

3.0 RESEARCH: PR ECONOMIC RESEARCH BY NMFS ECONOMISTS

During the second day of the workshop, economists presented their research. This gave the group an understanding of the various research questions economists pursued independently while conducting mandatory economic analyses in support of PR regulatory actions. The day ended with a special presentation arranged by Rebecca Lent on the Vaquita, the most critically endangered cetacean in the world (Section 3.11). We had an opportunity to discuss this case collectively and brainstorm some potential (human behavioral) paths forward to assist in the recovery of this animal.

The format for this session was open-ended in the sense that some economists presented one research project, while others presented the highlights of several projects. The chosen presentation format may link to the amount of time an individual has been working with protected species. The paragraphs that follow for each presentation are based on notes taken during the meeting with the actual Microsoft PowerPoint presentations included in the Appendices.

3.1 Spill-over Effect of Sea Turtle Regulations in Hawaii Longling Fisheries

Dr. Minling Pan, Economist with the Pacific Island Fisheries Science Center (Appendix D1).

- Following the 2001-2004 closure of the domestic swordfish fishery, gear regulations and sea turtle interaction caps (17 loggerheads and 16 leatherbacks) were established upon its reopening. In general, tight caps can lead to an unstable fishery and sudden closures create bad market conditions for swordfish. At first, trade-offs were examined by modeling predicted net revenues and loggerhead interactions for different closure options. Proposed seasonal area closures were not adopted, probably because the area to be closed would vary and be difficult to monitor year to year due to the inter-annual variability of turtle migrations. Instead, information on hotspot areas (based on temperature) was published and a voluntary avoidance was requested. However, it did not work well since the turtle shares the hotspot with fish. Science Center economists were then asked to look at spillover effects of the US swordfish closure, including whether the turtle conservation goal was achieved, and if foreign fisheries displaced domestic catch, resulting in an import increase and more turtle interactions overall.
- Prior to closure, Hawaii production supplied a large percentage of swordfish domestically consumed in the US. In this study, we provide a quantified estimate of the possible spillover effects resulting from the aforementioned regulations based on two

perspectives. First, this study estimates the spillover effect resulting from market replacement as U.S. swordfish consumption shifts from domestic production to foreign imports as a result of the domestic fishery closure. Subsequently, we estimated the spillover effects of the production displacement by the competitors in the specific ocean area where the Hawaii shallow-set longline swordfish fishery operates. Results indicate foreign production does respond to changes in domestic production, so reducing Hawaii swordfish production might not actually result in lower level of sea turtle bycatch overall in the Pacific Ocean. The Hawaii shallow-set longline swordfish fishery has one of the lowest sea turtle bycatch rates among the fleets fishing in the North and central Pacific. In other words, higher Hawaii swordfish production reduced sea turtle bycatch. Additionally, a much larger drop in turtle interactions could occur if the Hawaiian gear method was adopted by other countries. The new BiOP (incorporated results from this study) led to turtle cap increase (leatherback from 16 to 26 and loggerhead from 17 to 34). See Chan and Pan (2012) for details.

3.2 Risk Pools for Managing Bycatch

Dan Holland, NWFSC Economist (Appendix D2)

