN:** Sitka



Photo: Heidi Gartner

Note: variable color morphs



Photo: H. Meuret- Woody

*Didemnum vexillum* or Glove Leather Tunicate/Rock Vomit

Colonial Tunicate:

Found In: Discovered in Sitka,  
Alaska in June, 2010.

IMPACTS: Smothers marine life and aquaculture gear by overgrowing them. Secretes toxins and raises water acidity so nothing can grow on it. **Could negatively impact the valuable herring spawn resource in Sitka Sound.**



Photo: L. Shaw



Puget Sound Diver Demonstrating Origin of Name  
“Rock Vomit”, [www.pnwscuba.com](http://www.pnwscuba.com)



Didemnum vexillum....

Fouling mariculture gear in  
British Columbia



Photos: Puget Sound  
Partnership, Paul Barter,  
Linda Shaw

Suffocating mussels  
In New Zealand, and  
Puget Sound



Fouling oyster cage  
in Whiting Harbor  
Sitka



## Case Study: Georges Bank

**D. vex** was present in New England's intertidal since the 1980s, then jumped to Georges Bank in 2002, and now has expanded to 143 square miles of seabed with 50 – 90% coverage of the bottom.



Northern Georges Bank. Water depth 43 m (141 ft). November 1, 2003.  
Photo credit: Page Valentine and Dann Blackwood, U.S. Geological Survey.



Northern Georges Bank. Water depth 47 m (154 ft). November 1, 2003.  
Photo credit: Page Valentine and Dann Blackwood, U.S. Geological Survey.

**• Studies suggest that groundfish are unable to penetrate *D. vex* mats to feed on benthic prey beneath, such as worms. Worm populations increase under *D. vex* mats and groundfish stomachs are found with *D. vex* fragments as they attempt to feed. Valentine et al., 2007**

- A 2009 study by Mercer et al. in Long Island Sound concluded that :  
D. vex mats essentially “glue” the substrate to change the seafloor from a 3-D to a 2-D environment. Benthic infauna increase in numbers under mats possibly due to protection from predators such as *crab and demersal fish*.



# *Vibrio parahaemolyticus* or Seafood Gastroenteritis Bacterium

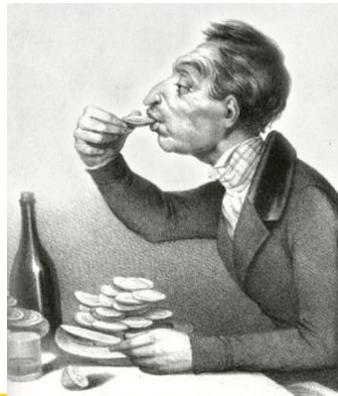
**Distinguishing features:** Microscopic gram-negative bacterium.

**Habitat:** Brackish and salt water, flourishes when temperatures exceed 15°C. Facultatively aerobic, can survive with or without oxygen.

**Impacts:** Gastrointestinal illness correlated with the consumption of raw or undercooked oysters. 24 hour incubation period in human body. **This is a human health issue!**

**Possible Vector:** Ballast Water discharge.

**Found IN:** An **outbreak** occurred in **Prince William Sound** in **July, 2004** among 62 cruise ship passengers **after eating raw oysters** raised in Prince William Sound. **Alaska was previously thought to be too cold** to support *Vibrio p.*. Outbreaks are correlated with harvesting of oysters at temperatures above 15 °C. It is possible, though not proven, that the organism **could have come to Alaska from Puget Sound via ballast water discharge or spat transfer**, as the serotypes are associated with Puget Sound outbreaks. *Vibrios*, including cholera (which survives in estuaries), have been documented in ballast water elsewhere in the world. Rising temperatures put Alaska at increased risk.



