The Role of Marine Reserves in Ecosystem-based Fishery Management

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NCSR curriculum modules are designed as comprehensive instructions for students and supporting materials for faculty. The student instructions are designed to facilitate adaptation in a variety of settings. In addition to the instructional materials for students, the modules contain separate supporting information in the "Notes to Instructors" section, and when appropriate, *PowerPoint* slides. The modules also contain other sections which contain additional supporting information such as assessment strategies and suggested resources.

Acknowledgements

We thank Bill Hastie of Northwest Aquatic and Marine Educators (NAME), and Jan Hodder of the Oregon Institute of Marine Biology (University of Oregon) for their thoughtful reviews. Their comments and suggestions greatly improved the quality of this module. We thank NCSR administrative assistant, Liz Traver, for the review, graphic design and layout of this module.

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NCSR Marine Fisheries Series

The marine fisheries issue is complex and represents an opportunity to approach the nature and management of a natural resource from several different perspectives in courses in natural resource or environmental science programs. Complete coverage of all fisheries-related topics is probably impractical for most courses unless the course is entirely devoted to fisheries. Instructors may select some topics for coverage and de-emphasize or ignore others. Thus, these curriculum materials are designed to meet a variety of instructional needs and strategies. The *NCSR Marine Fisheries Series* is comprised of the following:

1. *PowerPoint* Presentations

These presentations include *PowerPoint* slides, lecture outlines and detailed instructor notes on various marine fisheries topics.

- *Marine Fisheries Overview*
- *Marine Fisheries – Introduction and Status*
- *Marine Fisheries – Causes for Decline and Impacts*
- *Marine Fisheries – Management and Proposed Solutions*
- *Declining Expectations – The Phenomenon of Shifting Baselines*
- *The Role of Marine Reserves in Ecosystem-based Fishery Management*

2. *The Decline of Atlantic Cod – A Case Study*

This module provides a comprehensive examination of the decline of the Atlantic cod. Instructional materials include student learning objectives, a *PowerPoint* presentation with instructor notes, student handouts, suggested resources and assessment. Brief descriptions of other fisheries for development as case studies are also provided.

3. *Comprehensive Resources for NCSR Marine Fisheries Series*

This module provides detailed summaries for six excellent videos that examine various aspects of the marine fisheries issue:

- *Empty Oceans, Empty Nets* (2002) – an overview of major marine fisheries issues (one-hour) – student handout provided
- *Farming the Seas* (2004) – an examination of issues associated with aquaculture (one-hour) – student handout provided
- *Deep Crisis* (2003) – an examination of current research on salmon and bluefin tuna using modern technology (one-hour)
- *Strange Days on Planet Earth – Episode 3- Predators*
- *Strange Days on Planet Earth – Episode 5 – Dangerous Catch*
- *Journey to Planet Earth – The State of the Planet's Oceans*

This module also provides a comprehensive glossary of terms commonly used in marine fisheries.

In addition, complete citations and brief summaries of web, print and video resources are provided that can be used to:

- Enhance existing lecture topics
- Develop lectures on new topics
- Develop geographically relevant case studies
- Update fishery statistics
- Select articles for student reading
- Access video and photos for presentation purposes

4. Activity-based Instructional Modules

    - *Shrimp Farming – Environmental and Social Impacts* – an evaluation of the environmental and social impacts of shrimp aquaculture (one hour)
    - *Where Does Your Seafood Come From?* – students evaluate the sustainability of locally available seafood and the criteria that are used to make that determination (3-4 hours)

The manner in which instructors use the modules in this series will depend upon:

- The course in which the module will be used

The marine fisheries modules are most appropriate for inclusion in undergraduate courses such as *Environmental Science*, *Introduction to Natural Resources*, *Marine Biology*, *Introduction to Fisheries* and *Fisheries Management*. Parts of the modules may also have application in courses with a broader scope such as *General Ecology* and *General Biology*.

- The background of the students

The marine fisheries modules assume some understanding of basic ecology including populations, communities and ecosystem structure and function. The treatment of ecology in either a college-level or high school-level general biology course should be sufficient. Instructors may need to provide additional background to students who are not familiar with this material.

- The time that will be dedicated to the study of marine fisheries

There is sufficient information and resources in the marine fisheries modules to present anything from a single one-hour lecture to a major portion of a full academic term, lecture-only course. Instructors may select from the various components depending on course objectives and the amount of time allocated for marine fisheries topics.

The Role of Marine Reserves in Ecosystem-based Fishery Management

This instructional guide is designed to provide instructors with lecture support on the topic of marine reserves with an emphasis on their role in ecosystem-based fishery management. Our current understanding of the benefits of marine reserves is discussed, as well as some of the considerations in the design and management of marine reserve networks.

A general lecture outline and a more detailed *PowerPoint* presentation with instructor notes are provided. Print, video and web-based resources that cover the topic are summarized and cited. Instructors who wish to obtain greater detail on any of the topics discussed in this module are encouraged to seek out these additional resources or those cited in the *Comprehensive Resources for NCSR Marine Fisheries Series*.

Objectives

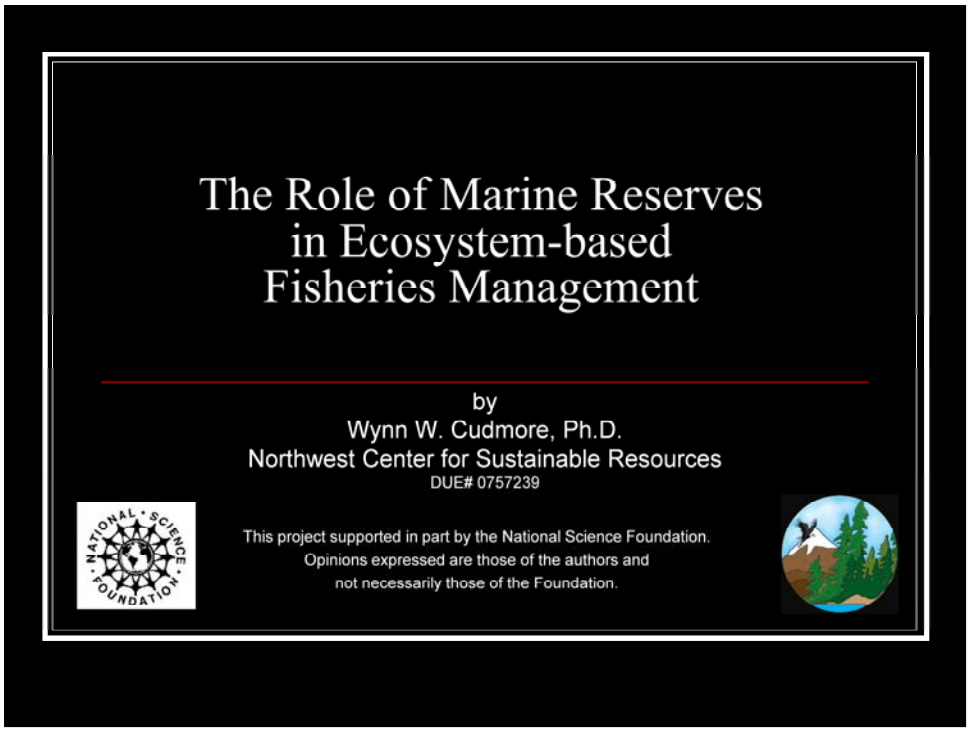
Upon successful completion of this module, students should be able to:

1. Define and characterize marine reserves as a type of marine protected area
2. Describe the benefits of marine reserves
3. Evaluate various criteria that must be considered in the designation of marine reserves
4. Describe management issues related to marine reserves
5. Represent the various viewpoints of people towards marine reserves

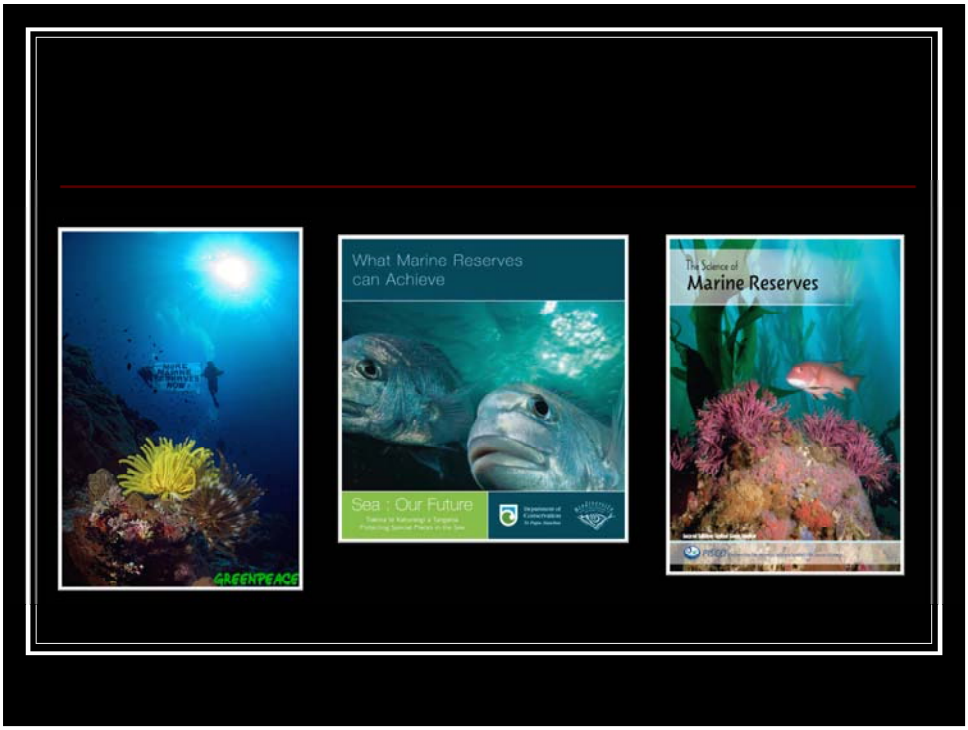
General Lecture Outline

I. Introduction
    A. Marine protected area definitions
    B. Distribution of marine reserves
II. Benefits of marine reserves within their boundaries
    A. Biomass, density, size and diversity
    B. Role of large females
    C. Restoration of ecological balance
    D. Case studies
III. Benefits of marine reserves outside their boundaries
    A. Spillover
    B. Larval export
IV. Marine reserve design
    A. Location considerations
    B. Size considerations
    C. Number in an area
    D. Proximity
V. Management issues
    A. Migratory species
    B. Displaced fishing effort
    C. Different viewpoints

PowerPoint Presentation and Instructor Notes



This presentation is an examination of the role of marine reserves in ecosystem-based fishery management. Marine reserves are defined and the benefits they provide within and outside their boundaries are described. Considerations for the implementation of marine reserve networks are discussed, as well as the different viewpoints that people have concerning marine reserves.



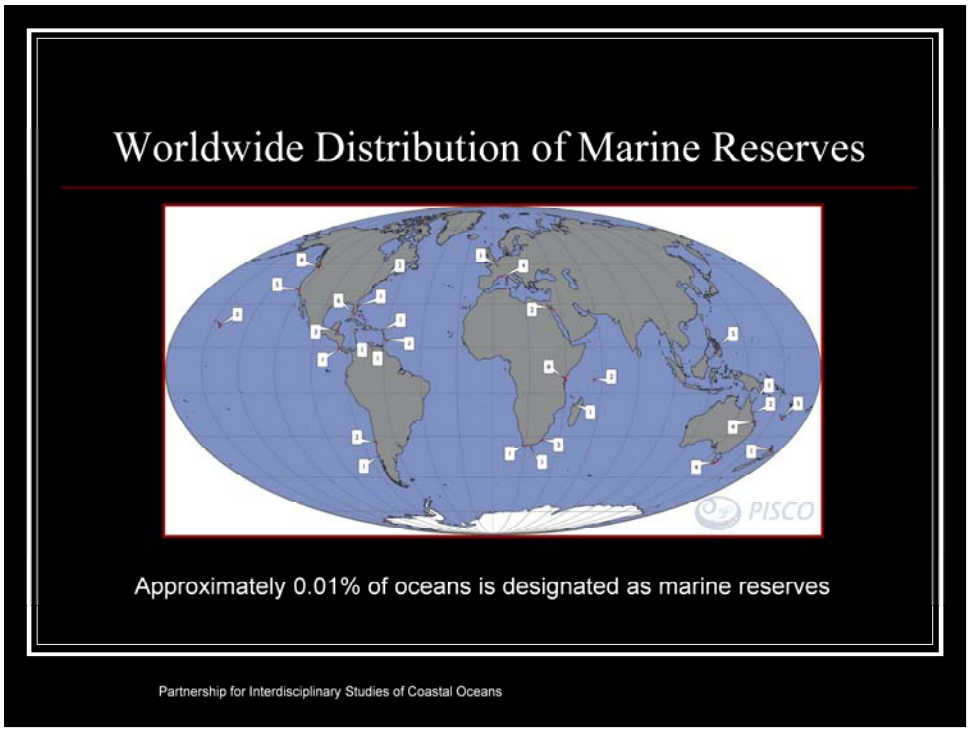
Various types of marine protected areas have become more widely accepted as a tool to conserve the natural biodiversity of marine ecosystems. Organizations as diverse as environmental groups (*Greenpeace* shown here), federal commissions and international organizations have promoted marine protected areas. Nearly all of the various organizations that have proposed solutions to marine fisheries declines (e.g., U.S. Commission on Ocean Policy, Pew Oceans Commission) have emphasized the importance of establishing marine reserves as part of any comprehensive ecosystem-based plan.

In the context of fisheries conservation, marine reserves are designed to protect a portion of the fish population to help ensure the persistence of that population. In a more general context, networks of marine reserves are designed to protect marine biodiversity and the ecosystem services that biodiversity provides.