Individual bycatch quotas may be a much more effective and efficient way to control bycatch in fisheries than imposing technological prescriptions, area closures or aggregate catch caps. However, when bycatch events are rare and highly uncertain individual quotas may be problematic. Two potential problems with an Individual Transferable Quota (ITQ) for rare bycatch are that the market may not work because people are risk averse and prudent which may cause them to hoard quota, and secondly, even if the market does work efficiently, it may subject fishermen to substantial financial risk. A natural solution is to spread the risk across a pool of fishermen. Risk pools, in which self-selecting groups of fishermen pool their bycatch quota and cooperate to manage bycatch can substantially reduce financial risk, but if not well designed can undermine incentives to avoid bycatch. For example, people in a low risk area will not want to pool with those in a high risk area; therefore, smaller regional risk pools might make sense. Risk pools are essentially insurance products and need to address moral hazard and adverse selection issues that are common to insurance products. Three risk pools operated in 2011 for the West Coast Groundfish ITQ. Monetizing bycatch quota was avoided by not charging a price for withdrawals. There was a set of defined best practices for minimizing bycatch risk (e.g., require short test tows, delineate areas). Quota pounds for bycatch species were all transferred to a holding vessel and access to that quota for large bycatch events was contingent on whether the vessel was compliant with risk pool rules. Carryover rules for quota could reduce individual and pooled risk. Multi-year TACs would also reduce risk but are not allowed under current US law. If it makes sense, it enables a risk pool to control free-riders by threats of exclusion and contingent access to quota rules. See Holland (2010) and Holland and Jannot (2012) for details.

3.3 Unilateral Conservation of Transboundary Resources: West Coast Swordfish & Pacific Sea Turtles

Dale Squire, SWFSC Economist (Appendix D3).

This study shows that areas off the US California coast closed to the driftnet fishery led to displacement of US domestic catch by foreign catch and also increased sea turtle bycatch. There was a loss in net benefits to the U.S.; a loss to consumer welfare (\$15M) as well as lower producer surplus (\$10M). As much as a \$75M loss in consumer surplus was associated with WTP to avoid increased turtle catch that resulted from displacement.

The trick is modeling the counterfactual, so we used an inverse demand model with substitution. We observed the fishery under the ESA action (a closure) and needed a counterfactual model which represents the fishery if the ESA action (i.e., no closures) was not in place. Equilibrium functions in the inverse demand model allow adjustments to declines in local production of swordfish (CA driftnet) and shocks through (1) increased foreign and Hawaiian imports; (2) substitution to domestic west coast longline and harpoon-caught swordfish; and (3) substitution to west coast albacore tuna. Using a vector auto-regression we predict changes in imports resulting from increases in prices as a result of lower domestic production. Harpoon caught swordfish was not a substitute for driftnet as it cannot fill consumption gap, and it was also unprofitable, with longline profits negative for 2008-2010. There is a longline counterfactual being done as well and is in progress.

Counterfactual estimates for sea turtle bycatch showed an annual leatherback bycatch rate of 1.51 turtles where closure reduced drift gillnet rate by 3.78 turtles per year as a result of reduced *effort (number of sets)*. Not all sea turtle bycatch is created equal. A lot of imports come out of the Eastern Pacific and the population of leatherbacks in that region is in very bad shape, while the Western Pacific is stronger. See Gjertsen et al. (2014) for details.

3.4 Counterfactual Estimates of ESA Regulations on U.S. West Coast Swordfish Fisheries on Pacific Sea Turtle Bycatch

Stephen Stohs, SWFSC Economist (Appendix D4)

The research objective is to use a counterfactual approach to estimate net sea turtle bycatch impacts of unilateral domestic regulation of west coast US swordfish fisheries. There was a large driftnet swordfish fishery closure in the EEZ off much of the California coast since 2001, and a longline closure occurred off the US West coast after 2004. Bycatch rates for swordfish fisheries from foreign fleets are all much higher than pre-closure US rates, particularly in the Eastern Pacific, which had the biggest increase share of swordfish imports. Substitution for decreased west coast production with swordfish imports from foreign fisheries with higher bycatch rates is estimated to result in a net increase in leatherback sea turtle bycatch.

