International Journal of ChemTech Research
CODEN (USA): IJCRGG, ISSN: 0974-4290, ISSN(Online):2455-9555
Vol.10 No.4, pp 422-429, 2017

Sustainable Analysis of Yellowstripe Scad Stock in Central Maluku Waters

A. Zaky Marasabessy [1,2] Nadjamuddin[3], Sudirman[3] and Aisyah Farhum[3]

[1]Doctoral Program of Agricultural Sciences, Hasanuddin University
Jl.Perintis Kemerdekaan Km.10 Makassar, Indonesia
[2]Fisheries and Marine Science Faculty, Darussalam University of Ambon
Jl Dusun Waehakila, Puncak Wara-Ambon,
Indonesia
[3] Faculty of Marine and Fisheries Sciences University of Hasanuddin Makassar Jl.
Perintis Kemerdekaan Km.10 Makassar, Indonesia

Abstract : Central Maluku regency has 484.5 million tonnes/year of potential of fishery resources with total allowable catch (TAC) of 387.3 million tonnes/year. Gill nets, one of the eco-friendly fishing gear classified by Food and Agriculture Organization, are commonly applied in Maluku waters for small-pelagic fish capturing, which includes yellowstripe scad (*Selaroides leptoleptis*). The availability yellowstripe scad's stock for ensuring the sutainability ultilization was investigate in this research, which performed by surplus production model. The results showed the stock (carrying capacity of the environment) of under-exploited with the available stock of 2.130.70 tonnes and the yield of 1769.23 tonnes, indicated the possibility of yield-increasing.
Keywords : sustainable, stock, yellowstirpe scad.

Introduction

The potential of capture fisheries resources of Indonesia was predicted to reach 6.5 million tonnes/year, (Ministry of Marine and Fisheries data of 2013), whereas this sector contributed to national economic growth of 6.5% in 2011 and 2012. Data in 2102 from Central Bureau of Statistic data indicated the magnitude of economic activity in fisheries sector which reached Rp 255.3 trillion. This figure potentially increaseswith an assumption of an increase in fisheries sector.

Central Maluku regency, covered by 136.12 thousand km^2 marine with 1.26 million Km coastline from 147.48 thousand km^2 area, potentially produces 484.5 thousand tonnes/year ofcaptured fishes with the total allowable catch (TAC) amounts to 387.3 thousand tonnes/year. However, only 41.3 thousand tonnes/yearwas utilized, generated by 14,134 fishermen that facilitated by 12,630 units of traditional canoe, 1,166 units of small-engine canoe, 324 units of moderate-engine canoe, 14 units of big-engine canoe and 682 units of motorboats.[3]

Gill net, an eco-friendly fishing gear classified by FAO, is commonly operated for small-pelagics capturing in Maluku waters. This is a rectangle-shaped tool, uniformed-mesh size and consists of with small floats, weights, upper- and lower line or upper line only. The drift gill nets, operated by sweeping a few dozensof mutually-coupled nets on the sea surface, are very popular for Indonesian fishermen with the main target of pelagics that horizontally migrate on the sea surface, such as skipjack tuna, indian mackerel, yellowstripe scad, bali sardinella, and fringescale sardinella [16].

The use of gill nets has impacted to decline the small pelagics fisheries in Indonesian,such as in Bali. An over-exploited of mature and immature fishes has led to reduce the fish stock, especially sardines, and emerged overfishing [17.] Thus, the widely-use of gillnets in Indonesia, especially for small pelagics, is potentially suspected as one of over-exploitation causes of small pelagics resources due to the net fishing activities have an impact on the decline in abundance, change in age structure, size and species composition, [5] and also the most abundant yield of fishing gear, [6] . Drift gill nets are basically same as the other gill nets, only the operation method is the difference[10]. The increase of fishing gears' mesh size should be concurrent with the fishing effort to preserve the species population , [9.] One of the factors that led to the abundance of the catch is the time of the arrest operation and growth. Growth influencespopulation dynamics through its effects on lifetime patterns of biomass production, natural and fishingmortality, and reproductive output [8.] Besides, the fishing time is one of the yield-affecting factors, assumed as the most abundant yield achieved in the mid-day, [16] .

The recent global fish stock is tended to be more severe,more than 20 percent have been lost, 40 percent have been captured, and the rest of 35 percent are over-exploited [3.] Most of fish species are estimated to become extinct and over-fished. This will affect not only the yields lower and earnings reduction, but also threatening for marine ecosystems. This might be due to the loss of ability to adapt and recover from external disturbance [15, 19].