In terrestrial habitats, national parks, wilderness areas and wildlife refuges preserve the nation's natural heritage and wildlife. A system of marine protected areas (MPAs) has been proposed that would preserve this legacy in a marine environment. Although land-based reserves have been part of national and international conservation strategies for decades, until recently the concept had not been broadly applied to marine environments.

There are several levels of protection that are provided in these MPAs. Three of the most commonly used designations are defined here. Note the distinction between marine reserves and other marine protected areas, which also afford some protection but not to the same comprehensive level as marine reserves.

Marine reserve – a type of MPA that prohibits all extractive activities including fishing; i.e., an ocean area that is fully protected from activities that remove biological organisms or alter habitats (except as needed for scientific monitoring). Networks of marine reserves are now widely viewed by scientists, managers and advocacy organizations as an important element of an ecosystem-based effort to preserve both marine biodiversity and sustainable fisheries.

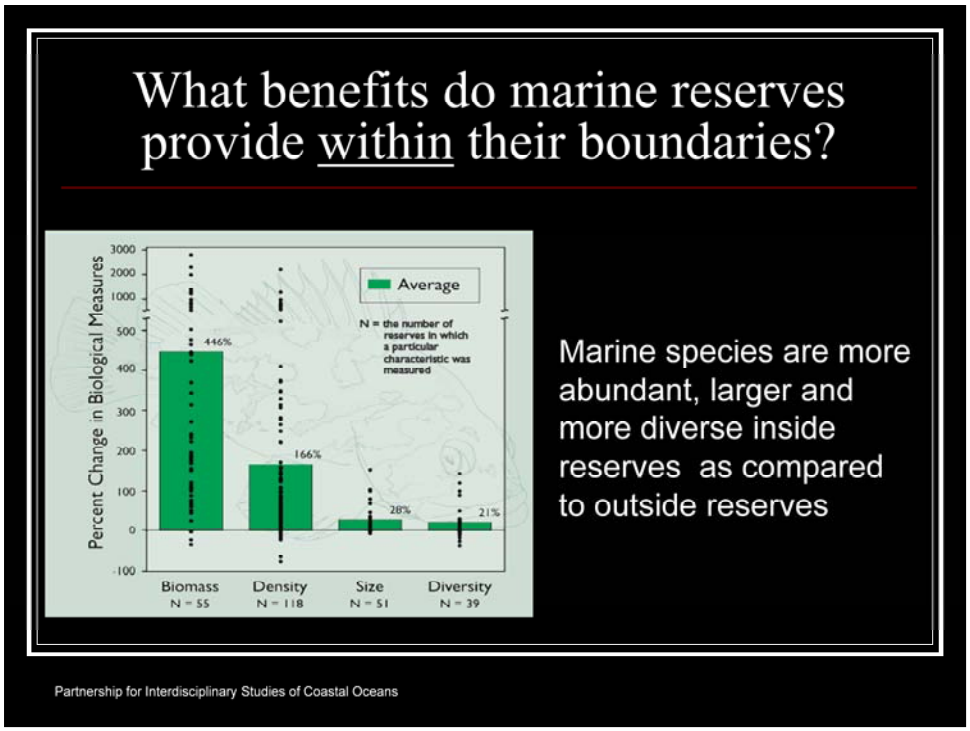


Numbers in boxes indicate the number of reserves at that location that have been studied by scientists with the results published in scientific journals. At the time of this study (2002) at least 124 marine reserves had been studied.

As of 2006, approximately 0.01% (13,900 mi^2) of the ocean is designated as marine reserves. Worldwide there are about 4500 marine protected areas, covering approximately 0.6% of the ocean (849,000 mi^2).

In the past, *de facto* reserves existed throughout the world's oceans due to the presence of inaccessible areas we could not fish (too far, too deep, too rocky, etc.).

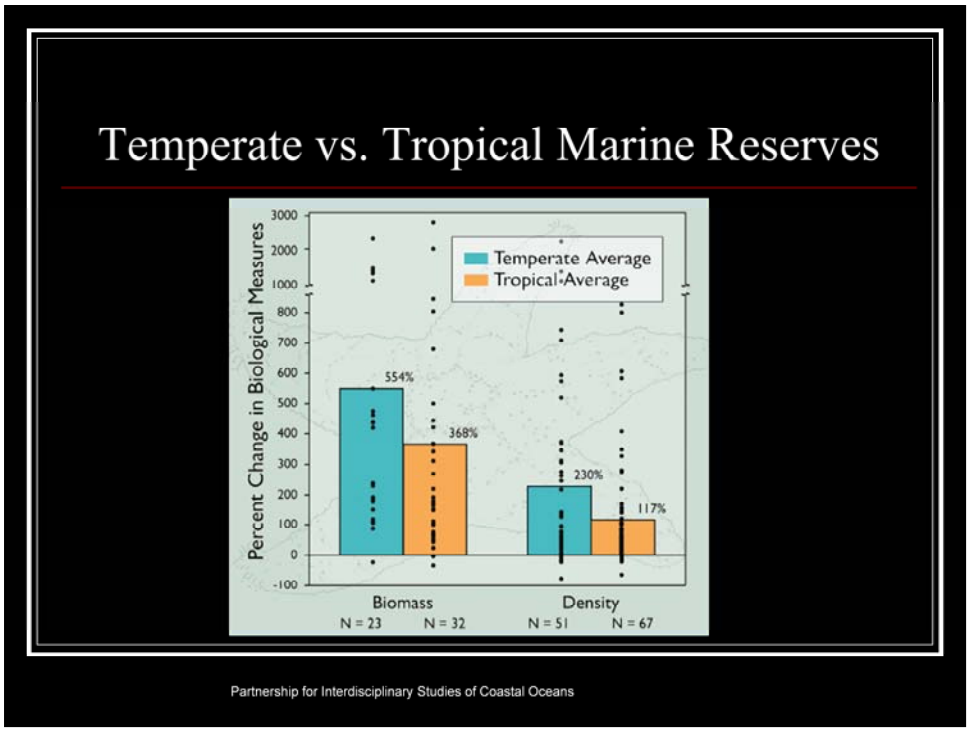
However, with increased demand, larger vessels and improved technology (e.g., on-board electronics, dredges and trawls designed for rocky bottoms and for fishing at great depths), many of these areas are now accessible to fishermen.



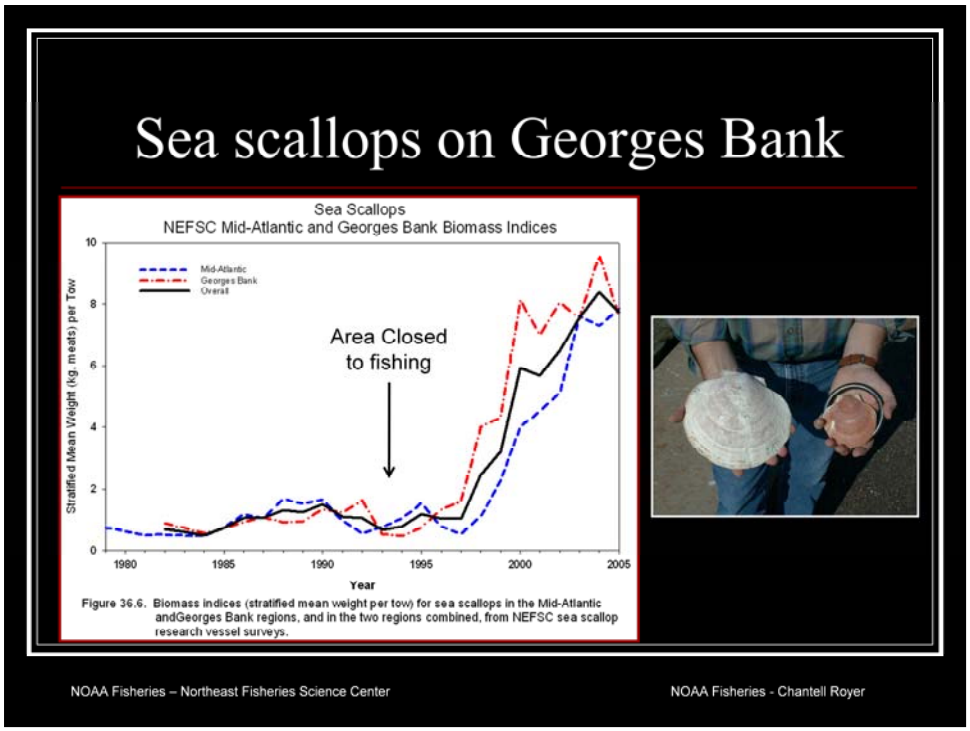
In general, marine reserves serve as an “insurance policy” against fishery declines and marine ecosystem degradation. The biological diversity supported by marine reserves builds in some resiliency to disturbances and catastrophic events (e.g., bottom trawling and warming due to climate change) that may further degrade marine ecosystems. Marine reserves are not as effective against other types of environmental degradation, such as that caused by oil spills, marine pollution or ocean acidification.

It has long been known that fish biomass increases in response to a decrease in fishing pressure. During both World Wars, for example, when fishing effort in the North Sea declined to near zero, groundfish biomass increased between 2-4-fold within a few years. Fish biomass in marine reserves would be expected to respond in a similar fashion.

Studies of more than 124 marine reserves from around the world found that within reserves, marine species (fish, invertebrates and marine algae) were more abundant, larger and more diverse (see bar graph) than non-reserve areas. Green bars indicate mean values (% change when reserve areas are compared to non-reserve areas) for biomass, density, body size and species diversity. Black dots represent the range of values. Most reserves showed positive changes in values. Biomass increased by over 400% on average.



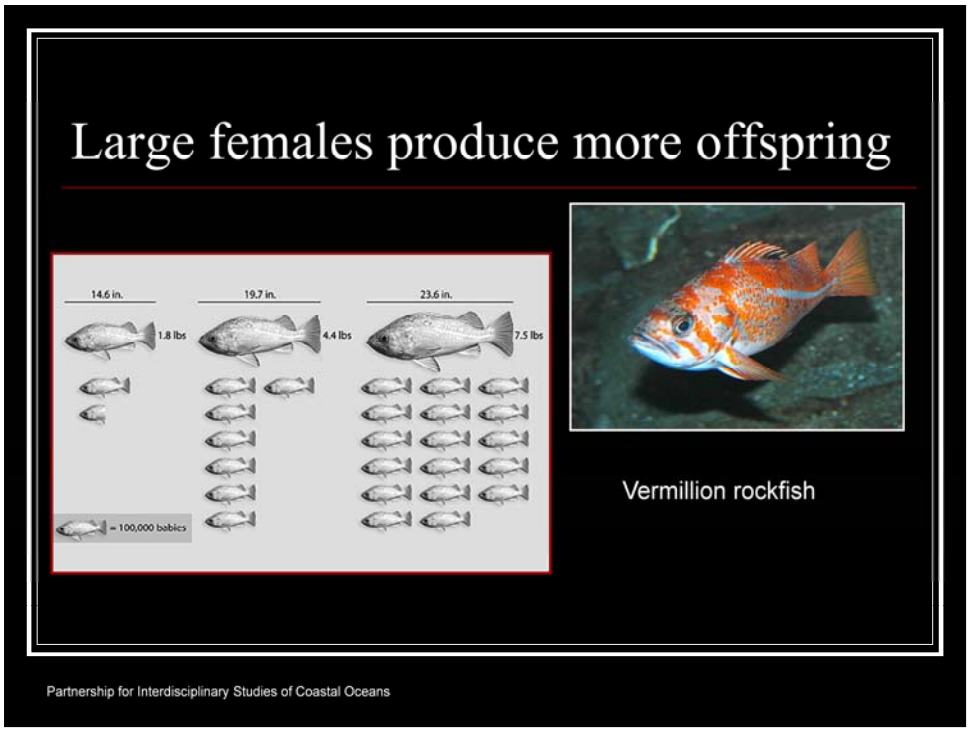
Both temperate and tropical reserves showed an average increase in biomass and density of fish, invertebrates and marine algae when compared to non-reserve areas.



Although not designated as marine reserves, sea scallops increased dramatically inside the closed areas designed to protect Atlantic cod just a few years after the emergency closure in 1994. Between 1994 and 2002 sea scallop biomass on Georges Bank increased more than 20 fold. In 2003, scallop biomass inside the closures was 25 times the biomass before the closures. Compared to areas outside the closures that were being fished, scallop biomass was 4-5 times greater inside the closed areas. This change took place over just 10 years and was presumably due to scallops not being harvested during the closure period.

Sea scallops shown in photo at right – a large shell on left and small shell on right with a metal ring used to determine minimum size allowed to be harvested. Only the adductor muscle of the scallop is marketed.

This suggests that for some species, recovery can be quite rapid once fishing pressure is removed. Some long-lived, slow-growing species and complex benthic habitats probably recover only on longer time frames.