3.5 Regulatory Impacts on Exit from the California Drift Gillnet Swordfish Fishery: A Treatment-Control Duration Model Based Approach

James Hilger, SWFSC Economist (Appendix D5)

Regulatory measures imposed on firms to protect natural resources may lead to firm attrition. This research utilizes a difference-in-differences hazard rate methodology to provide an empirical estimate of the impact of regulatory changes on firm attrition and the number of industry participants. This methodology is applied to fishery regulation implemented on vessels engaged in the CA DGN fishery. The analyses provide a counterfactual fleet size estimate for the counterfactual state of non-regulatory implementation. The duration of initial participation tenure in the fishery, from entrance to exit, is modeled using a duration model approach. The impact of the regulation on tenure duration is estimated by means of a treatment-control approach. Qualitative results are robust across multiple distributional specifications of the duration model and covariate specifications. In a second stage, counterfactual fleet-size estimates are recovered via simulation. Empirical results suggest that the regulation had a significant impact on exit rates and led to a reduction in DGN fleet participant vessels during the period from 2001 to 2010. These findings are consistent with the hypothesis that increased regulatory policies impact fleet participation rates and led to larger exit rates and smaller fleet size.

3.6 Welfare Analysis of the Transition to Catch Share Management

Dr. Min-Yang Lee, NEFSC Economist (Appendix D6).

The analysis examined how much better or worse off the country would have been if the New England groundfish fishery had stayed fishing on the Days-at-Sea (DAS) system instead of moving to the catch share system. We simulated counterfactual catch and value under the DAS system and used an inverse demand model to compute lost consumer surplus. The results indicate we would have been \$33 million worse off with DAS (\$25 million in CS and \$7.5 million in producer surplus). This approach was applied *ex-post* but an *ex-ante* analysis would not have been possible. See Lee and Thunberg (2013) for detail.

3.7 Economic Research in Support of Protected Species

Cameron Speir, Economist, SWFSC Santa Cruz (Appendix D7).

The SWFSC Fisheries Ecology Division (Santa Cruz) economics group currently has several distinct projects involving habitat issues for protected salmon and steelhead species. Some examples include: (1) A theoretical model of groundwater management and in-stream flow that uses a farm-profit optimization approach, subject to instream flow requirements, to examine different spatial and temporal policy options. The non-intuitive result is that under certain drought conditions, water should be allocated to withdrawals closer to the stream because the impact on stream flow is shorter in duration and more controllable. (2) An analysis of a Klamath

Irrigation Project water buyback program showed the price paid to farmers for more in stream flow is much higher than estimated use value of irrigation water. (3) The effect of unconventional oil production (hydraulic fracturing) on water quality is an important and emerging issue in coastal rivers in southern California that contain ESA-listed steelhead trout. (4) The effect of water exports from the San Francisco Bay Delta on the regional agricultural economy. Water management in the Delta is a major focus of NMFS action to protect endangered fish species. We use two methods to estimate agricultural employment impacts from historical water supply reductions: a synthetic control set-up and a structural model of agricultural production. Preliminary results indicate that impacts are smaller than some previous estimates but locally important. See Speir and Stradly (*in review*) and Speir *et. al.* (2015).

3.8 Economic value of precision sampling for marine mammal abundance and bycatch estimates; Compliance and Policy Instruments

Kathryn Bisack, NEFSC Economist (Appendix D8) presented an overview of six economic research studies on protected species:

1. The CEA of gear research relative to a closure, Virginia Chesapeake Bay poundnets and sea turtles, demonstrated the cumulative cost of a gear modification, including gear research costs, was lower than a closure. Gear modifications in the Virginia poundnet fishery were cost-effective relative to the closure (Magnusson et al. 2012).
2. A behavioral model to evaluate closed areas uses a positive math programming (optimization) model. Desirable features of the model are that it focuses on 30 minute squares, estimates changes in harvest by species and area, and can incorporate several policy instruments (days-at-sea, trip limit changes, area closures, gear modifications) simultaneously. Additional research is necessary to incorporate uncertainty and other behavioral responses such as compliance behavior.
3. An investigation of the implication of using ITQs for reducing harbor porpoise bycatch in a multi-species fishery used a numerical bio-economic model incorporating spatial and temporal patterns of abundance and harvest rates of 6 commercial fish species and harbor porpoise. Results indicate that porpoise ITQs, when compared to closures, are more profitable than closures, and distribute effort and profit reductions more evenly across seasons and areas (Bisack and Sutinen 2006).
4. Expanded upon Bisack and Sutinen (2006) to evaluate how a single policy instrument can be used to manage both porpoise and cod. Several programs for porpoise protection can achieve the same conservation outcomes with a modest difference in industry profits. At the industry level, the program selection may then rest on the goal

of cod management. Significant differences in vessel profits, however, may make consensus on the appropriate program difficult (Bisack 2008).