## Some Other Marine Invasive Species In Alaska in 2010

### Scientific name

• *Caprella mutica*

Kachemak Bay, Ketchikan, Sitka, Dutch Harbor

### Common name

Skeleton Shrimp



## Some Other Marine Invasive Species In Alaska in 2010

### Scientific name

### Common name

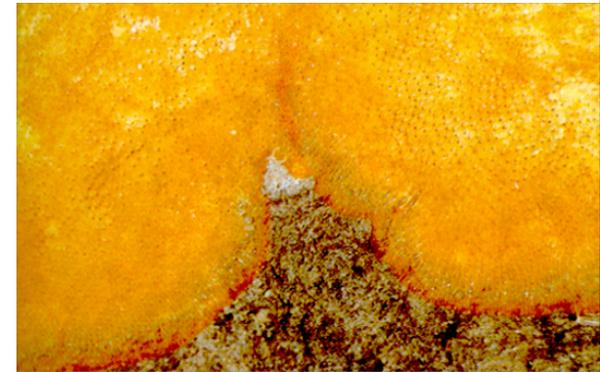
- *Schizoporella japonica*

Bryozoan

Kodiak, Kachemak Bay, Ketchikan, Sitka



Male bay pipefish (*Syngnathus leptorhynchus*) with egg-filled brood pouch. Length: 6 inches (15 cm).



Reported by Williams (2007) as one of a 56 species of non-natives fouling California seagrass beds. Grows on blades with effect of stopping photosynthesis and growth. Eelgrass is an important habitat in Alaska for primary productivity, juvenile fish and waterfowl.

## Some Other Marine Invasive Species In Alaska in 2010

### Scientific name

• *Cliona thosina*

Prince William Sound, Kachemak Bay

### Common name

Boring Sponge



A yellow Boring Sponge

**Sponge Bob's EVIL TWIN! Boring Sponges grow on oysters and other mollusks and "bore" holes into their shells, weakening and sometimes killing the oyster and damaging beds. This species is thought to have been introduced to Alaska from contaminated oyster spat.**



Shells with boring sponge holes



## Alaska's Seaweeds:



### Status of our Seaweeds

- There are 3 known aliens here:  
(not considered invasive)
  - *Ceramium kondoi*
  - *Porphyra purpurea*  
(not considered invasive yet, but could be)
  - *Sargassum muticum*
- We still don't have a comprehensive baseline; still discovering new or undescribed species.
- We are witnessing range extensions possibly due to climate change.
- Unique species that are cold water adapted have a high risk of extinction (Golden V Kelp). Island effect.

Slide courtesy Mandy Lindebergh: NOAA ABL



Range extension - Giant Kelp  
*Macrocystis pyrifera*



AK endemic - Golden V Kelp:  
*Aureophycus aleuticus*

## Some Other Marine Invasive Species In Alaska in 2010

### What about Climate Change and the Arctic?

- *Molgula citrina* -solitary tunicate
- Discovered in Seldovia, 2008 by Lambert, Shenkar and Swalla

North Atlantic species, so WHY IS IT HERE?:

- Overlooked?
- Ballast water, Hull Fouling, Sea Chest?
- through Arctic? – prevailing currents are from Pacific to Atlantic through the Arctic. Vessels could bring Atlantic species to Pacific. - See Denny Lassuy's talk!



[www.ascidians.com](http://www.ascidians.com)



## *Some Concerning Marine Invasive Species That Could Invade Alaska from the West Coast of North America*

- *Spartina* (four species) Cordgrasses\*
- \*Gino Graziano will cover *Spartina* in his talk today!



- *Carcinus meanus* European Green Crab
- *Watersipora subtorquata* Bryozoan
- *Ciona intestinalis* Common Sea Squirt
- *Ciona savignyi* Pacific Transparent Sea Squirt
- *Undaria pinnatifida* Japanese kelp or Wakame



*AND, WHAT ABOUT Crassostrea gigas* Pacific (Japanese) Oyster?

*And, Eriocheir sinensis* Chinese mitten crab (Denny Lassuy will cover this topic in his talk on climate change and invasion in Alaska!)

# Some Concerning Marine Invasive Species That Could Invade Alaska from the West Coast of North America

## • *Carcinus meanus* European Green Crab

- Infested San Francisco Bay in late 1980s, now in CA, OR, WA and British Columbia, moving north.
- Voracious predator, eats shellfish and could compete with native crabs such as Dungeness
- High environmental tolerance/adaptability. Modeling has shown Alaska to be suitable habitat.
- Life history traits, i.e., long-living larval stage, may enable transport Via ballast water and/or natural dispersal north to Alaska in currents
- Invasion meltdown effect: decline of native California clams due to EGC predation and competition from invasive clam.



Larval Green Crab - Planktonic

## *Some Concerning Marine Invasive Species That Could Invade Alaska from the West Coast of North America*

- *Watersipora subtorquata* Bryozoan (moss animals)

- Cabo San Lucas, Mexico to Coos Bay, Oregon

Intertidal, common on artificial structures.