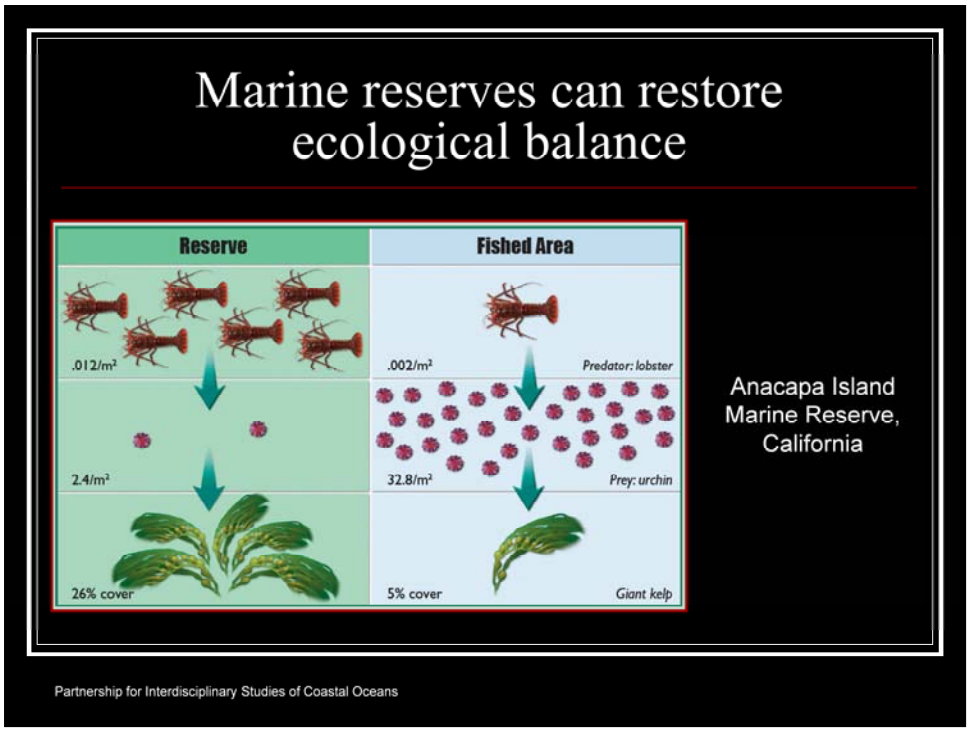


The fact that marine reserves support a larger biomass of larger individuals when compared to non-reserve areas is very important. For fish with long life spans, in particular, “big, old, fat females” (as a result of their higher reproductive potential when compared to younger, smaller females), contribute more significantly to the next generation. As illustrated here for rockfish, larger individuals produce larger numbers of eggs and therefore, leave significantly more offspring. A 23-inch female vermillion rockfish, for example produces 17 times more young than a 14-inch vermillion rockfish. This species reaches sexual maturity at 5-9 years and has a maximum lifespan of at least 60 years.

Recent studies have also shown that these large females produce offspring that grow faster and survive starvation better than offspring from younger females.

This unusually large, 44 inch, 60-pound female short-raker rockfish was caught in March 2007 in the Bering Sea south of the Pribilof Islands, Alaska at a depth of about 2100 feet. The catcher-processor *Kodiak Enterprise* caught the rockfish while trawling for pollock. Scientists at the NOAA Alaska Fisheries Science Center (Dr. Chris Spencer shown here) examined the fish and found it to be 90-115 years old and full of developing embryos. The huge reproductive potential of individuals like this in a population allows populations to replenish themselves. Unfortunately, large females are also among the most valuable individuals in a population economically. As fishing pressure is exerted on a population, all size classes (above some minimum size depending on gear type and regulations) are initially harvested (including large, old females). Further harvesting prevents fish from growing large and old.

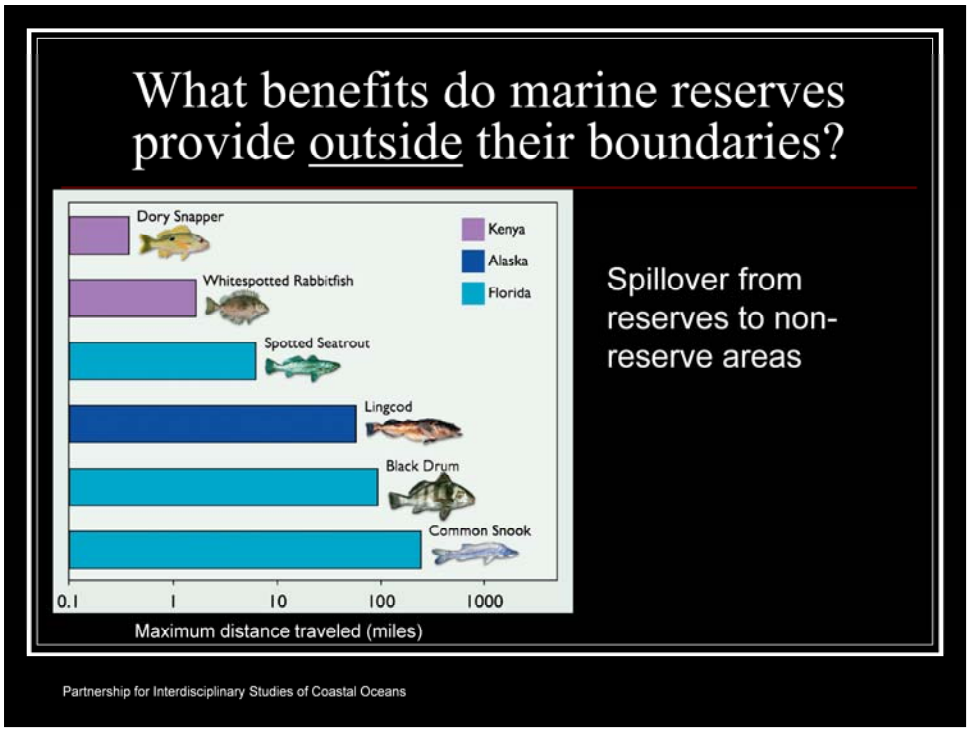
Marine reserves would provide greater assurance that a significant number of "big, old fat females" would survive to replenish the population.



Anacapa Island Marine Reserve, California (established 1978, expanded 2003)

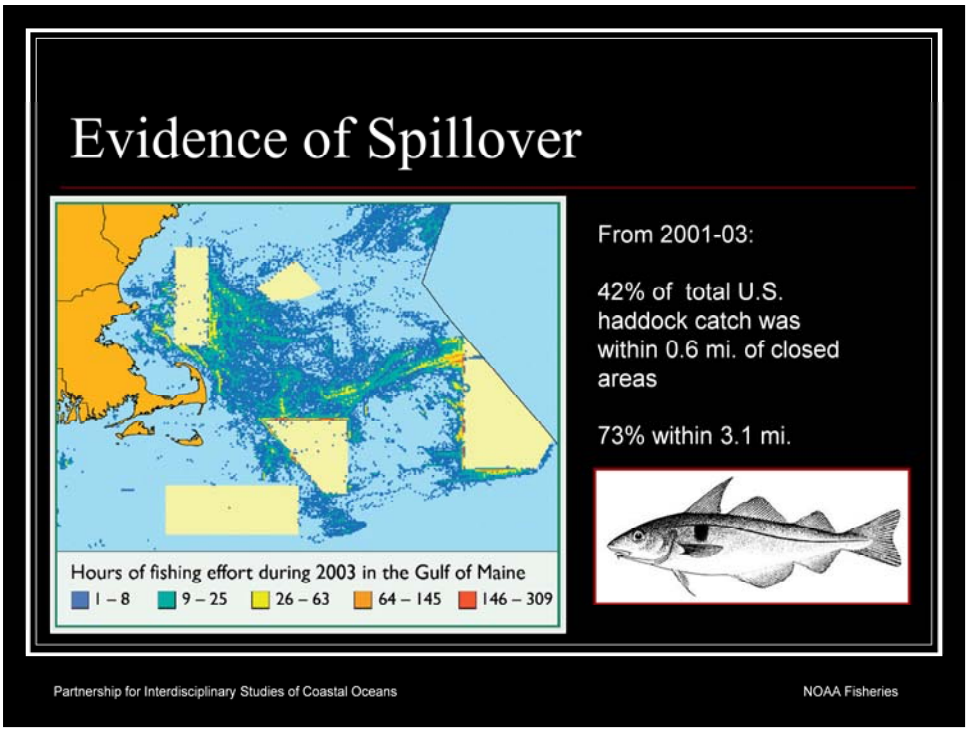
Kelp forests along the California coast are known to support a high level of nearshore marine biodiversity. They provide habitat, cover, food, etc. for a wide variety of invertebrate and vertebrate species, including some commercially important fish species. A portion of the kelp forest food web is illustrated here - spiny lobsters eat sea urchins, which eat kelp. In areas where lobsters are heavily fished (right portion of diagram), sea urchins proliferate and reduce kelp biomass (or cover), creating what are known as "urchin barrens." These areas support a significantly lower level of biodiversity. Sea urchins were 13 times more abundant in fished areas when compared to reserve areas.

In the marine reserve, spiny lobsters became 6 times more abundant (due to no fishing), sea urchins were consumed at a higher rate and kelp forests and the diversity they support flourished (left portion of diagram).



For marine reserves to become accepted by the fishing industry, they must provide the potential for increasing fish abundance in non-reserve areas. The movement of fish from the reserve to outside the reserve is called **spillover**. As population density increases within a reserve, individuals are more likely to move out of the reserve and into adjacent non-reserve areas.

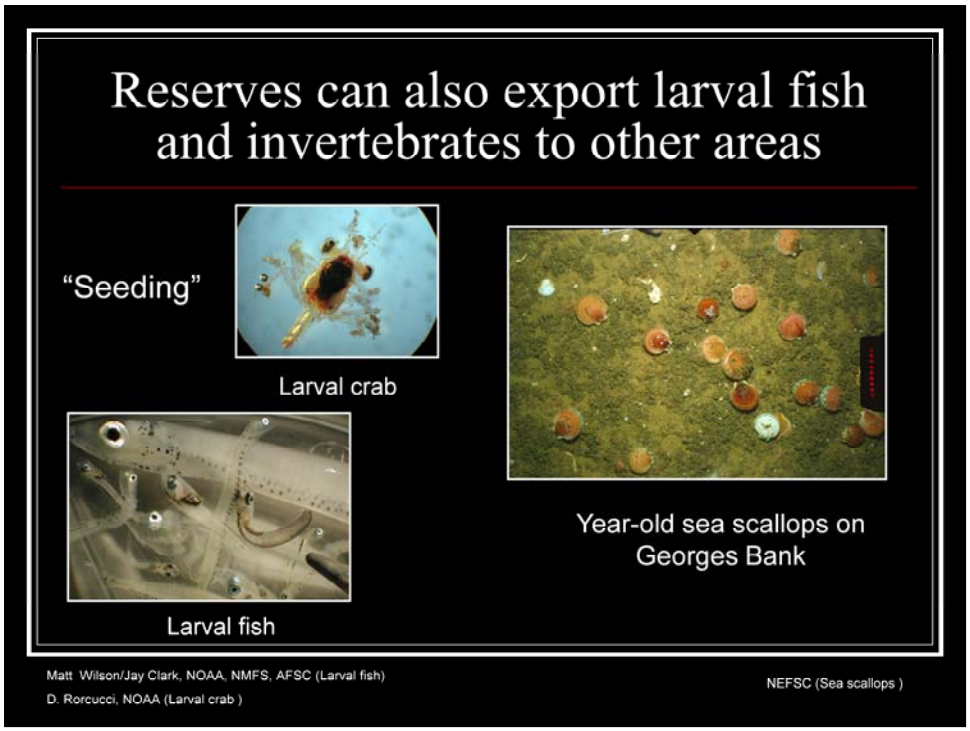
Fish species vary in their ability to move away from the reserve. This graph shows maximum distance traveled (in miles) by tagged fish from marine reserves in three different areas (Kenya, Alaska and Florida). Studies like these provide some evidence in support of the idea that reserves will serve as a source of fish for non-reserve areas. They also provide information that helps design the size of a reserve.



Although not established as marine reserves, five area closures implemented from 1994-98 to protect Atlantic cod and other demersal species provide some evidence for spillover. These areas were closed to any bottom-fishing gear. Note that with these closures in place, fishermen expend a disproportionate amount of fishing effort on the margins of these closed areas.

Catch rates along the closure margins for haddock and yellowtail flounder are higher than in other areas. From 2001 to 2003, 42% of total U.S. haddock catch was taken within 0.6 miles of these closed areas and 73% within 3.1 miles. This higher catch rate is apparently due to “spillover” from the closed areas.

Map from:
Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). 2007
The Science of Marine Reserves www.piscoweb.org/ 22 pp.

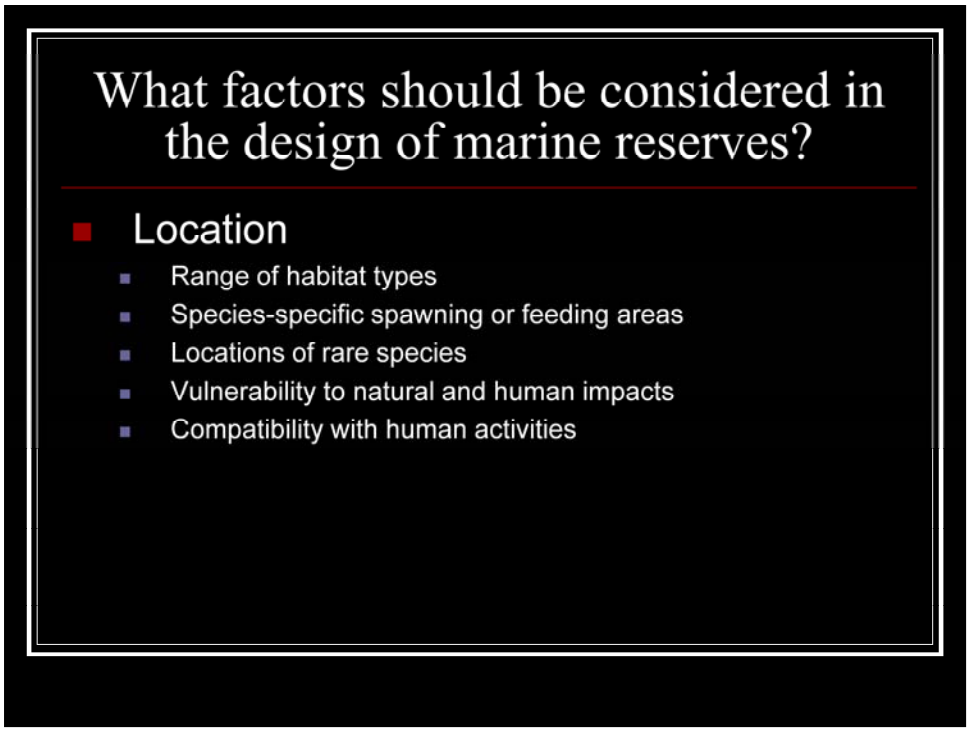


Most marine species (both vertebrate and invertebrate) have a larval stage (photos on left) that drifts in ocean currents, often great distances from where spawning occurred. In addition to adults moving from reserve to non-reserve areas, larvae may be exported from the reserve area to a non-reserve area in a process called **seeding**. This movement can help replenish non-reserve areas.