The gill net use-related studies have been conducted to maintain the availability of fisheries stock, especially small pelagics, to be sustainable [16.] Investigated the sustainability stock of *Sardinella lemuru* in Bali strait, indicated an over-exploitation from the high abundance in there.
Yellowstripe scad, one of the small pelagics, is chosen as our sample in this study. This is drift gillnet-captured and high economic value for Maluku in habitats.

Objective

This study aimed to analyze the availability of yellowstripe scad stock to investigate whether over-exploitated or not.

Methods

Time and Location

This study was conducted in Central Maluku regency, and data collection was performed in January–March 2015. Look at on figure 1

Figure1: Map of Central Maluku regency

Type and Source of Data

The obtained data is secondary data from several related references and institutions that related to the study –i.e. Marine and Fisheries Department of Central Maluku. The secondary data analysis is performed by data collected from another people for the study, and a viable option for researchers who may have limited time and resources [18].

Data collection

The obtained datawere from the 2004–2013 annual yellowstripe scad yields, which is sourced from the five-year report of the yields.

Data analysis

The examination of stock availability based on ten years yield and the CPUE data of yellowstripe scad (2004 -2013) from the Marine and Fisheries Department of Central Maluku regency was conducted to indicate if the fish is over-fished or not. The estimation of fisheries potential based on biological and economic factors was often done by researchers using the Gordon-Schaefer bioeconomic [2]. The model of approach used to assess the availability of fish stocks by Clark [1] was the surplus production model. This model assumed the fish stock as the sum of biomass by the equation:

$$\frac{dx}{dt} = F(x)$$

= fish stock =function of the fish stock change

MSY was obtained using the following equation:

a. Fising effort (E)

$$E_{MSY} = \frac{\propto}{2\beta} = \frac{K_{qr}}{2kq^2} = \frac{r}{2q}$$

b. Production (H) in MSY level

$$H_{MSY} = \frac{\propto^2}{4\beta} = \frac{K^2q^2r}{4Kq^2} = \frac{Kr}{4}$$

c. Fish stock in MSY level

$$x_{MSY} = \frac{K}{2}$$

Which:

x

= fish stock

r = fish intrinsic growth rate

K = carrying capacity

Results and Discussion

Yellowstripe Scad Production

The total production ofyellowstripe scad in the past 10 years is shown in the following table 1:

Table 1. Yellowstripe scad production

Year	Production (tonnes)
2004	974
2005	1,331
2006	1,983
2007	2,580
2008	2,927
2009	1,693
2010	2,125
2011	2,250
2012	1,120
2013	2,451
Total	**19,434**

Source: Marine and Fisheries Department of Central Maluku, 2015

The table 1 presents the fluctuative production of yellowstripe scad. The increasing is experienced from 2004 to 2008, between 974 to 2,927 tonnes. However, the decrease has been experienced, reached only 1,693 in 2009 which is slightly different compared by 2005, then it reached 2,125 tonnes in 2010 but lower than 2007 and 2008. In 2012, the decrease was experienced again, produced only 1,120 tonnes, then increased in 2013 but not like previous years. According to [14], marine ecosystem might experience a time shift, which resulted in non-stationary of the fish populations dynamics. The Assumption of time-invariant parameters in the model of the stock recruitment possibly caused an error of forecasting the fish stock recovery which caused the shift in recruitment. The growth rate of yellowstripe scad in 2004–2013 is presented in the following figure 2.