- Fouling, common on ship's hulls, tolerant of copper based anti-fouling compounds.

- Facilitates spread of other invasives by providing substrate for settlement on anti-fouling coated hulls.

- Prevention measures are the only practical means of control



California Academy of Sciences



Luis A. Slorzano

# Some Concerning Marine Invasive Species That Could Invade Alaska from the West Coast of North America

## SOLITARY TUNICATES

*Ciona intestinalis* Common Sea Squirt or Vase Tunicate



*Ciona savignyi* Transparent Sea Squirt



*Styela clava* Club Tunicate



Photos: [wdfs.wa.gov](http://wdfs.wa.gov)

### •Impacts:

- May out-compete other organisms for food and space, altering natural community dynamics
- Threaten aquaculture, fishing and other coastal and offshore activities
- Increase the weight of aquaculture cultivation equipment, making work more demanding
- Increase operating costs for shellfish producers and processors
- *Ciona savignyi* is flourishing in Hood Canal, Washington and is associated with leaky septic systems.

# Asian Kelp or Wakame: *Undaria pinnatifida*

## **Profile: Could Invade Alaska**

Habit: annual kelp, SE-P, low intertidal to 5m depth, subtidal rocky shorelines, fast growing to ~2m; 10-20°C.

Native Distribution: Japan, Korea, China

Transport Mechanism: Oyster farming, vessels.

Non-native Distribution: Australia, New Zealand, Mediterranean Sea, France, Argentina, Mexico, (2000) California – San Diego to SF Bay.

Invasive Impacts: can displace native kelp species including canopy species, fouling fishing gear and other marine structures.

Management: aggressive; manual removal on scuba; commercially grown and harvested.



*Undaria pinnatifida*  
(Harvey) Suringar



# What About Pacific Oyster? *Crassostrea gigas*

*They're already here – sort of!*

- Native to Japan. Mariculture Species in Alaska and Pacific Northwest (Washington's most valuable shellfish).
- Assumed to be non-reproductive in Alaska because it requires temperatures above 64°F (18°C) to reproduce. Could climate change raise our water temperatures this high?
- Wild populations have established in Washington and British Columbia..
- Considered to have filled “empty” niches where it has established in Pacific Northwest.

**HOWEVER,**  
Pacific oysters were introduced to the Netherlands for farming in the 1960s, where it was considered too cold for them to reproduce. In the late 1990s (note 30 year lag phase) they began to reproduce and spread in the Wadden Sea and have since replaced native blue mussel beds in the Netherlands, Germany and Denmark and formed solid reefs in many areas.



[ww2.nabis.govt.nz](http://ww2.nabis.govt.nz)



Crassostrea gigas reef in Wadden Sea



Crassostrea gigas shells in Pipestem Inlet, Vancouver, Canada,  
Green crab trap to the upper left



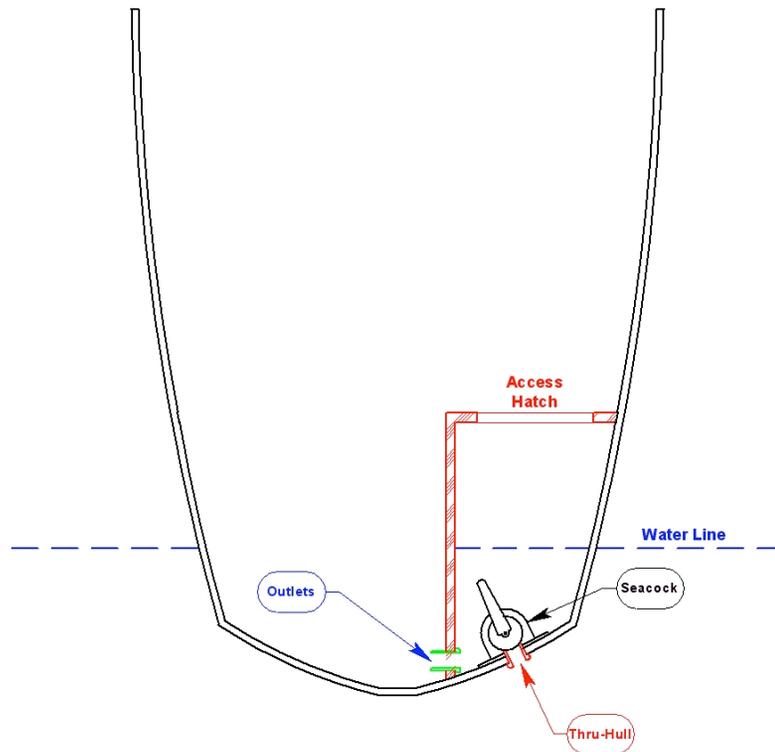
Photo: L. Shaw

# How Do they Get Here?

[massbay.mit.edu](http://massbay.mit.edu)