Evidence for the degree to which seeding occurs are scant. Many reserves are either too small or too recent to document the phenomenon. One exception is the evidence from the closures described on the previous slide. In addition to scallop biomass increasing inside closure boundaries (discussed earlier), substantial increases in the numbers of year-old sea scallops (shown in photo here) outside the closure areas suggest seeding.

NOAA Fisheries is studying the potential for larval transport from protected areas using satellite-tracked drifters which were deployed at 3 MPAs off the Florida coast and tracked for 60 days. Results suggest that larval transport is largely in one direction from the Florida Keys east and northwards. This study demonstrates that MPA's on the southeast U.S. coast are likely connected via larval transport and that a network of MPA's will support both fishery management and conservation goals.

www.ccfhr.noaa.gov/ecosystems/sanctuaries/mpa_design.html



See Notes Slide 14

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Designing and designating locations of marine reserves can be challenging – science, politics, culture and economics must all be considered. Ultimately, the specifics of a marine reserve design are determined by the goals established for the reserve. There are four major considerations that need to be addressed.

1. Location

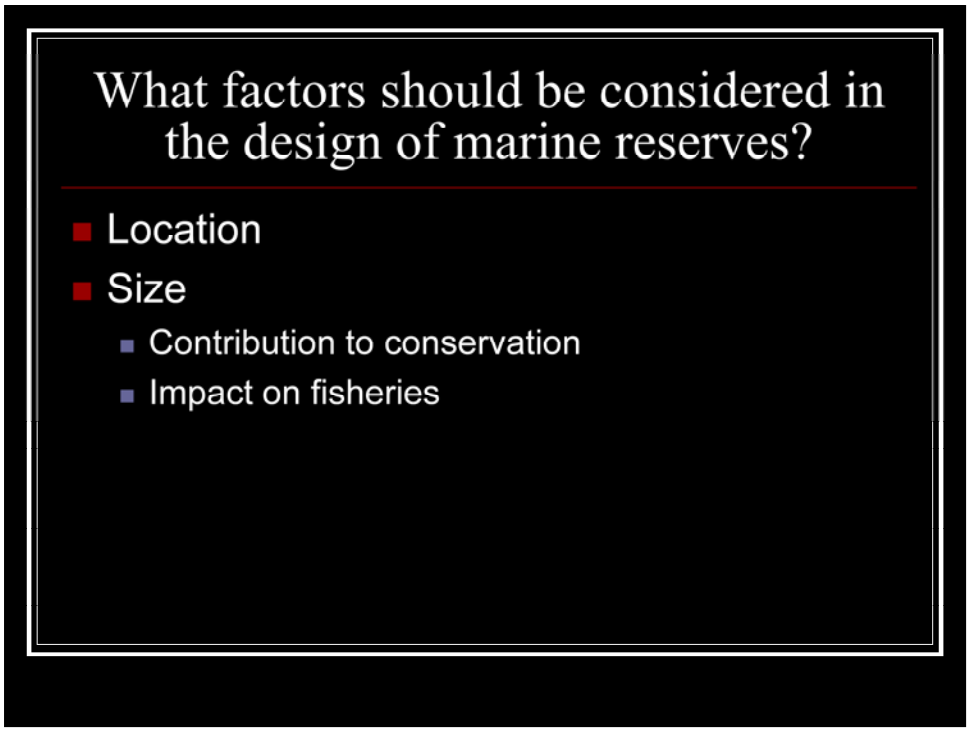
We should learn from the establishment of terrestrial wilderness areas which were established primarily in high elevation sites due to their low economic value (and least political resistance) rather than any particular biodiversity measure. Marine reserves should avoid this pitfall. Both species protection and ecosystem protection should be primary considerations when locating a marine reserve. Wide ranging species like tuna and salmon provide a particular challenge whose management cannot be fully realized even with a network of marine reserves. Unlike terrestrial reserves, corridors may not be as necessary given the fluid medium between reserves and the mobility of many species.

For reserves designed to maximize protection of marine biodiversity, large reserves that include those areas with the highest biodiversity should be selected (i.e., "biological hotspots"). For reserves that are established primarily to support sustainable fisheries, locations must be selected based on the biology of the targeted species (e.g., species-specific spawning, nursery or feeding areas and the home range of the species). For example, the following areas have been shown to be particularly important for large predatory fish such as swordfish, tuna and sharks:

1. The east coast of the U.S. south of Cape Hatteras
2. The east coast of Florida
3. Open ocean south of the Hawaiian Islands
4. East of the Great Barrier Reef in Australia

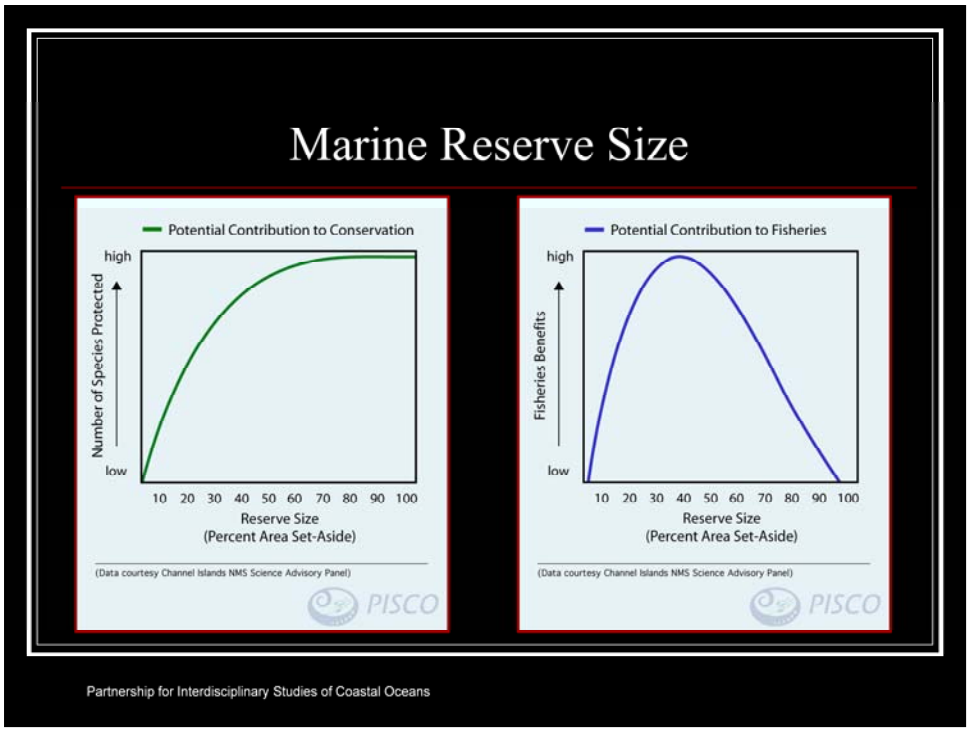
Some considerations concerning location include:

- Are the various habitat types within the region represented?
- Are species-specific spawning or feeding areas represented?
- Are areas occupied by rare or geographically restricted species represented?
- Are selected areas vulnerable to natural and human impacts such as pollution?
- Are locations compatible with other human uses (e.g., fishing, tourism, transportation)?



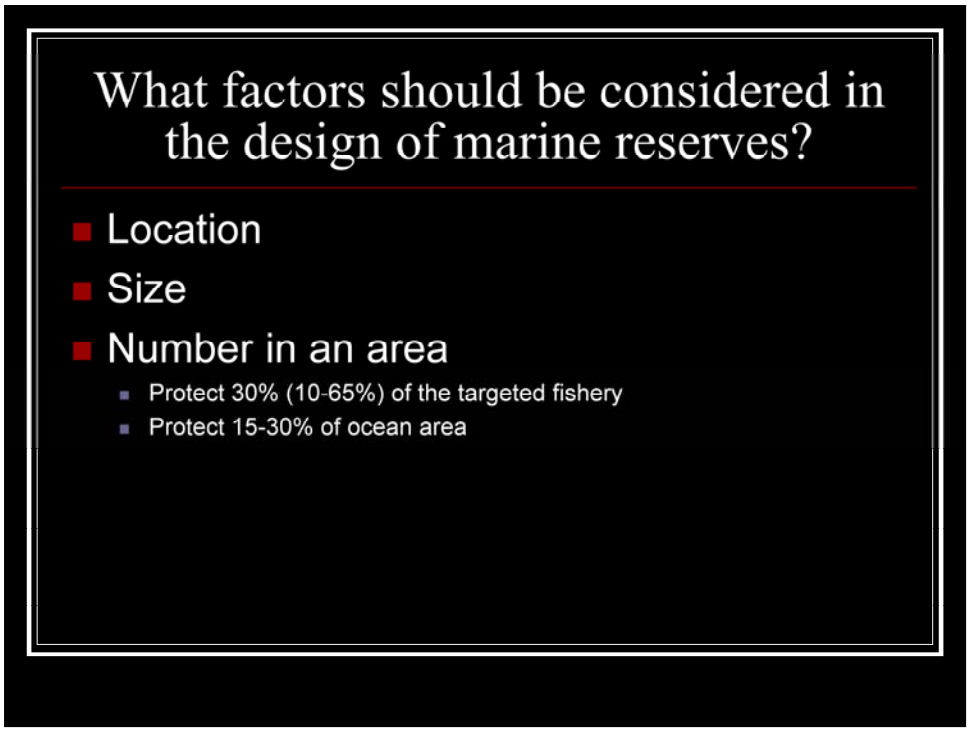
2. Size

The size of a marine reserve is also among the first considerations. Reserve size is largely a tradeoff between conservation values (which are maximized by large reserves) and the impact of reserve size on fisheries (which is more complex).



These two graphs illustrate the relationship between reserve size and the benefits they provide. As reserve size increases, conservation value (graph at left) also increases, but note that there are diminished returns with higher percentages set aside. The size of a marine reserve determines the type of species that will benefit most from the reserve. Small reserves, for example, may provide minimal protection for wide-ranging species such as large sharks or swordfish, which spend a significant amount of time outside the reserve. The benefits for highly mobile species can be maximized by selecting areas that are used by these species for a particularly vulnerable part of their life cycle (e.g., fixed spawning, feeding, or nursery areas). On the other hand, sedentary species that rarely stray from the reserve may gain nearly complete protection.

Note that the benefit to fisheries (graph at right) reaches some ideal value at moderate levels set aside. At lower levels, reserve areas are of insufficient size to provide significant spillover. At high levels, fewer areas are open to fisheries.



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3. Number of reserves in an area

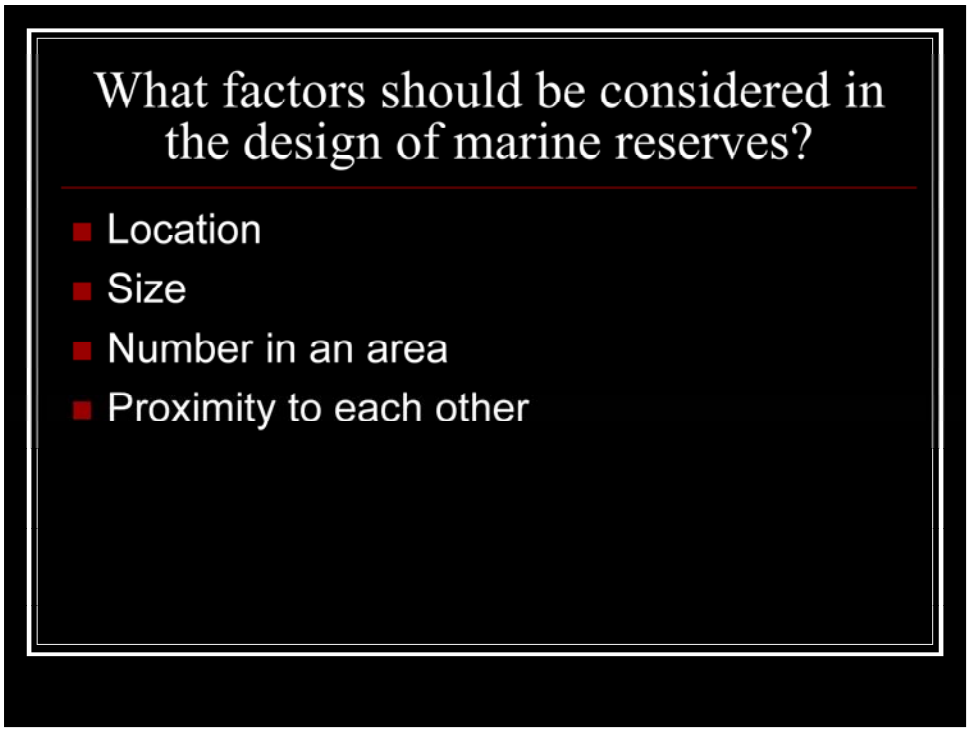
In some instances a number of smaller reserves may be more feasible than a single larger reserve. One advantage of multiple, smaller reserves is that chance events (either natural or human-caused) are less likely to impact several reserves than a single reserve. Thus, multiple reserves provide some insurance against catastrophic events such as hurricanes, oil spills, etc.

For marine reserves designed to protect marine biodiversity, the greater the area in reserves, the greater the benefit. The amount of coverage in this case therefore will be determined by socioeconomic factors (i.e., What consensus can be reached between various interests?)

For marine reserves designed to benefit fisheries by providing a sustainable harvest, population models suggest a network of marine reserves that protect a range of 10-65% (median 30%) of the targeted fishery. Note that this is not the same as 10-65% of the area.