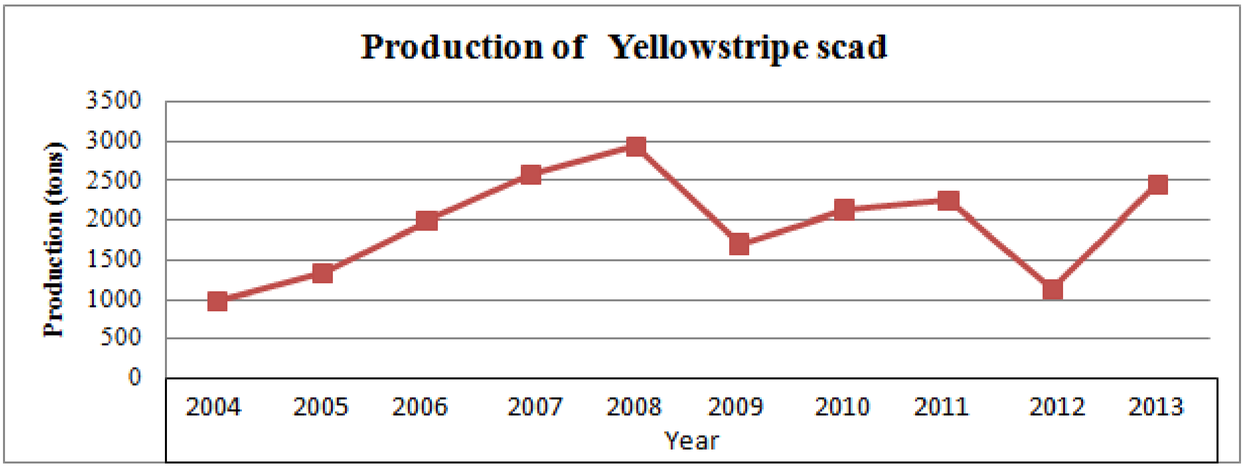


Figure 2.Production of yellowstripe scad on 2004 - 2013

Figure 2 above indicates the fluctuation (variation) of yellowstripe scad production in 2004–2014. The increases were experienced in 2004–2008, then decreased in 2009 and increased again in 2010 and 2011. In 2012, the production was fell down, then increased in 2013.

The fluctuative yield is suspected as the phenomenom of the climate change problems that affects to the marine environment, results in the adversity in fishing ground determination by fishermen, consequently affects to the yield. The impact of climate change is an anthropogenic-caused thus causes the decline in the marine productivity, the change in the food dynamics, the reduce in the habitat-forming species abundance, the shift in the species distributions, and the presence of various diseases. Although the uncertainty in explaining the spatial and temporal changes, climate change is the fundamental problem causes damage to marine ecosystems[6] . Stated it has a variation in the assessment based on the format, type of stock condition assessment, terminology and threshold used to describe the condition of fish stock and the classification of jurisdictional framework [11]. These complicate the efforts to determine the fish stockcondition, potentially create misunderstanding among public on how to interpret the information of the fish stock condition, fisheries management and more-general scienceprocess. This is especially true when considering the stock division in two or more jurisdictions. Find that the CPUE index can be a good empirical approximation for stock size changes in fisherieswith limited information [13] .

Comparison of Yellowstripe Scad Production and Effort

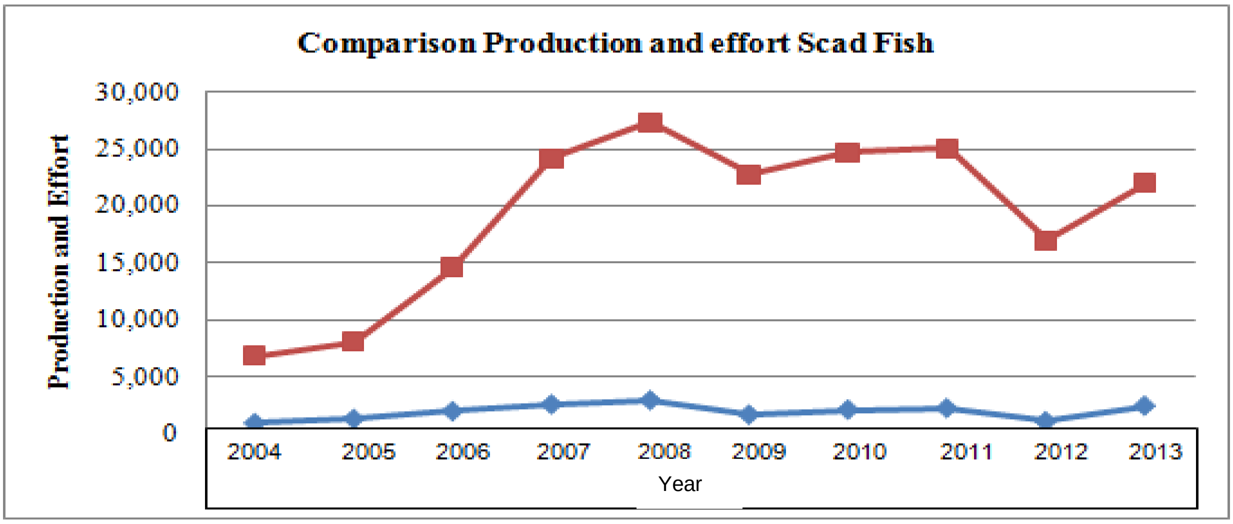
The total production and effort of yellowstripe scad in Central Maluku waters is presented in following table 2.