## HUMAN MEDIATED VECTORS

- **Vessel Traffic:**
- Ballast Water Discharge/Sea Chests (water intake compartments)
- Hull Fouling
- Examples: coastwide oil and liquefied natural gas tankers, military vessels, oil and gas drilling platforms, cruise ships, other commercial ships and barges, commercial and recreational fishing vessels and their gear.



## How Do they Get Here?

### HUMAN MEDIATED VECTORS

- **Mariculture and Trade:**
- Escaping fish/shellfish
- Spat transport and live seafood trade, including packing material
- Transport of docks/portions of docks
- Aquarium/.pet trade has potential



Photo:L. Shaw

### OR, NATURAL MECHNISMS

- **Natural Dispersal** from Pacific Northwest Populations of invasive species, via larvae, seeds, or fragments



Alaska's risk to invasion is increasing with development, visitation, commerce, development and climate change

# What are we Doing About It?

*Communities where Green Crab and Tunicate Monitoring Efforts Have or Are Occurring and Organizations Involved*



# What are we Doing About It?

## *Sitka Bioblitz and D. vex Response*

We\* sponsored a community based, volunteer “bioblitz” in Sitka last June, a rapid assessment of marine invasive species present in and potentially new to Sitka.

**AND, AS A PART OF THE BIOBLITZ....**

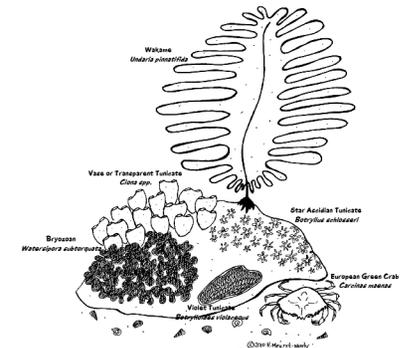
**Discovered *Didemnum vexillum* in Whiting Harbor!**

We\*\* have formed a response team for the *D. vex* infestation:

- Received funding from USFWS for response effort
- Conducting land-based, SCUBA and ROV surveys to assess extent of the infestation (ADF&G & NMFS)
- Secured the dock structures in Whiting Harbor to avoid winter storm break-up and dispersal
- Developed educational brochure for general public/vessel owners to minimize spread.
- Considering/Planning for management options to control and/or eradicate infestation

\*Tammy Davis, \*\*Dave Gordon, Patrick Fowler, Eric Coonradt, Troy Tydingco, Alaska Department of Fish and Game, Linda McCann, \*\*Greg Ruiz, Smithsonian Environmental Research Center, Sarah Cohen, Romburg Tiburon Center, San Francisco State University, Heather Mueret-Woody, Sitka Tribe, John Stein, Marnie Campbell, Sitka Sound Science Center, Linda Shaw, National Marine Fisheries Service, Marine Subcommittee of the Alaska Invasive Species Working Group, \*\*Denny Lassuy, Fish and Wildlife Service, Gary Freitag, SeaGrant, Victoria O’Connell, Paul Norwood, Grant Miller, Sitka Sound Science Center, Bob Reid, City of Sitka

### Sitka Bioblitz



**June 12-14, 2010**



## What could YOU Do about Marine Invasive Species In Alaska?

- Spread the word, not invasive species! D. vex Brochure
- Report any marine invasive species sightings to: **1-877-INVASIV**  
Photographs and specific locations are helpful
- Get involved with monitoring programs.  
Contact: Linda Shaw (907)-586-7510



# SUSTAINABILITY - IT'S IN OUR HANDS

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•C. Sarah Cohen, San Francisco State University

•Linda Shaw, NOAA National Marine Fisheries Service

•Heather Mueret-Woody, Sitka Tribe

•Marnie Campbell, UAS-Sitka

•Gary Freitag, Sea Grant and UAS-Ketchikan

•Grant Miller, Whiting Harbor Aquafarm

•Lynn Wilbur, Sitka Sound Science Center

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