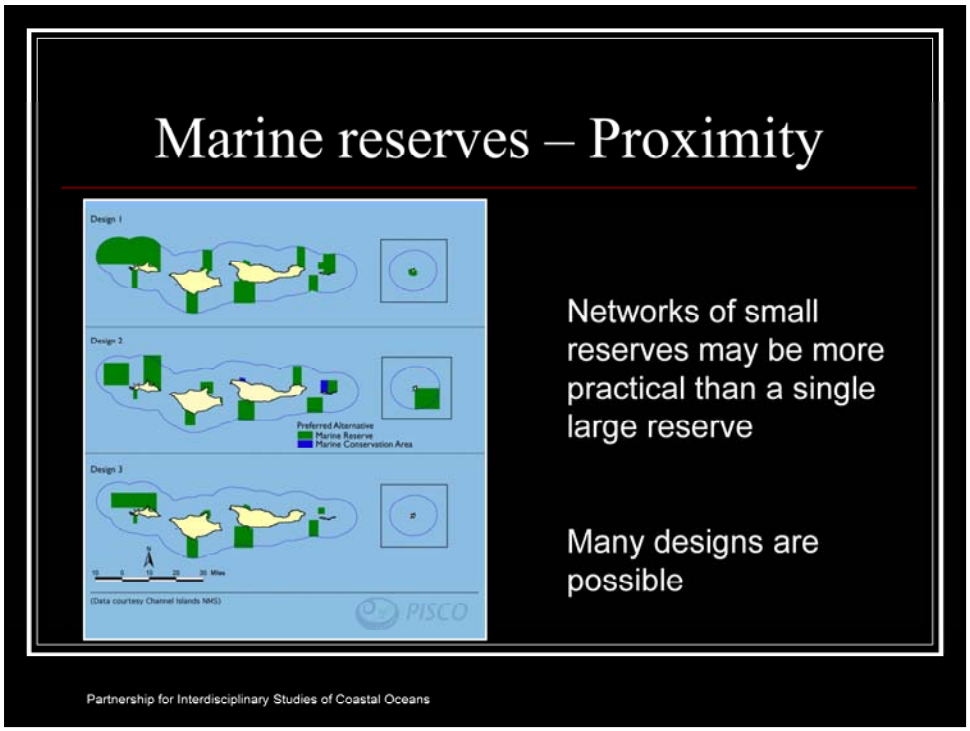
Some fisheries biologists have suggested that 15-30% of the oceans should be set aside to protect marine biodiversity and provide sustainable fisheries. Daniel Pauly has published research that suggests if we wanted to return fish stocks to what they were in 1970, 20% of oceans would have to be put into marine reserves. Balmford, et al. (2004) estimate that to establish reserves for all major fisheries would require 20-30% of the world's oceans, would cost $5-19 billion per year and would create about 1 million jobs.

Current marine protection targets aim to protect 10-30% of marine habitats by 2013. Since 1984, the area of marine protected areas has grown at a rate of 4.6%. At this rate, the goal of 15-30% of ocean area to be protected will not be reached for several decades rather than during this decade. Thus, a rapid increase in marine protected area coverage will be needed to achieve this conservation goal. See Wood, et al. (2008) for details.



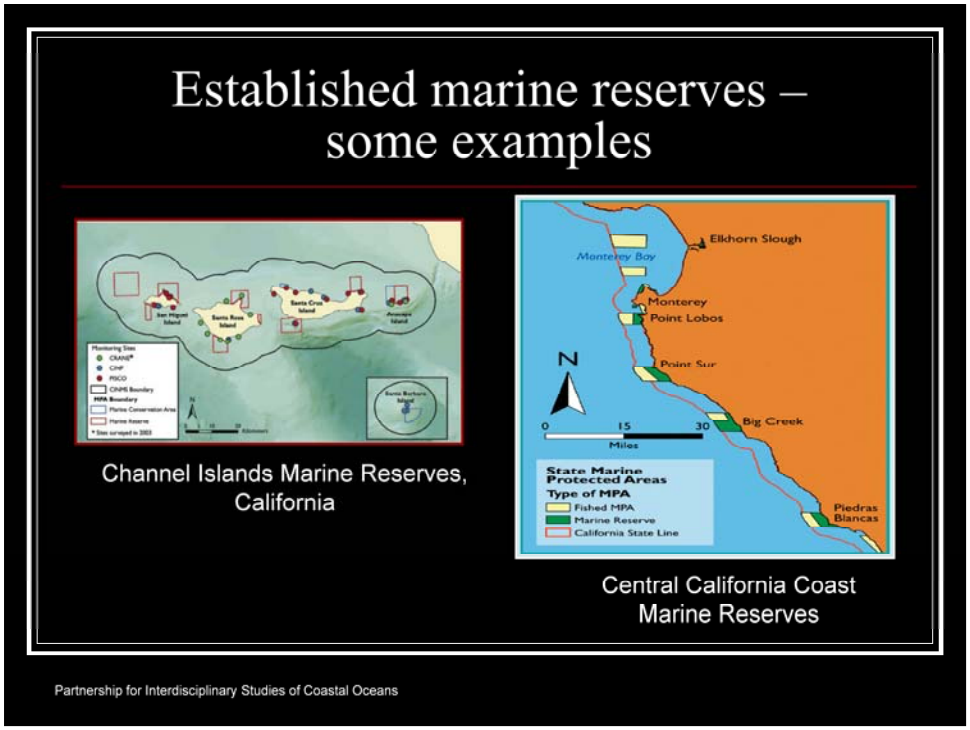
4. Proximity to each other

In many situations, networks of smaller reserves are probably more practical than a single large reserve. When this is the case, the distance between reserves must be considered.



To function as a network, reserves must be close enough together so they can replenish each other via both spillover and seeding. Many different designs are possible. Three different designs for the Channel Islands Reserve are shown here as the green blocks on the map illustrating some of the tradeoffs that must occur when reserves are established. Designs 1 and 2 here, meet most ecological criteria established for the network, but do not address some economic and social concerns. Design 3 addresses some of those concerns, but eliminates some areas popular for recreational fishing from the reserve system.

Note: Marine conservation areas (blue areas in diagram) represent a type of marine protected area that is less restrictive than a marine reserve. Recreational and some types of commercial fishing may be allowed in these areas with restrictions that provide some protection for marine ecosystems.



See notes slide 20

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At least 45 countries have established marine reserves. Some of the longest established reserves are in New Zealand, the Caribbean and in Australia. Long-term studies of these reserves have provided us with information on how we can expect fish populations and marine biodiversity in other reserves to respond. The Great Barrier Reef Marine Park, for example, encompassing over 133,000 square miles, was established in 1975 off the coast of NE Australia. In 2004, Australia designated 33% of this area as marine reserves.

Thus far in the U.S., the establishment of marine reserves has been implemented only in state territorial waters (i.e., 0-3 nautical miles from the coast).

The Northwestern Hawaiian Islands Marine National Monument (established in 2008) is now the world's largest MPA (140,000 square miles). It is not designated as a marine reserve, but the current plan is to phase out fishing by 2011.

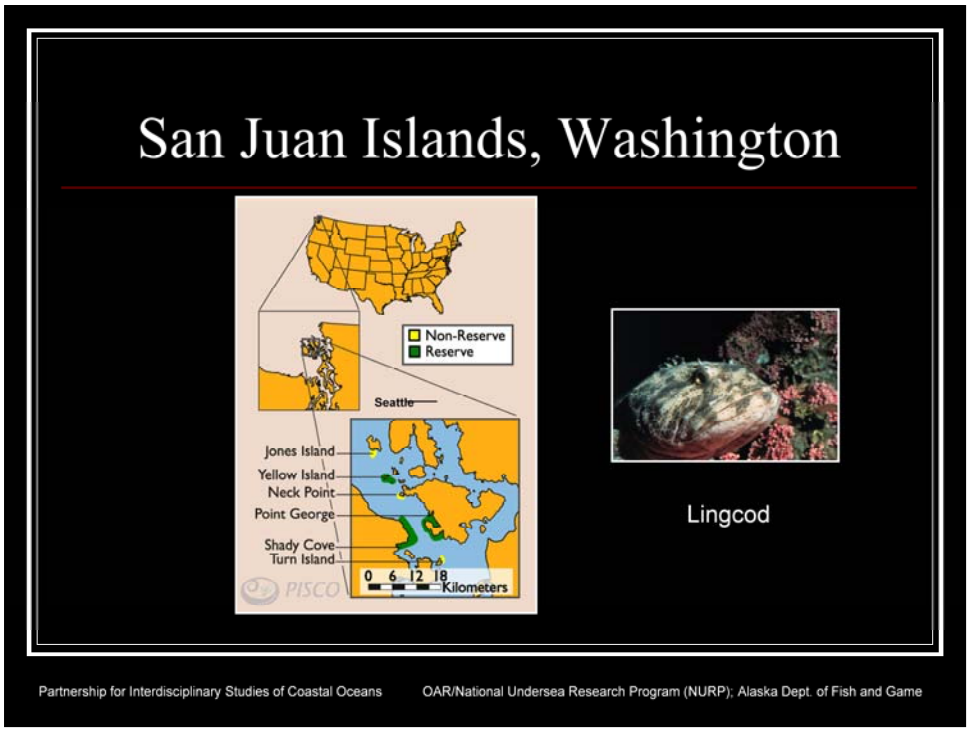
The Channel Islands Marine Reserves off Santa Barbara, California are among the oldest reserves in the U.S. The easternmost of these reserves – Anacapa Island – was established in 1978 and has been monitored continuously. Changes in kelp forests within the reserves were discussed previously. Colored circles in the diagram represent various study sites used to monitor conditions in reserve and non-reserve areas:

CRANE (green) – Cooperative Research and Assessment of Nearshore Ecosystem Program
CINP (blue) – Channel Islands National Park
PISCO (red) – Partnership for Interdisciplinary Studies of Coastal Oceans

The black line around the islands represents the boundary of the Channel Island National Marine Sanctuary (CINMS).

In August 2006, the state of California established a network of 29 marine protected areas along its central coast covering 200 miles from Santa Barbara to San Francisco. Fourteen of these are designated as marine reserves covering 7.5% of California state waters. Note in diagram at right that marine reserves and fished MPAs are adjacent to each other. Also note that these MPAs are in state waters within 3 nautical miles of the coast (red line in diagram at right). Expansion is expected with additional areas in northern and southern California to be designated in 2011. Protected areas include some of the most diverse and unique habitats including kelp forests, coastal bays, lagoons, estuaries, undersea canyons, rocky reefs and seagrass beds. The MPAs are designed to protect non-migratory species such as rockfish, abalone, and other shellfish rather than migratory species such as tuna and salmon.

See www.dfg.ca.gov/mrd/mlpa for details.
See Fact Sheets on Channel Island Reserves (created by COMPASS and PISCO)
www.piscoweb.org



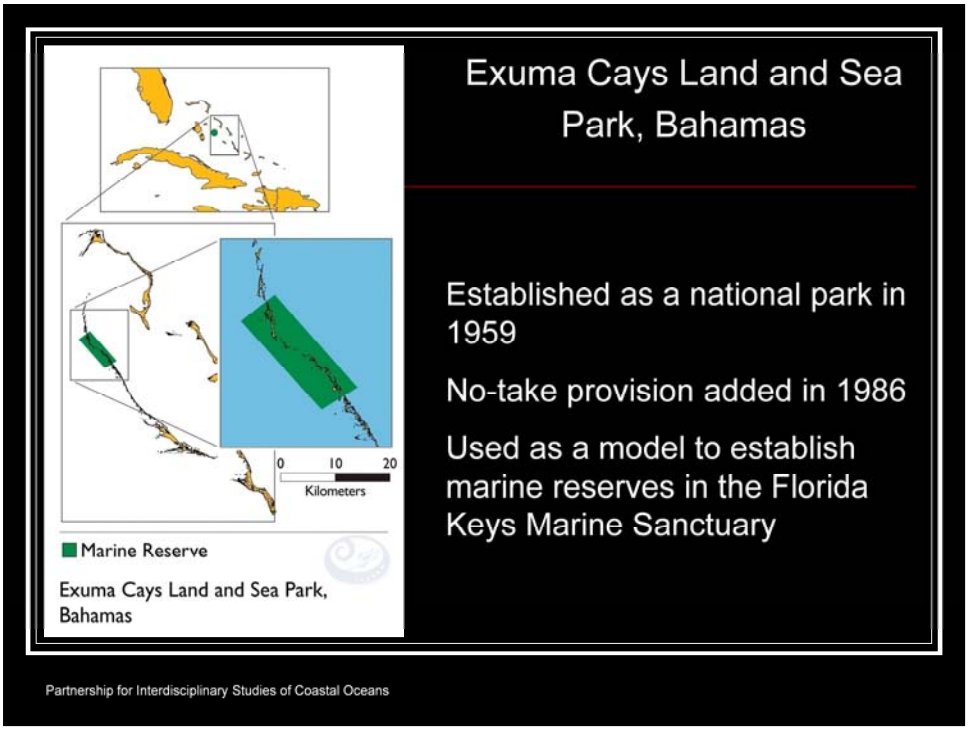
In 1990 Washington state established five marine reserves in Puget Sound to protect unique habitats around the San Juan Islands and to provide research sites undisturbed from recreational fishing. These reserves now contain larger and more abundant fish when compared to non-reserve areas. Reproductive rates are also higher within the reserves. Lingcod, an important commercial and recreational species, in particular, has benefitted from these reserves.

Oregon has been in a lengthy process of marine reserve designation since 2005. More recently, Oregon's governor called for up to 9 marine reserves in state waters off the Oregon Coast provided they did not result in significant negative impacts to coastal communities (particularly fishing interests). The Oregon Policy Advisory Council was established to evaluate marine reserve proposals and in November of 2008 recommended the establishment of two pilot marine reserves – one off Port Orford and one off Depoe Bay.