Table 2. Total Production and Effort of Yellowstripe Scad

Year	Production	Fishing effort
	Yellowstripe scad (Tonnes)	Yellowstripe scad (trip)
2004	974	6,810.34
2005	1,331	8,027.27
2006	1,983	14,530.58
2007	2,580	24,154.56
2008	2,927	27,280.01
2009	1,693	22,720.81
2010	2,125	24,620.19
2011	2,250	24,974.08
2012	1,120	16,919.21
2013	2,451	21,935.10
Total	**19,434**	**191,972.15**

Source: Marine and Fisheries Department of Central Maluku, 2015

The table 2 above indicates that the increase in total production 2004–2008 is accompanied by the increase in fishing effort of fishermen. Referring to the total catches in one year, the annual average production of large pelagics is 1,943 tonnes. The highest average of annual production is between 2012 and 2013, amounted to 1,331 tonnes, while the lowest is between 2008 and 2009, amounted to 347 tonnes.The fishing effort also has the fluctuative trend, described in data of 2004–2013. The annual average of fishing effort is 19,197.22 trips. The increase is experienced in 2006-2007, amounted to 9,623 trips and also increased to get the second highest production in 2007, amounted to 2,580 tonnes. Meanwhile, the lowest fishing effort is experienced in 2010-2011, amounted to 353.89 trips, while the yield only increased 125 tonnesat the same year. Look at following figure 3.



The figure 3 above shows the directly proportional of production and effort of yellowstripe scad between 2004 and 2013. This means the increase in fishing effort could alter the yield of yellowstripe scad in Central Maluku waters.

Estimation on Biological Parameters on yellowstripe scad

Biological parameters were estimated using a Gordon-Schaefer model. The parameters include: intrinsic growth rate (*r*), carrying capacity of environment (*K*) and fishing capacity coefficient (*q*). These results would be useful in determining the maximum sustainable yield (MSY). Intrinsic growth rate is the maximum rate at which the population will grow under ideal condition (e.g. limited resources, no competition, no predation, no environmental stress.

The results show the biological parameter for yellowstripe scad, e.g. intrinsic growth *r* of 3.102815537, *q* of 0.0000593930 and *K* of 2,280.813 tonnes (Table 3).

Table 3. Biological Parameters for yellowstripe scad

No.	Parameter	value
1	r	3.102815537
2	q	0.000059393
3	K (ton)	2,280.81

Source: Processed Data, 2016.

Estimation on Sustainable Yield of Yellowstripe Scad

The variables used for this MSY estimation are only in the form of biological parameters, performed by analysis on the yield and fishing effort. The results indicate that theproduction has been above the sustainablelimit, although in 2008 the production is still lower than the sustainable yield. The actual yield amounted to 1,588.80 tons, while the catch sustainable amounted to 1,765.75 tons. In 2009, the catch is sustainable amounted to 1,681.64 tons sedangan sustainable catches amounted to 1,739.26 tons, and in 2012 the actual catches amounted to 1,113.26 tonnes, while the estimated MSY amounted to 1,549.68 tonnes. The number of overall actual yield have exceeded MSY, where total yield in 2004-2013 isis amounted to 17,382.57 tonnes, greater than MSY of 15,092.39 tonnes. Likewise, the average of annual production is amounted to 1,738.26 tonnes/year, higher than MSY of 1,502.93 tonnes/year. Look at following table 4.

Table 4. Comparison of Actual Production and MSY ofyellowstripe scad

Year	**Yellowstripe scad**	
	Actual production (tonnes)	**MSY (tonnes)**
2004	956.56	802.29
2005	1,316.26	802.29
2006	1,965.42	1,420.89
2007	2,576.62	1,759.21
2008	1,588.80	1,765.75
2009	1,681.64	1,739.26
2010	1,847.07	1,763.39
2011	2,245.31	1,765.82
2012	1,113.26	1,549.68
2013	2,091.63	1,723.80
Total	**17.382.57**	**15.029,39**
Average	**1.738,26**	**1.502,93**

Source: Processed Data, 2016

To compare between actual production and MSY of yellowstripe scad a figure 4 is presented below.