5. Economic value of scientific information was researched in relation to estimating the cost-benefit tradeoffs of improving the precision of the harbor porpoise stock assessments and their impact on the sink gillnet fleet. Results indicated that an increase of \$217,000 in marine mammal data collection resulted in an increase of \$850,000 in fleet profits (Bisack and Magnusson 2014).
6. Factors influencing the pinger compliance decision of a vessel operator/owner (e.g. economic, moral, social and legitimacy factors) are being researched. Bisack and Das (in review) using a probit framework incorporate economic and normative factors to examine compliance behavior of fishermen with regard to pinger regulations. Results indicate a fisherman who had a *history of violations*, a *low detection rate* the previous year, were characterized as a high revenue earners fishing multiple gears were more likely to be non-compliant with pinger regulations (Bisack and Das, in review). There are 4 phases to this compliance study: 2 formal compliance models and 2 years of ground-truthing focus group research.

See Bisack and Sutinen (2006), Bisack (2008), Magnusson et al. (2012), Bisack and Magnusson (2014), and Bisack and Das (in review).

3.9 Using Non-Market Valuation to Value Protected Marine Species: A Review of the Literature

Dan Lew, Economist, Alaska Fisheries Science Center (AFSC) (Appendix D9)

WTP estimates for preservation, enhancements (e.g., population increases and extinction risk reductions), or conservation programs are often ill-defined. The focus of PR species valuation studies is typically on measuring the total economic value of protected species using state preference methods. Criticisms of stated preference methods are generally associated with hypothetical bias. A comprehensive review by Kling, Phaneuf, and Zhang (2012) indicated problems remain with these methods but there has been considerable progress to address them over the decades. The types of species valuations were divided into aggregate and disaggregate valuation studies, with the latter producing individual species values. There are 30 or so disaggregate species valuation studies (5 valuing cetaceans, 11 valuing pinnipeds, and 4 valuing fish). There are several meta-analyses of this literature, including a 1996 Loomis and White review and a 2009 update of that study by Richardson and Loomis. There were only 7 marine T&E studies in the 1996 study and an additional 5 in the 2009 study, which are mostly contingent valuation. The Martin-Lopez et al. (2008) review found 20 marine species valuation studies but there is over-counting. Some recent studies use choice experiments, but there is still contingent valuation work being done. There is a trend toward using web-enabled surveys among recent choice experiment studies. Most studies are in developed countries (many in the US)

where values range from -\$120 to \$350 per household in 2013 dollars. There is a need for more WTP estimates that are policy relevant. A note on coral studies is that they have been primarily done to measure “use values” instead of valuing individual species or total economic value. There is good progress but we need more studies on lesser known species, such as MMPA species, that are not ESA. There are still big questions on valuation; for example, is there a cap on WTP for all species? We need more benefit transfer work and more research on the relationship between conservation, management measures, and regulations. In response to a question about whether preferences really are stable, there is a best practice for information provision.

A discussion centered on pushback from NOAA General Council associated with individual WTP versus WTA, in relation to cultural values. One participant felt that WTP has been accepted but consideration of those cultural aspects would take things out of the realm of individual preferences, with another adding that only in the last ten years has valuing extinction risk been accepted by respondents. It used to be argued that people could not understand and value extinction risk. OMB says that we really need to value critical habitat, not just the species, which can be difficult to do because there is not a tight connection between the critical habitat and recovery probability or extinction risk.