The process can be monitored from:

www.oregonmarinereserves.net

www.ouroregonocean.org

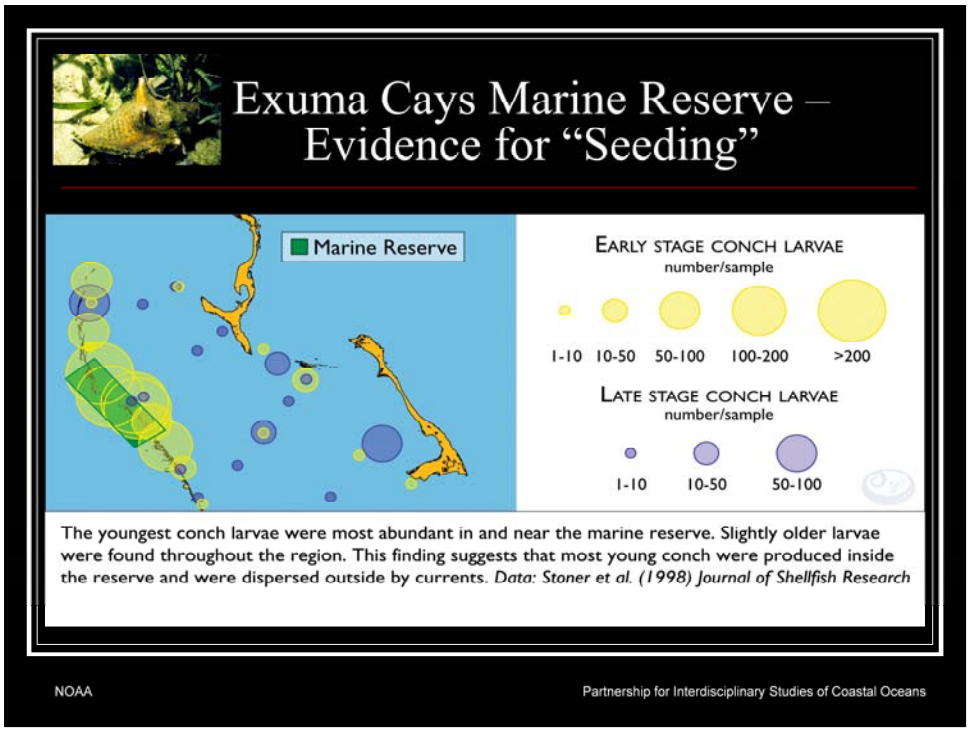


The Exuma Cays Land and Sea Park in the Bahamas (176 square miles) was originally established as a national park in 1959. Its original charter allowed limited fishing, but in 1986 a no-take provision was added. Although the term was not yet in wide use at the time, from this point on the park has been managed as a "marine reserve."

In addition to providing benefits to local fisheries, there have also been other economic benefits (tourism, in particular). The park has also yielded educational benefits and serves as an outdoor classroom for Bahamian students. The success of the Exuma Cays Land and Sea Park led to its use as a model to establish no-take zones (marine reserves) within the Florida Keys Marine Sanctuary in the U.S.

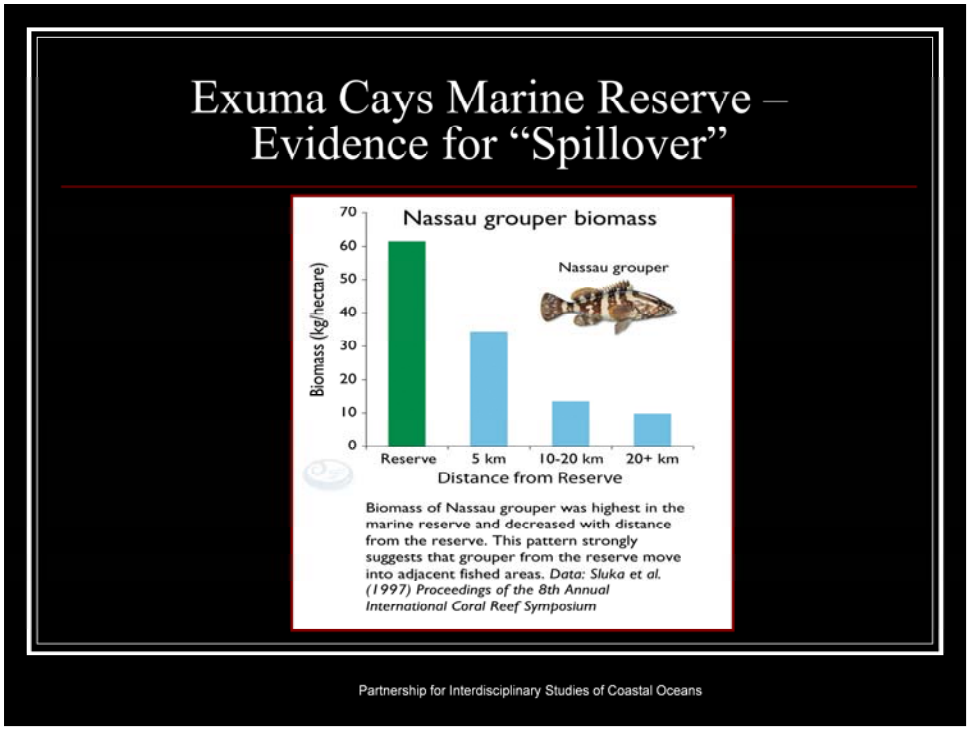
For more information on the Exuma Cays Land and Sea Park, see:

www.bnt.bs/marine_reserve_success.php

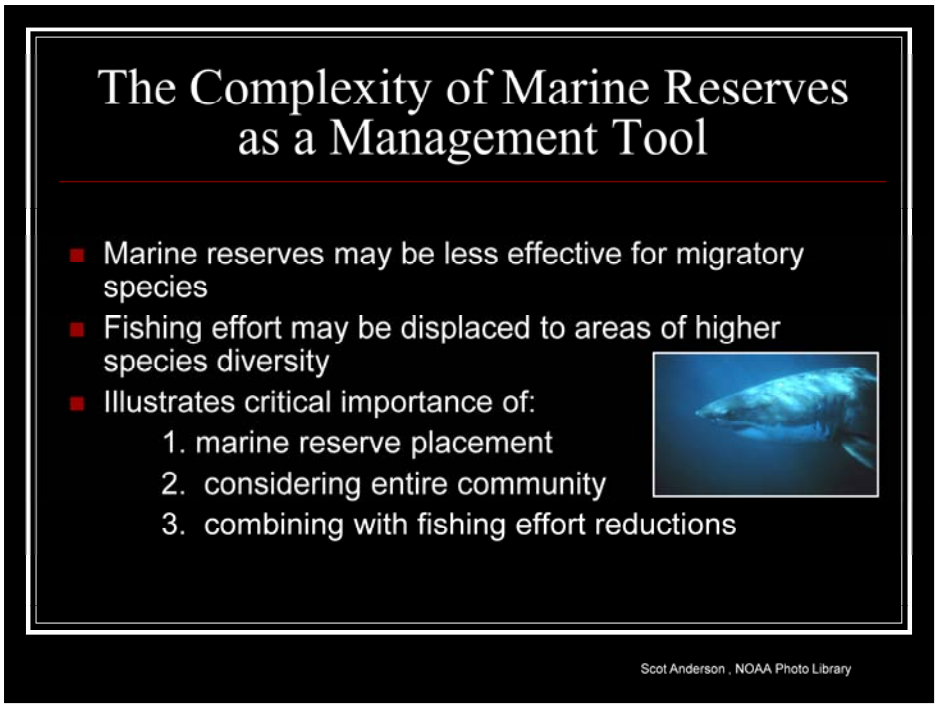


Conch's are shelled mollusks that are harvested for human consumption, fish bait and for the shell trade. The queen conch (shown in inset here) is in decline throughout its range due to overfishing and poaching. Conch harvest in the U.S. is now prohibited.

This figure illustrates the role of marine reserves in conch reproduction (density of the youngest conch larvae is highest inside the reserve) and dispersal (density of older conch larvae). Larvae are dispersed from inside the reserve to outside the reserve by ocean currents.



Nassau groupers are one of the signature species of the reserve. This graph provides evidence that spillover of adult fish is occurring from the reserve to non-reserve areas. Grouper biomass was highest inside the reserve and progressively decreased as distance from the reserve increased. Groupers tagged in the park have been found as far as 150 miles away. Local fishers are aware of this relationship and support the establishment of additional reserves.



Marine reserves may not be as effective a management tool for wide-ranging migratory species as they are for more sedentary species. Baum and others used mathematical models to illustrate the effects of closing various areas in the Northwest Atlantic to swordfishing, a highly mobile species pursued by equally mobile fishing vessels.

The results indicated that marine reserves can actually do more harm than good if fishing effort remains the same and is simply shifted to another area. For example, under one scenario, closing an area reduced sea turtle bycatch and protected blue and mako sharks (species of relatively low conservation concern). However, fishing effort simply moved to another area of higher species diversity causing declines in sharks of higher conservation concern.

This illustrates the critical importance of placement of marine reserves. Also, single-species approaches to conservation may have a detrimental effect on the overall community. Management strategies such as establishment of marine reserves will probably be most effective when paired with reductions in fishing effort.

Source:
Baum et al. 2003. Collapse and conservation of shark populations in the northwest Atlantic. Science 299:389-392.
(graphs of data and a map that shows areas in NW Atlantic are available in original article)

See notes slide 26

Notes slide 26

Supporters say that marine reserves will:

1. promote sustainable fisheries and enhance fishery yields by providing 'spillover' of adult fish and 'seeding' of juvenile fish into non-marine reserve areas
2. provide a buffer against errors in traditional fishery management
3. provide reference areas in research for comparison to fished areas
4. protect marine biodiversity including non-commercial species while most traditional fishery methods protect only a few commercially-important species
   In general more diversity = more stability (confirmed by experimental evidence – see Worm, et al, 2006). Stock diversity begets fisheries sustainability. The diversity-stability relationship appears to hold true for fisheries much as it does for populations (genetic diversity → population stability). More species in an ecosystem results in fewer collapses and a quicker recovery from a collapse.
5. help buffer marine ecosystems against other disturbances including overfishing, habitat degradation and global climate change

Global climate change poses a serious challenge to the location and design of marine reserves. Marine reserves that are fixed in location run the risk of becoming obsolete under a global climate change, illustrating the need for an adaptive management approach.

Adaptive management is a strategy that recognizes the complexity and uncertainty involved in managing ecosystems. Given that we have an incomplete understanding of the outcomes of any particular management action, adaptive management promotes considering management activities as "experiments" that require a continuous cycle of planning, implementation, monitoring and evaluation of outcomes. Under adaptive management, management activities (such as establishing marine reserves) are maintained, adjusted or perhaps abandoned based on their effectiveness in reaching management goals.

Most of the points listed above are self-explanatory or have been discussed previously.

The idea of marine reserves as **reference areas** deserves additional explanation. If we are to attempt to restore fisheries and/or marine ecosystems, it is important to have a "yardstick" against which progress can be measured. Functional marine reserves can serve as these reference areas. Without these benchmarks, it is difficult to know if other efforts are successful or not. For example, fish populations may vary due to both natural environmental variation and the direct (fish harvest) and indirect (e.g., habitat degradation due to bottom trawling, bycatch) effects of fishing. Marine reserves provide marine scientists with an area where fish population fluctuations are due to natural environmental variation alone for comparison with non-reserve areas where population fluctuations are due to a combination of natural variation and fishing effects.

The recreational opportunities and the economic benefits that go with them provided by marine reserves in some areas should also be mentioned. Scuba diving, for example, in the coral reefs of the Florida Keys and the kelp forests of central California, attract large numbers of tourists.

See notes slide 27

Notes slide 27

Not everyone agrees that marine reserves should be established as part of a comprehensive fishery management plan. Most arguments center around the socioeconomic impact to fishermen and the potential for fishing effort to shift into other areas.
Detractors of marine reserves contend that:

1. Benefits of marine reserves are controversial and have not been conclusively demonstrated. Particularly, the evidence for spillover and seeding to non-reserve areas is not compelling. Also, a related argument is that research on marine reserves in the tropics is not applicable in temperate waters.
2. Sustainable fisheries management is better obtained by controls on fishing effort – the only way to end overfishing is to fish less
3. Size of marine reserves must be carefully matched to movement of target species to get maximum benefit in sustained yield
4. Adding marine reserves to a fishery regulated by catch quotas will require that the quota be reduced
5. Adding a marine reserve to a fishery will reduce the area that can be fished. This reduction will not be compensated for by the benefits of marine reserves.
6. Marine reserves are not a 'cure-all' that will address all marine conservation problems
7. The evidence that marine reserves provide benefit to fisheries outside the boundaries is less than compelling
8. Marine reserves may shift fishing effort to areas that cannot withstand fishing pressure.
9. Marine reserves could lead to increased seafood imports from countries with fewer restrictions.

To some degree the arguments against marine reserves are based on the tradeoff between short-term economic benefits and long-term conservation (and possibly economic) gains. It is quite possible that measurable benefits from some reserves may not be realized for more than a decade after they are established. Given that the concept of marine reserves is relatively new, there is a significant amount of uncertainty in our understanding of how they will perform. As with ecosystem management in terrestrial systems, an adaptive management approach seems warranted where each reserve is seen as an experiment from which much can be learned. We should be prepared to modify the design of marine reserves if the established goals are not being achieved.

See "Suggested Classroom Activity" for one way to introduce students to the various viewpoints people have on marine reserves.