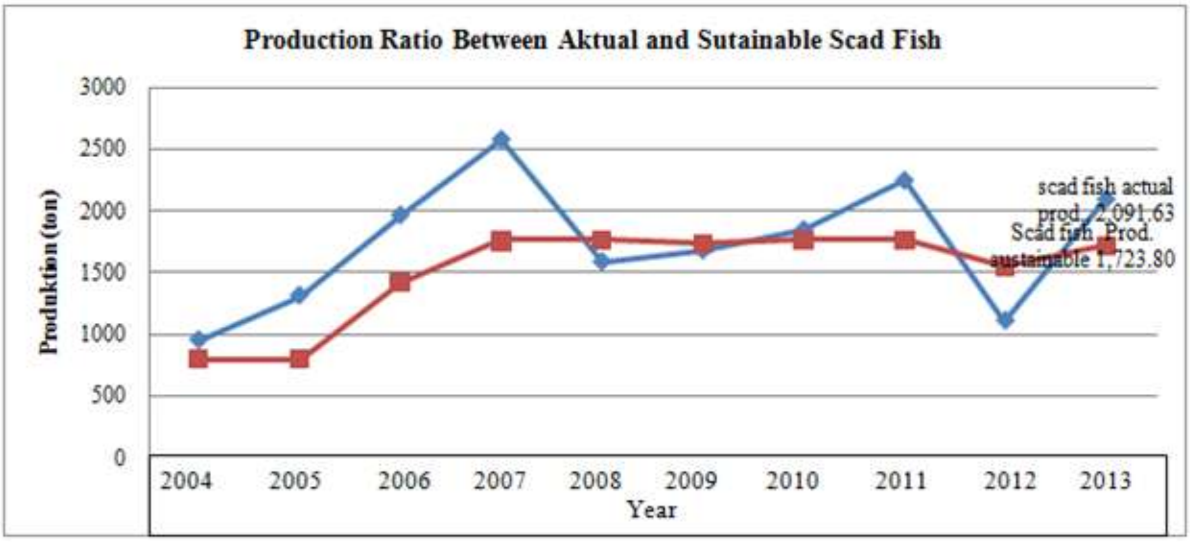


Figure 4. Comparison of actual production and MSY of yellowstripe scad

Analysis of Yellowstripe Scad Stock

The analysis on yellowstripe scad stock is needed in concern of the fisheries resources management, especially capture fisheries, theactual fish stock is a major threat for the sustainability, thus a good management could be major force for this challenge[12] . The analysis of fish stock is given in the following table 5.

Table 5. Analysis of Yellowstripe Scad Stock

Parameter	Fish Scad
X Stock (tonnes)	2,130.70
H Yield (tonnes)	1,769.23
E Fishing effort (trips)	26,121

Source: Proceed data, 2016.

The table 5 above shows that the yellowstripe scad stock is in accordance with the carrying capacity of environment, amounted to 2,130.70 tonnes of stock and 1,769. 23 tonnes of yield. Meanwhile, the fishing effort is amounted to 26,121 trips. The analysis indicates the lower yield compared to the stock availability in Central Maluku waters, shown by the yield of 1,729.23 tonnes and the available stock of 2,130.70 tonnes. This means that in the increase in fishing effort is still allowed in order to increase the yellowstripe scad production.

Conclusion

The yield of yellowstripe scad (*Selaroides leptoleptis*) in Central Maluku waters is still not exceeding the over-exploited limit due to the lower actual production compared by stock availability. In other words, the carrying capacity of environment still provides abundant stock of yellowstripe scad, tend to the increase in fishing effort in order to alter the production.

References

1. Clark, CW. 1976. Mathematical Bioeconomics: The Optimal Management of Renewable Resources. John Willey & Sons. New York.
2. Deli A, Muhammad S, Masbar R, and Asmawati,2016. Analizys Of Bioeconomic Environmental Interaction Model On The Sustainable Pelagic Fishery Resources In The Western Coast Of

Sumatera, Aceh Province, Indonesia. International Journal of Contemporary Applied Sciences Vol. 3, No. 3, March 2016 (ISSN: 2308-1365).