3.10 Economic value of PR

Kristy Wallmo, Economist with NMFS’s Office of Science and Technology (Appendix D10)

This presentation was an overview of NMFS-sponsored protected species non-market valuation studies. Choice experiments were used in all. Issues examined in these studies included: scope sensitivity, warm-glow, hypothetical bias, heterogeneity in WTP, questionnaire design, information effects, and anchoring effects. The Cook Inlet beluga whale study is looking at differences between rural and urban households. In a study of economic values for Steller sea lion, preference and value sensitivity to baseline conditions of the species was examined. The Klamath River study looked at ordering of uses and length of survey. The Protected Species Valuation Study, which valued 16 species over two phases, is being used to examine issues related to scope, differences in preferences and values between species, temporal stability of preferences, influence of cost vectors, and geographic variability of preferences. Multiple focus groups found they could not expect people to value changes to more than 3 species, and only ESA status improvements (not directly on population estimates). Some people wanted to do a little for all the species, but they did find significant differences between species in the survey. Respondents want to know how extinction will impact the ecosystem. The sentiment is OMB is still not keen on valuation work. We need a new blue ribbon panel on choice experiments, as the last one was on contingent valuation.

A discussion arose around the issue of adding up values beyond three species. We can say what a given three species are worth and then as we add on more species there is probably an

increase in WTP, but we can't quantify it with their data models even though they did look at more species than those in the study. The reason we don't include policy instrument in the valuation is that you may get an embedding issue where respondents may value the instrument in addition to the species, though separation may not be possible. In short, respondents are valuing more than the species. Research reported in Lew and Wallmo (2011) provides strong evidence of scope sensitivity--i.e., preferences are sensitive to the amount of the improvement in the species being valued. This means that there is an increase in value for more species than just one, but since the scope test was only done to examine scope effects for up to three species, we cannot determine whether there is a decreasing marginal WTP as you add more species beyond three, although that is what would be expected. See also Mansfield et al. (2012), Wallmo and Lew (2011, 2012), and Lew et al. (2010).

3.11 The Vaquita Case: Potential Buyouts

Sarah Mesnick with the SWFSC (Appendix D11)

The Vaquita may be extinct within three years, as it is down to the last 100 with 30 breeding females. The primary issue is bycatch in a gillnet fishery, which is the legal fishery for blue shrimp and illegal fishery for totoaba. A Vaquita-free shrimp net has been developed specifically for the small vessels they use in the drift gillnet fishery but are not yet in use. We need an immediate and complete closure of the top of the Gulf of California, which will soon be announced. We also need ideas for an incentive package to deal with the problem in the long run, (options include buyouts, market incentive for non-entangling gear, and alternative economic livelihoods). The fishery consists of approx. 900 registered vessels and 2000 people. The blue shrimp are worth \$30 per pound in US. One cooperative to date has adopted the new nets.

A discussion opened around whether captive breeding was an option, but the answer is no. One participant suggested using economic incentives for the community to improve recovery. One option might be a cooperative with exclusive control of fishing in the area. We could also address the consumer demand side of the problem by pressuring US buyers not to buy the shrimp unless caught in the new trawl. The previous gillnet buyout was not well structured. People were bought out and then they got new nets. If a closure is imposed, get the message out to the fishery that it is not permanent, and other options or compensation are coming, otherwise people may end up actively trying to kill the Vaquita to get rid of the problem.

4.0 WORKSHOP RECOMMENDATIONS

The primary objective of the workshop was to provide an opportunity for NMFS economists to discuss PR exclusively and to network on research and issues facing PR. The group agreed this objective was met fully. While recognized as a good start, it was generally agreed that there is more work to be done. An ad-hoc approach has been the typical route taken to determine what is, and is not, being done in relation to economics analyses and research related to PR at NMFS. An alternative would be to follow a more formal process, similar to the