Marine Reserves:

- are a type of marine protected area that excludes all extractive activities including fishing
- can be a useful management and conservation tool
- provide benefits both within and outside their boundaries
- cover only 0.01% of ocean area
- must be designed with both conservation and socioeconomic factors in mind
- should be used in conjunction with other management tools

Partnership for Interdisciplinary Studies of Coastal Oceans

See notes slide 28

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Marine Reserves Summary
Marine reserves:

- are the most restrictive type of marine protected area that excludes all extractive activities including mining, oil extraction and fishing.
- can be a useful management and conservation tool.
- provide benefits both within and outside their boundaries – increased biomass, density, diversity and size of species inside reserves have been documented. Spillover and seeding are expected for adjacent non-reserve areas.
- cover only 0.01% of ocean area.
- must be designed with both conservation and socioeconomic factors in mind. The establishment of marine reserves is often a contentious process. Stakeholders must be willing to accept short-term economic loss for long-term conservation (and perhaps economic) gain.
- should be used in conjunction with other management tools. It should be noted that marine reserves are not designed to be implemented in the absence of other regulations. Marine reserves are not the final answer to fisheries decline and marine conservation in general. They should be established as part of a broad ecosystem-based management plan that also includes other, more conventional management tools such as quotas, reduction in fishing effort, gear restrictions and seasonal closures.

Marine reserves cannot solve all marine conservation problems. Overfishing and ocean pollution for example are not likely to be addressed by implementing a network of reserves. However, when integrated with other fishery management practices such as temporary fishery closures, and other traditional fishery management methods, they hold promise for both improving marine biodiversity and sustaining fisheries.

For additional information on the scientific basis of marine reserves, see the Partnership for Interdisciplinary Studies of Coastal Oceans (www.piscoweb.org).

This on-line video, available in 8, 2-4 minute segments provides an excellent explanation of our current state of knowledge on marine reserves. The video may be used as a summary of the main points in this presentation or as a stand-alone overview on marine reserves.

Segments are as follows:

1. Introduction
2. Changing perspectives
3. Many problems, one tool
4. The evidence
5. Rate of change
6. Spillover and export
7. Reserve networks
8. Conclusion

Photo Credits

- National Oceanic and Atmospheric Administration (NOAA)
- NOAA Fisheries: D. Rorcucci, Chantell Royer, Matt Wilson/Jay Clark
- NOAA Photo Library, Scot Anderson
- Northeast Fisheries Science Center
- OAR/National Undersea Research Program (NURP); Alaska Dept. of Fish and Game
- Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO)

Suggested Classroom Activity

The establishment of marine reserves is often a long, sometimes contentious process that concerns many stakeholders. This has certainly been the case in Oregon. In an effort to introduce students to the various viewpoints of individuals involved in the controversy, a "town meeting approach" may be used in the classroom. In this approach, students select a stakeholder they wish to represent during a town meeting moderated by the instructor. For the marine reserves issue, stakeholders may include various commercial fishing interests, recreational fishers, environmental groups, government regulators, fisheries biologists, and local businesses (particularly those connected to the fishing and tourism industries). The objective of the activity is to air the viewpoints of all interested parties, and then to discuss different management solutions and how to resolve conflicts between different stakeholders. This approach is more fully described in the NCSR module entitled, *Town Meeting: An Approach to Exploring Environmental Issues*.

Resources

The literature on marine fisheries declines is voluminous and scattered. I have tried to organize resources such that they will serve a variety of instructor needs. There has been a concerted effort to emphasize those print and web resources that provide the most recent and easily accessible information. Selections from journal articles are primarily from readily available journals (e.g., *Science*, *Nature*) and from the "secondary literature" (e.g., *Scientific American*, *Bioscience*) rather than the less accessible and more detailed "primary literature" found in fisheries journals.

I. Marine Reserves Resources

Allsopp, M., et al. 2007. Oceans in Peril: Protecting Marine Biodiversity. WorldWatch Report 174, WorldWatch Institute, Washington, D.C. 56 pp.

This document published by the environmental group WorldWatch Institute, *is a general treatment of biodiversity issues in our oceans. Fisheries issues and proposed solutions are well-covered in the publication in addition to marine pollution, climate change and ocean acidification.* WorldWatch *adds its voice to the many who have proposed an ecosystem-based approach to ocean management. Strong protection of marine ecosystems with a well-enforced network of marine reserves is the centerpiece of their vision for future management.*

Baum, et al. 2003. Collapse and conservation of shark populations in the northwest Atlantic. Science 299:389-392.

Balmford, A. et al. 2004. The worldwide costs of marine protected areas. Proc. Nat. Acad. Sci. 101:9694-9697.
www.pnas.org

Botsford, L.W., D.M. Kaplan and A. Hastings. 2004. Sustainability and yield in marine reserve policy. American Fisheries Society Symposium 2004.

Easton, T.A. 2007. Taking sides: Clashing views on environmental issues, 12th ed. McGraw-Hill Co., Inc Dubuque, IA. 362 pp.

This widely used publication presents opposing viewpoints on a wide variety of environmental issues. Issue #25 (pp. 260-276) in this edition presents the views of Robert R. Warner, professor of marine ecology at University of California at Santa Barbara who supports the establishment of marine reserves and Professor Michel J. Kaiser (University of Wales), who argues that limiting fishing effort is a more effective way to manage fisheries. The publisher maintains a web site for educators designed to support classroom use of this resource at www.mhcls.com/takingsides/.

Ecosystem Principles Advisory Panel. 1999. Ecosystem-based fishery management: A report to Congress by the Ecosystem Principles Advisory Panel, National Marine Fisheries Service, Washington, D.C.

Halpern, B. 2003. The impact of marine reserves: Do reserves work and does reserve size matter? Ecol. Appl. 13:17-37.

Hastings, A. and L.W. Botsford. 1999. Equivalence in yield from marine reserves and traditional fisheries management. Science 284:1537-1538.

Hooker, S.K. and L.R. Gerber. 2004. Marine reserves as a tool for ecosystem-based management: The potential importance of megafauna. BioScience (Jan 2004).

Joint Nature Conservation Committee
http://www.jcc.gov.uk/page-1576

This document describes the ecosystem-based approach to fisheries as envisioned by this British conservation agency. It includes a brief history of ecosystem-based fishery management and some general guiding principles for its implementation.

Link, J.S. 2002. What does ecosystem-based fisheries management mean? Fisheries 27:18-21.

Marine Fish Conservation Network
www.conservefish.org/site/catch06/index.html

The Media Center on this web site has a number of reports that cover most aspects of fisheries conservation issues from the perspective of an environmental group dedicated to marine conservation.

Marine Protected Areas of the United States
http://mpa.gov/

This site is managed jointly by the National Oceanic and Atmospheric Administration and the Department of the Interior. Information and additional resources concerning the U.S. system of marine protected areas is provided.

McLeod, K.L., et al. 2005. Scientific consensus statement on marine ecosystem-based management. Signed by 221 academic scientists and policy experts with relevant expertise and published by the Communication Partnership for Science and the Sea. 21 pp.
http://compassonline.org/?q=EBM

Mumby, P., et al. 2006. Fishing, trophic cascades and the process of grazing on coral reefs. Science 311:98-101.

This article describes the results of research on marine reserves in the Caribbean.

National Center for Ecological Analysis and Synthesis. University of California, Santa Barbara.
www.nceas.ucsb.edu

This center conducts research on marine reserves and has published a concise statement of the scientific consensus on marine reserves.

National Fisheries Institute
www.aboutseafood.com

The National Fisheries Institute is a U.S. seafood industry trade group. In addition to promoting the marketing and consumption of seafood, the group also provides an industry perspective on fisheries issues. Several concise "Position Papers" are available that describe the industry's position on fisheries management, bycatch, ocean sustainability and ecosystem-based management.

NOAA National Marine Sanctuaries
www.sanctuaries.nos.noaa.gov

This site describes the U.S. marine sanctuary system. It is important to note that while "marine reserves" generally prohibit all extractive activities including fishing, "marine sanctuaries" generally allow fishing but prohibit other extractive activities such as offshore oil development. Sometimes marine reserves are imbedded within marine sanctuaries.

Norse, E.A. 2004. Marine reserves: The best option for our oceans? Ecological Society of America 495-502.
www.frontiersinecology.org

This collection of essays on the merits of marine reserves represents the mosaic of opinions on this controversial fishery management tool. Representatives from conservation organizations, the fishing industry, government and academia are included.

NRC. 1999. National Research Council. Sustaining Marine Fisheries. National Academy Press, Washington, D.C.

Palumbi, S.R. 2003. Marine reserves: A tool for ecosystem management and conservation. Pew Oceans Commission, Washington, D.C.
www.pewtrusts.com

Partnership for Interdisciplinary Studies of Coastal Oceans (PISCO). 2007. The science of marine reserves (2nd edition, United States Version) 22 pp.
www.piscoweb.org/

PISCO is a marine research program conducted by scientists from four West Coast universities. This site presents our current scientific understanding of marine reserves including summaries of the results of monitoring efforts in marine protected areas. Links to many other resources are provided. There is also an on-line video version of the document (available in eight 2-4 minute segments) on the PISCO web site.
www.piscoweb.org/outreach/pubs/reserves

Pew Oceans Commission. 2003. Marine reserves: A tool for ecosystem management and conservation. Pew Oceans Commission, Arlington, VA.
www.pewoceans.org or www.pewtrusts.org

This is an excellent review of marine reserves.

Pikitch, E., et al. 2004. Ecosystem based fishery management. Science 305:346-347.

This brief summary article, authored by 17 prominent fisheries scientists, provides a useful entry into the principles of ecosystem-based fishery management.

Roberts, C., et al. 2001. Effects of marine reserves on adjacent fisheries. Science 294: 1920-1923.

Roberts, C.M., J.P. Hawkins and F.R. Gell. 2005. The role of marine reserves in achieving sustainable fisheries. Phil. Trans. of the Royal Society of London 360:123-132.

Sobel, J. and C. Dahlgren. 2004. Marine reserves: A guide to science, design and use. Island Press, Washington, D.C.

This is a comprehensive general text on marine reserves that includes examples of implementation, rationale for their use and evidence of success.

Sumaila, U.R., et al. 2007. Potential costs and benefits of marine reserves on the high seas. Marine Ecology Progress Series 345:305-310.

Tupper, M.H. 2002. Marine reserves and fisheries management. Science 295:1233.

Wickstrom, K. 2002. Marine reserves and fisheries management. Science 295:1233.

Wood, L.J., L. Fish, J. Laughren and D. Pauly. 2008. Assessing progress towards global marine protection targets: shortfalls in information and action. Oryx 42:340-351.

Worm, B., et al. 2006. Impacts of biodiversity loss on ecosystem services. Science 314(5800):787-790.
http://www.sciencemag.org/cgi/content/abstract/314/5800/787

This article documents the effects of closures and marine reserves on diversity, ecosystem stability, tourism and other ecosystem services. The diversity-stability relationship is confirmed by experimental evidence.

Worm B, et al. 2007. Biodiversity loss in the ocean: How bad is it? Response. Science 316:1282-1284.
http://myweb.dal.ca/bworm/Worm_etal_2007a.pdf

This interesting exchange among fisheries scientists concerning the loss of all seafood species by 2048 also includes an account of the recovery of haddock after emergency closures on Georges Bank in 1992.

See the following web sites for information on Oregon's efforts to establish marine reserves within the territorial seas of that state:

www.greenfireproductions.org/oceansonline/common_ground/cg_screen_dates.html
www.oregonmarinereserves.net
www.ouroregonocean.org

II. Resources For Digital Images

There are a number of web-based sources for fisheries-related digital photos that instructors can use to augment NCSR fisheries modules. Most of those listed below allow educational use of their images without seeking copyright permission as long as proper acknowledgement is presented along with the photo. However, instructors should check the documentation on each web site and follow the required procedure for use.

ARKive – Images of Life on Earth
www.arkive.org

This web site provides useful biological and conservation information (description, status, range, habitat, threats and conservation) on a wide variety of species as well as images and short video clips.

FishBase – A Global Information System on Fishes
www.fishbase.org

FishBase *is a huge relational database that emphasizes the biological characteristics of nearly all fish known to science. Photos and other media are available for download.*

MarineBio
www.marinebio.org

A comprehensive conservation-based site that includes links to multimedia (video and images) for a number of commercially important fish species.

Marine Photobank
www.marinephotobank.org

This SeaWeb-*sponsored web site provides access to a great deal of fisheries-related information that is useful to instructors including publications, links to other sites and a "marine photo bank." The images in the photo bank are free for non-commercial use and would be useful to develop in-class presentations. All aspects of fisheries are portrayed in these images including fishing methods, aquaculture, marine species of concern, bycatch and marine protected areas.*

Northeast Fisheries Science Center
www.nefsc.noaa.gov

This regional center of the National Marine Fisheries Service provides all of the original line drawings from the "Bible of New England Fisheries," Fishes of the Gulf of Maine.

NOAA Ocean Explorer
http://oceanexplorer.noaa.gov/gallery/gallery.html

This site includes visual and audio material from NOAA Ocean Explorer expeditions. There are videos, podcasts, slideshows and audio files available. Files are organized into several categories including: maps, living ocean, sound in the sea, cultural heritage, history, technology, explorers and a YouTube video playlist.

NOAA Photo Library
www.photolib.noaa.gov/collections.html

This site, maintained by the National Oceanic and Atmospheric Administration, is a government site with several image collections relevant to fisheries. Instructors will find the following collections particularly useful:

The National Undersea Research Program
National Marine Sanctuaries
Fisheries
National Marine Fisheries Historical Image Collection

III. Video Resources

America's Underwater Treasures. 2006. Jean-Michel Cousteau Ocean Adventures. DVD 120 min.
PBS Home Video
1-800-PLAY PBS
www.pbs.org

This two-part, two-hour production examines all 13 of the U.S. National Marine Sanctuaries. Their role in the conservation of marine biodiversity is emphasized including their role in the recovery of marine fish stocks.