3. Department of Marine and Fisheries District central Maluku 2015. Fisheries Statistics Report, 2015.
4. Eggert H and Greaker M, 2009. Effects of Global Fisheries on Developing Countries. Possibilities for Income and Threat of Depletion. Discussion Paper Series, Environment for Development. January 2009 ,, EfD DP 09-02 .
5. Emmanuel B. E, Chukwu L.O, and L.O. Azeez, 2008. Gill net selectivity and catch rates of pelagic fish in tropical coastal lagoonal ecosystem. AfricanJournal of Biotechnology Vol. 7 (21), pp. 3962-.
6. Emmanuel B. E, 2010 Evaluating the selective performance of gillnets used in a tropical low brackish lagoon south – western, Nigeria**.**Journal of American Science, 2010;6(1).
7. Guldberg- Ove Hoegh and Bruno John F, 2010. The Impact of Climate Change on the World's Marine Ecosystems. *Science* 18 Jun 2010 Vol. 328, Issue 5985, pp. 1523-1528 DOI: 10.1126/science.1189930
8. Kai Lorenzen, 2016. Toward a new paradigm for growth modeling in fisheries stockassessments: Embracing plasticity and its consequences. G Model FISH-4334; No. of Pages 19. www.elsevier.com/locate/fishres
9. Montcho S. A, Agadjihouèdé H, Montchowui E, Lalèyè P. A. and Moreau J. 2015 Population parameters of Oreochromis niloticus (Cichlidae) recently introduced in lake Toho (Benin, West Africa) International Journal of Fisheries and Aquatic Studies 2015, ISSN: 2347-5129 IJFAS 2015; 2(3): 141-145 © 2015 IJFAS
10. Martasuganda, S. 2002. Gill net. Serial Fishing Technology Environmental. IPB Bogor. 69 p.
11. Matthew J. Flood, Ilona Stobutzki , James Andrews, Crispian Ashby, Gavin A.Begg, RickFletcher, CalebGardner, LeeGeorgeson, Scott Hansen, Klaas HartmannPatrick Hone,James Larcombe, Luke Maloney, Anthony Moore, Justin Roach, Anthony Roelofs, Keith Sainsbury, Thor Saunders, Sean Sloan, Anthony D.M. Smith, John Stewart, Carolyn Stewardson, Brent S. Wise. 2016. Multijurisdictional fisheries performance reporting: How Australia's nationally standardised approach to assessing stock status compares. Fisheries Research, Volume 183, November 2016, Pages 55 573.
12. Miles R, 2011. An Ecosystem Approach to Sustainable Production. Earth & Environment 6: pp 161-189. University of Leeds Press
13. Nguyen Ngoc Duy, Ola Flaaten, 2016. Efficiency analysis of fisheries using stock proxies. Fisheries Research 181 (2016) 102–113: www.elsevier.com/locate/fishres
14. Perala T. A., Swain D. P., Kuparinen A, 2016. Examining non-stationarity in the recruitment dynamics of fishes using Bayesian change point analysis. Canadian Journal of Fisheries and Aquatic Sciences, e-First Article doi: 10.139/cjfas-2016-0177.
15. Pauly, D, V. Christensen, S. Guénette, T.J. Pitcher, U.R. Sumaila, C.J. Walters, R. Watson, and D. Zeller. 2002. "Towards Sustainability in World Fisheries," Nature 418: 689–95
16. Puspita G, 2009. Changes in Physical Properties gill nets Eyes Used Hanyut After 5, 10, 15, and 20 Years. Department of Fisheries Resource Utilization, FPIK-IPB, Bogor, Indonesia. Science Research Journal Volume 12 Number 3 (D) 12310
17. Setyohadi D, Muhammad S, Marsoedi, Y. Risjani, Bintoro, G, 2013. Gillnet Selectivity and Mesh Size Regulation for Bali Sardine Fishery, (*Sardinella lemuru*) in Bali Strait. Journal of Applied Environmental and Biological Sciences 3(2)1-5.
18. Smith, A. K., Ayanian, J. Z., Covinsky, K. E., Landon, B. E., McCarthy, E. P., Wee, C. C., & Steinman, M. A. (2011). Conducting high-value secondary dataset analysis: An introductory guide and resources. Journal of General Internal Medicine, 28(8), 920- 929. doi:10.1007/s11606-010-1621-5
19. Worm, B., E.B. Barbier, N. Beaumont, J.E. Duffy, C. Folke, B. Halpern, J. Jackson, H. Lotze, F. Micheli, S.R. Palumbi, E. Sala, K.A. Selkoe, J.J. Stachowicz, and R. Watson. 2006. "Impacts of Biodiversity Loss on Ocean Ecosystem Services," Science 314: 787–90.

***** *****