PBS also maintains a web site (www.pbs/kqed/oceanadventures/episodes/treasures/) *that provides links to the National Marine Sanctuary web site, live underwater video feeds and additional information on the marine sanctuary system.*

A Sheltered Sea – The Journey of the California Marine Life Protection Act. 2008. The Baum Foundation. 23 min.
www.thebaumfoundation.org
Distributed by Coyote Films
www.coyotefilms.net

This short film describes the establishment of a network of marine reserves off the California Coast beginning with the passage of the California Marine Life Protection Act in 1999. The rationale behind the network and its design are discussed as well as some of the controversy it generated. The viewpoints of major stakeholders are provided. The video will be of particular interest to those who teach in California, but the issues discussed are relevant to marine reserves anywhere.

A Sheltered Sea – The Southern Passage. 2009. The Baum Foundation. 25 min.
www.thebaumfoundation.org
Distributed by Coyote Films
www.coyotefilms.net

This film is a companion to the one described above. It provides more detail on the rationale for establishing a network of marine reserves off the southern California Coast. Interviews and historical photos are used to document the abundance of marine life in the past, which is then compared to the current condition. The importance of kelp forests as a diverse habitat supporting fish, marine mammals and marine invertebrates is illustrated with video of excellent quality. Although the film clearly supports the establishment of marine reserves, several different viewpoints are presented.

Common Ground I: Oregon's Oceans. 2005. Green Fire Productions. DVD 28 min.

Common Ground II: Oregon's Ocean Legacy. 2007. Green Fire Productions. DVD 15 min.

Common Ground III: Oregon's Network of Marine Reserves and Marine Protected Areas. 2009. Green Fire Productions. DVD 18 min.

This series of three short films describes the rationale behind the establishment of a network of marine reserves off the Oregon Coast. The viewpoints of several stakeholders are presented including marine biologists, recreational fishermen, commercial fishermen, small business owners and conservationists. The latest scientific information on the effectiveness of marine reserves is also included. The DVDs can be ordered for $15 each (or $20 for the entire set) from www.oceansonline.org. *Brief excerpts are also available on-line for preview.*

Deep Crisis. 2003. Scientific American Frontiers. VHS 57 min.
PBS Home Video
1-800-PLAY PBS
www.pbs.org

This one-hour Scientific American Frontiers *production, narrated by Alan Alda, is conveniently divided into three equal segments of approximately 20 minutes each. The first addresses salmon in the Pacific Northwest with an emphasis on new technologies being used at hydroelectric dams on the Columbia River to monitor salmon populations and reduce impact. The second examines recovery efforts for Atlantic salmon in Maine including captive breeding of wild stocks and their re-introduction into Maine rivers. The third segment describes current research on Atlantic bluefin tuna using tagging technology and aerial surveys to monitor tuna population sizes and migration patterns.*
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES.*

Empty Oceans: Global Competition for Scarce Resources. 2004. DVD 30 min.
Films for the Humanities and Sciences
1-800-257-5126
www.films.com

This video illustrates the social and economic consequences of marine fishery declines. An emphasis is placed on the international aspect of the issue with examples from West Africa, Japan, Spain and Canada. A short video clip of the film can be seen on the distributor's web site.

Empty Oceans, Empty Nets. 2002. Habitat Media. VHS/DVD 57 min.
734 A Street
San Rafael, CA 94901
415-458-1696
www.habitatmedia.org

This one-hour video explores most aspects of commercial fisheries from several perspectives including commercial fishers, fishery scientists and concerned citizens. It is probably the most comprehensive, high quality video production on this topic. Case studies of the Atlantic cod, salmon, bluefin tuna and swordfish are provided. The ecological impact of commercial fishing is emphasized but there is also good coverage of proposed solutions and success stories. Current efforts to restore fisheries, protect essential fish habitat and implement market-based solutions are included.

A low-cost ($12) edited version of this production is now available for educators. An activity guide that describes six student exercises linked to this video production is also available on the Habitat Media web site. Although designed primarily for high school students, several of these exercises could be adapted for college-level courses. (Available at www.habitatmedia.org/educators.html)

The *Marine Fisheries Series Activity Guide* can be accessed at:
www.pbs.org/emptyoceans/educators/activities.html
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES*.

Fate of the Ocean – Our Threatened Fisheries. 2005. VHS/DVD Two 30 min. programs
Films for the Humanities and Sciences
1-800-257-5126
www.films.com

This two-part series takes a global view of the issue of declining fisheries. A wide range of examples are examined from around the world. The first program, Plundering the Oceans, *explains the general nature of fishery declines using examples from India, the Mediterranean and the North Atlantic (cod and tuna). The second program,* Protecting the Oceans, *describes examples of sustainable fishing practices, some of which may be used as models for large-scale reform of fishing policy. Examples from the Canary Islands, Oman and Great Britain, including marine reserves, ecotourism and aquaculture are used to illustrate. A sample video clip and a detailed outline of the videos are available at the distributor's web site.*

Farming the Seas. 2004. Habitat Media. VHS 56 min.
734 A Street
San Rafael, CA 94901
415-458-1696
www.habitatmedia.org

This 1-hour video production addresses the many issues surrounding aquaculture - the cultivation of fish and other marine organisms. General issues are discussed and specific case studies are provided from the United States (bluefin tuna), Canada (salmon), China (carp) and Thailand (shrimp). The notes that follow provide a summary of the content of the Farming the Seas *video production. Approximate elapsed time is given at the beginning of each section to facilitate the selection of excerpts or other planning.*
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES.*

Fisheries – Beyond the Crisis. 1998. The Nature of Things. VHS 46 min.
Bullfrog Films
P.O. Box 149
Oley, PA 19547
610-779-8226
www.bullfrogfilms.com

This production, hosted by David Suzuki, examines community responses to the decline of marine fisheries in the Bay of Fundy, Canada and in southern India. Both communities opposed a quota system of management and demanded a locally controlled, ecosystems-based approach to achieve long-term sustainability of the fisheries and the communities they support.

Fish for today, fish for tomorrow. 2008. Marine Stewardship Council. On-line 8 min.
www.youtube.com

This short "You tube" *video describes the rationale and process for Marine Stewardship Council certification of seafood.*

A Fish Story. 2007. Public Broadcasting Service - Independent Lens. DVD 54 min.
www.pbs.org/independentlens/fishstory
www.pbs.org/independentlens/fishstory/updates2.html

This video production is most appropriate for those instructors who would like to present the social impacts of fishery declines. The plights of two Massachusetts fishing families are followed, one from Gloucester and the other from Chatham, during a time of increased regulation and declining fish stocks.

An update is provided by the Northeast Seafood Coalition, a non-profit organization that represents commercial fishermen, fishing-related business owners and fishing community members. A representative of the coalition describes how fishing regulations implemented after the collapse of the groundfish fishery are affecting the fishing industry.

Gutted: The Demise of Scotland's Fishing Industry. 2005. Wide Angle. DVD 57 min.
Films for the Humanities and Sciences
1-800-257-5126
www.films.com

This one hour documentary depicts the social impacts of fishery declines on a community in Scotland. Much like the situation in New England, overfishing of cod and other species in the North Sea, followed by government restrictions on fishing, decimated local economies. A short video clip of the film can be seen on the distributor's web site.

Has the Sea Given Up Its Bounty? 2003. New York Times. 10 min.
www.nytimes.com/packages/khtml/2003/07/29/science/20030729_OCEANS_FEATURE.html

This is an interactive video feature developed by Andrew Levin of the New York Times on the effects of bottom trawling and overfishing on the world's oceans. Brief video segments, animations and diagrams are used to illustrate. There is also an associated NY Times article.

Journey to Planet Earth – The State of the Ocean's Animals. 2007. PBS. DVD 60 min.
www.pbs.org/journeytoplanetearth/about/purchase.html
PBS Home Video
1-800-PLAY PBS

This PBS production addresses global marine conservation issues including several that are related to marine fisheries. Short segments that highlight the Atlantic cod fishery off the New England coast, the impacts of industrial fishing on traditional fisheries in Senegal, Africa, the decline of shark populations and the salmon fishery in the Klamath Basin, Oregon are included. Other segments describe conservation issues concerning sea turtles, dolphins and sea otters.

Journey to Planet Earth – The State of the Planet's Oceans. 2009. PBS. DVD 60 min.
www.pbs.org/journeytoplanetearth/about/purchase.html
PBS Home Video
1-800-PLAY PBS

The Journey to Planet Earth *series (hosted by Matt Damon) is designed for a general audience and addresses a number of current environmental issues. This episode examines marine issues with an emphasis on global climate change and overfishing.*
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES*.

The Long View: A Plan to Save Our Ocean Fish. 2006. Marine Fish Conservation Network
Web-based. 12 min.
www.conservefish.org/site/catch06/index.html

This conservation-based site includes a downloadable 12-minute video that provides a good overview of the U.S. fisheries management situation from the perspective of an environmental organization dedicated to marine conservation.

New Whiting Fishery in Newport. 2000. Oregon Field Guide. VHS/DVD 15 min.
Oregon Public Broadcasting Productions
7140 SW Macadam Ave.
Portland, Oregon 97219-3099
1-800-241-8123
www.opb.org

This short Oregon Field Guide *segment describes the development of a new trawl fishery off the Oregon Coast for Pacific whiting.*

Net Loss – The Storm Over Salmon Farming. 2003. Moving Images Video. DVD 52 min.
Bullfrog Films
P.O. Box 149
Oley, PA 19547
610-779-8226
www.bullfrogfilms.com

This video production examines the risks and benefits of "net pen" salmon farming, a type of aquaculture used in Washington and British Columbia in which salmon are raised in giant underwater cages. While decades of past management failures have caused the decline of many wild salmon populations, salmon farming is seen as a sustainable method for providing fish for markets. This video production examines the controversy surrounding salmon farms and the threat they pose to wild salmon. The perspectives of salmon farmers, conservationists, traditional fishermen and government officials are portrayed.

Oceans and Marine Life – Marine Video and Animation
National Environmental Trust
www.net.org/marine/video.vtml

This environmental organization posts on-line video clips (or links to clips on other sites) concerning fisheries issues. Short (2-3 minute) videos include:

- *"Take a Pass on Chilean Sea Bass" – a humorous depiction of seafood choices made by consumers in a restaurant*
- *"Overfishing Animation" – an illustration of the global decline of large, predatory fish over the past 50 years (based on data from Myers and Worm, 2003)*
- *"Small Fish, Big Problem" – a humorous depiction of shifting baselines*

Over-exploiting the Oceans – The Dangers of Overfishing. 2007. VHS/DVD 47 min.
Films for the Humanities and Sciences
1-800-257-5126
www.films.com

This video production examines the environmental and socioeconomic impacts of overfishing from a global perspective. Ancient artisanal fishing practices are contrasted with large-scale modern fishing techniques used in the oceans off the African coast. International economic and political factors are also examined. A sample video clip and a detailed outline of the video are available at the web site above.

Resources Assessment and Conservation Engineering – Field Videos
Alaska Fisheries Science Center
NOAA Fisheries
www.afsc.noaa.gov/race/media/videos/vid_habitat.htm

Underwater video has been used in an attempt to evaluate benthic habitats and the impacts of bottom trawls on those habitats. The Alaska Fisheries Science Center of NOAA Fisheries has posted a number of on-line video clips that illustrate the impacts of various types of fishing gear.

Strange Days on Planet Earth. 2004. Episode #3 – Predators. National Geographic Television and Film. Vulcan Productions, Inc. DVD 20 min.
www.nationalgeographic.com
www.pbs.org
1-800-PLAY-PBS
This video is divided into three segments of roughly equal length. Each segment describes the intricate relationships between fish populations and other environmental phenomena. In the first segment, historical archives are used to describe how the decline of large African mammals is related to the availability of fish in Ghana. As fish populations decline, hunting for "bush meat" increases to compensate for the loss of protein in the diet. Conversely, when fish numbers increase, hunting declines and wildlife populations rebound. The second segment establishes a connection between fish kills on the coast of Namibia and the release of large amounts of hydrogen sulfide from marine sediments. The hydrogen sulfide deposits appear to have resulted from the decomposition of phytoplankton, which flourished after sardine populations were depleted by foreign fishing fleets in the 1970s. The final segment examines various proposals for achieving sustainable fisheries management. Marine reserves and aquaculture (integrated aquaculture and open access "Aquapods") are emphasized.
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES*.

Strange Days on Planet Earth. 2008. Episode #5. National Geographic Television and Film. Vulcan Productions, Inc. DVD 60 min.
www.nationalgeographic.com
www.pbs.org
1-800-PLAY-PBS
DETAILED NOTES ON THIS VIDEO ARE AVAILABLE IN THE *COMPREHENSIVE RESOURCES FOR NCSR MARINE FISHERIES SERIES*.

Weather the Storm: The Fight to Stay Local in the Global Fishery. 2008. DVD 37 min.
Bullfrog Films
P.O. Box 149
Oley, PA 19547
610-779-8226
www.bullfrogfilms.com

This production by the Ethnographic Film Unit at the University of British Columbia presents the case for supporting small-scale, artisanal fisheries as part of a global sustainable fisheries strategy. In contrast to industrial floating fish factories that deplete fish stocks and then move to other areas, artisanal fisheries serve local communities and can readily adapt their fishing methods to changing local conditions. Small-scale fisheries from around the world are described, but the emphasis is on the ground fishery (cod, haddock and halibut) off the west coast of France. Although the film is narrated in English, much of the conversation among fishermen, community members and others involved in the industry is in French with English subtitles.

Where's the Catch? 2005. VHS/DVD 26 min.
Films for the Humanities and Sciences
1-800-257-5126
www.films.com

This video examines fisheries in the Pacific Islands (Fiji, Kiribati and the Marshall Islands) emphasizing the impacts of fishery declines on subsistence and commercial fisheries. The roles of modern indiscriminate fishing techniques, illegal fishing, and government corruption and their impact on Pacific Island culture are illustrated. A sample video clip and a detailed outline of the video are available at the web site above.